Regional Review Workshop on Completed Research Activities

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Part 1: Agricultural Extension Research

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Table of Contents

Pre-Extension Demonstration of Teff Thresher in Selected Districts of Arsi and East Shoa zones

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Abstract

The research activity was carried out in three purposively selected districts namely Shirka, Tiyo from Arsi zone and Lume from east Shoa zones with the objectives of demonstrating and evaluating *teff thresher technology under farmers' management, creating awareness on the importance of the technology and estimating cost-benefit of the technology. Demonstration of Teff thresher was undertaken in comparison with traditional Teff threshing practice. The study was done on two treatments which were Teff threshing using machine and traditional way of threshing Teff. Then the process was replicated on six experimental sites. To facilitate further dissemination result demonstration method was followed to enable farmer`s to quickly compare demonstration`s result with those traditional practice and also method demonstration was used to show farmers step by step how technology work. Training was organized on Teff thresher technology; a total of 201 participants of which 141 (70%) were male and 60 (30%) female from three districts participated on both theoretical and practical training on Teff thresher technolog. Average threshing capacity of teff thresher was around sixteen (16.5) quintals eight working hours whereas threshing teff by traditional animal trembling it was about four point five (4.5) quintals eight working hours. The result of this finding indicates that mean comparison of labor to teff thresher technology to traditional teff threshing which was animal trembling. Teff thresher technology reduced from twelve people to four people which significant number. As far as animal labor were concerned: teff thresher technology reduced animal labor from 6 to zero. Feedbacks obtained from participant farmers, DAs and experts also asserted that the threshing machine has additional advantages of reducing post-harvest losses grain and straw quality. Thus, based on these evidences the teff thresher technology was recommended for further scaling up in teff producing areas.*

Key words: *Demonstration, Teff Thresher, Threshing and Labor.*

INTRODUCTION

Threshing is one of the postharvest operations that are 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 et. al., (2008). Moreover, time and labor required to thresh teff are high and farmers regard this activity as arduous but yet unavoidable.

Use of the mechanical thresher significantly reduces grain losses as compared to traditional method. The traditional way of teff threshing is associated with high losses which are found to be about 83 kg per 1 ton of cereals threshed. Asfaw et. al., (2010) and Dejene et. al., (2008) estimated the loss in traditional threshing up to about 10% of the produce.

The Teff Thresher's social impact is three pronged, creating more prosperous communities, more education opportunities, and healthier grain production. Firstly, the Teff Thresher boosts teff production, increasing agricultural prosperity and self-sustainability and reducing

poverty. The product will also spur the formation of local micro businesses that sell the machines or provide services for other farmers. Secondly, the Teff Thresher will prevent children from being removed from school during the harvest. Finally, the Teff Thresher will produce a safer, more hygienic grain, improving the health of a majority of the population in Ethiopia.

To minimize above stated problem and avail technology Asela Agricultural Engineering Research Center fabricated and evaluated Teff thresher that has threshing capacity of 200kg/hr, threshing efficiency of 100% and cleaning efficiency 86-97% based on feed rate and drum speed. Despite having these all advantage teff thresher was not demonstrated to farmers of Arsi and East Shoa zones.

Therefore, this research was intended to demonstrate teff thresher in Arsi and East Shoa zones.

Objectives

- To demonstrate and evaluate teff thresher technology under farmers' management
- To create awareness on the importance of the technology
- To estimate cost-benefit of the technology

Material and methods

Materials

Materials used to conduct pre-extension demonstration of Teff thresher technology were Teff thresher, Stopwatch and Balance.

Methods

Site selection

Demonstration of teff thresher, selection of PAs and participant farmers should follow certain procedures. The first step was contact of zone's office of agriculture. Then contact district's office of agriculture. Finally discussion was held on objectives of the demonstration, criteria for the selection of district, and explains the criteria to select representative PAs. For the purpose of this study Tiyo, Shirka and Lume districts were purposively selected because of their Teff production potential and accessibility from Arsi and East Shoa zones respectively.

Kebele selection: Selection of appropriate kebeles were took into consideration applicability of technology, accessibility of kebeles to the road for implementation of the activity, demonstration/result diffusion to other non-participant farmers and representativeness of kebele to other similar kebeles around the selected kebele for further diffusion of the technology through field days. Taking into consideration these criteria six kebeles two from each district were selected for the accomplishment of this study.

Farmers Selection: two types of farmers were selected as hosting and participant farmers. Selections of hosting farmers were done with the involvement of all member farmers, DAs and representative district expert after thorough discussion. Selections of demonstration member farmers were done in collaboration with respective Development Agents (DAs). Farmers were selected based on willingness to participate on every stage of the demonstration, innovativeness of the farmer willingness to allocate resource for the demonstration purposes, willingness for cost sharing, willingness to share knowledge and experience among others and gender balance. For the purpose of this study six hosting one from each kebele with fourteen members were selected.

Technology evaluation and demonstration method/techniques

Demonstration of Teff thresher was undertaken in comparison with traditional Teff threshing practice. The study was done on two treatments which were machine threshing and traditional way of threshing Teff. Then the process was replicated on six experimental sites. To facilitate further dissemination result demonstration method was followed to enable farmer`s to quickly compare demonstration`s result with those traditional practice and also method demonstration was used to show farmers step by step how technology work. In demonstration process the mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day.

Data types and Method of data collection

The 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, 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, and farmers' opinion was collected using data collection method/technique such as field observation, household/participant interview, focus group discussion.

Method of Data analysis

The study was employed simple statistical analytical tools like mean values for data analysis. Economic return/profitability of the technology was analyzed using partial budgeting

Result and Discusion

Training of farmers and stakeholders

The implementation of this research activity used training on knowledge, skill and attitude was the main methods that used to create awareness on Teff Thresher technology among farmers, to enable farmers', DAs' and experts' on Teff thresher technology. Thus, multidisciplinary team consists of Engineers`, Extensionist and Socio-economist were organized to deliver the training in capacity building and facilitating extension efforts of Teff thresher technology.

On organized training on Teff thresher technology; a total of 201 participant of which 141 (70%) were male and 60 (30%) female from three districts participated on both theoretical and practical training on Teff thresher technology (Table 1). The training was mainly focused on how to operate technology, relative advantage of technology over local practice.

Table 1. Training to stakeholders on Teff thresher technology.

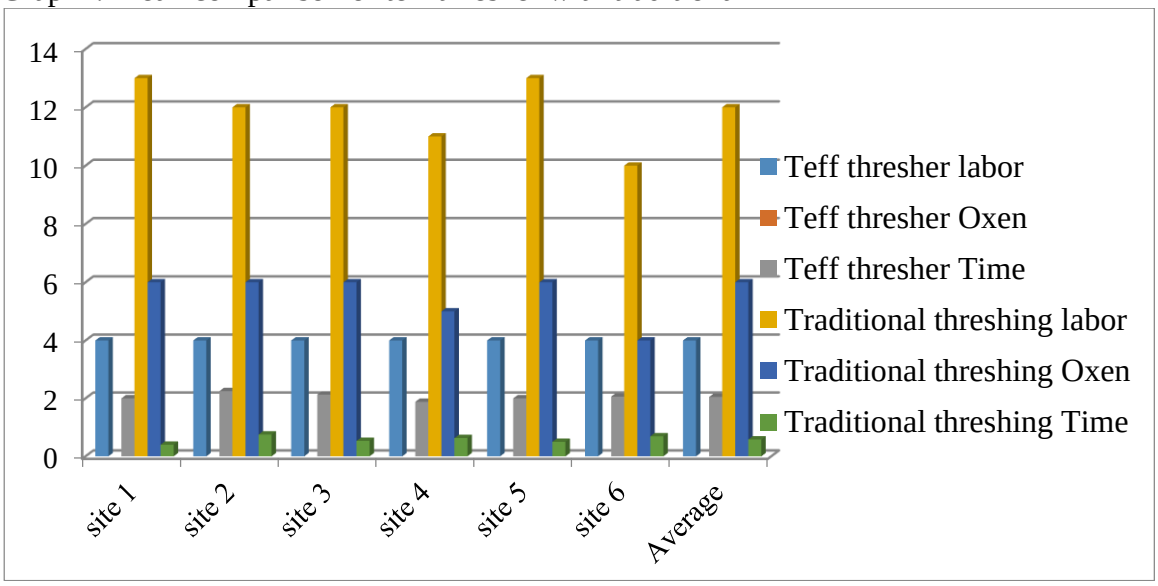
Disticts	Description of participants	Male	Female	Total
Tiyo	Farmers	45	15	60
	Agricultural Experts	4	-	4
	Development agents	3	1	4
	Supervisor	3	1	4
Shirka	Farmers	35	20	55
	Agricultural Experts	4	-	4
	Development agents	2	2	4
	Supervisor	4	-	4
Lume	Farmers	30	20	50
	Agricultural Experts	4	-	4
	Development agents	3	1	4
	Supervisor	4	-	4
Grand total		**141**	**60**	**201**

Source: Own computed data 2022

Threshing capacity of technology

The most important factors influencing threshing capacity of teff thresher technology were; crop moisture content, feeding rate, grain straw ratio, crop sheaf length, performance of the operator and others. As indicated in the graph below the average threshing capacity of teff thresher was around sixteen (16.5) quintals per eight working hours whereas threshing teff by traditional animal trembling it was about four point five (4.5) quintals per eight working hours. The result of this finding indicates that mean comparison of labor to teff thresher technology to traditional teff threshing which was animal trembling. Teff thresher technology reduced labor force needed from twelve people to four people which was significant number. As far as animal labor were concerned: teff thresher technology reduced animal labor from 6 to zero.

Graph1. Mean comparison of teff thresher with traditional



Source: Own computed data 2022

Profitability analysis of Teff thresher

The Profitability analyses of Teff thresher technology was calculated using partial budget analysis which is useful tools in the decision process and manage to decide on alternative uses of resources. As result shown in the following table the net return obtained from deduction of increased income from increased cost due to introduction of Teff thresher technology. Thus, Teff producer obtained net benefit of five thousand birr (5000) from one hectare land.

Table 2: Economic analysis using partial budget analysis

Column 1 **ısed income due to change**:	**Column 2** **ısed costs due to change:**
Income increased due to decreased crop lose: 3.5quintals X 4700Birr=16,450 Birr/ha Subtotal = 16,450 Birr	**Cost increased due to purchase of machine:** **15,000Birr** Subtotal = 15,000Birr
Reduced costs due to change: Reduced labor cost: 8 Person X 200 Birr = 1,600 Birr/hec. Reduced cost of oxen 13 oxen X 150 Birr = 1,950 Birr/hec Subtotal = 20,000 Birr	Reduced income due to change: **Subtotal = 15,000Birr**
Change in income: **(subtotal from Column 1 minus subtotal Column 2)** **20,000 – 15,000 = (5,000)**	

Source: Own computed data 2022

Farmers` perception

Five scales likert scale method was used to measure respondent's opinion/views towards the new technology with respect to traditional way of teff threshing. Among the farmer interviewed about 62%, 25%, & 5% of participant farmers were responded that the operation of machine was very simple, simple and medium to operate the teff thresher technology respectively. Whereas about 4% and 4% of the respondents were responded that it was difficult and very difficult to operate and teff thresher technology and requires some modification on the technology. As far as maintenance of the technology was concerned; about 42%, 40% & 7.5% of respondent farmers were responded that the maintenance of technology was very simple, simple and medium respectively to maintain teff thresher technology. Whereas about 7.5% and 3% of the respondents were responded that it was difficult and very difficult to maintain technology. In addition to that about 32%, 38.3% and 23% of the respondent farmers also indicated that the affordability of the technology was very high, high and medium respectively. Whereas only 6.5% of respondents were responded that it was low to afford technology.

Table 2.Farmer's response towards the technology

No	ria	Attributes	No of respondent	Percentage (%)
1	f operation	Very simple	125	62
		Simple	50	25
		Medium	10	5
		Difficult		4
		Very difficult		4
2	Maintenance	Very simple	85	42
		Simple	80	40
		Medium	15	7.5
		Difficult	15	7.5
		Very difficult	6	3
3	Price to afford technology	Very high	65	32
		High	77	38.3
		Medium	46	23
		Low		6.5
		Very low		-

Source: Own computed data 2022

Conclusion and Recommendation

The demonstration of teff thresher technology was conducted to evaluate and demonstrate the machine. Demonstration of Teff thresher was undertaken in comparison with traditional Teff threshing practice. The study was done on two treatments which were Teff threshing and traditional way of threshing Teff. Then the process was replicated on six experimental sites. Result demonstration method was followed to enable farmer`s to quickly compare demonstration`s result with those traditional practice and also method demonstration was used to show farmers step by step how technology work. The net return obtained from deduction of increased income from increased cost due to introduction of Teff thresher technology. Thus, Teff producer obtained net benefit of five thousand birr (5000) from one hectare land. The demonstration result indicated that the demonstrated machine had much advantage over the traditional threshing system interims of threshing capacity and reducing labor costs required for threshing and cleaning. Feedbacks obtained from participant farmers, DAs and experts also asserted that the threshing machine has additional advantages of reducing post-harvest losses grain and straw quality. Thus, based on these evidences the teff thresher technology was recommended for further scaling up in teff producing areas.

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Pre-Extension Demonstration of Small-Scale Wood Gas Stove for House Hold Purpose in Selected Districts of Arsi

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Abstract
The research activity was carried out in three purposively selected districts namely Muness, Tiyo and Digelu Tijo from Arsi zone with the objectives of d*emonstrating and evaluating small scale wood gas stove technology under farmers' management, create awareness on the importance of the technology, enhance stakeholder's linkage and estimate cost-benefit of the technology. Demonstration of small scale wood gas stove was undertaken in comparison with traditional three stone cooking stove. Then the process was replicated on six experimental sites. To facilitate further dissemination result demonstration method was followed to enable farmer`s to quickly compare demonstration`s result with those traditional practice and also method demonstration was used to show farmers step by step how technology work. Training was organized on wood gas stove technology; a total of 205 participants of which 60 (29.27%) were male and 145 (70.73%) female from three districts participated on both theoretical and practical training on wood gas stove technology. Biomass use efficiency of small scale wood gas stove technology was done in comparison to traditional three stone Cooking stove (TSCS). The result of this finding indicated that mean biomass consumption of small scale wood gas stove was 0.96 kg to boil five liters of water in metal pan. Whereas mean biomass consumption of traditional three stone cooking stove (TSCS) was 1.54 kg which was significant number. To boil the amount of water; small scale wood gas stove took 10.7 minutes. Whereas traditional three stone cooking stove (TSCS) took 15 minutes. Feedbacks obtained from participant farmers, DAs and experts also asserted that the small scale wood gas stove has additional advantages of reducing energy consumption and time. Thus, based on these evidences small scale wood gas stove was recommended for further scaling up.*
Key words: *Demonstration, small scale wood gas stove, traditional three stone cooking stove, Biomass and Time.*

INRODUCTION

There is strong scientific evidence that the average temperature of the earth's surface is rising. This was a result of the increased concentration of carbon dioxide (CO2), and other greenhouse gases (GHGs) in the atmosphere as released by burning fossil fuels Abdeen, M.O. (2008). This global warming will eventually lead to substantial changes in the world's climate, which will, in turn, have a major impact on human life and the environment.

The key factors to reducing and controlling CO2, which is the major contributor to global warming, are the use of alternative approaches to energy generation and the exploration of how these alternatives are used today and may be used in the future as green energy sources.

The development of micro-gasification is relatively new in the cooking energy sector. Many stakeholders are not yet aware of the potentials and challenges of revolutionizing the way we make fire to cook food. A gasifier cook stove powered by *wood-gas* from dry solid biomass shows great promise for making an important contribution to the goal of reducing the negative health-effects of household air pollution from cooking (Christa Roth, 2013).

There is growing concern about the negative health effects of smoke from open fires and rudimentary cook stoves operated with solid biomass or coal. In the last few decades, since indoor air pollution is understood as chronic health problem, many improved wood stoves have been developed and promoted to developing world by different organizations. Although, there is improvement in indoor air pollution problems, still there are gaps to be filled. There is an ardent quest to shift to cleaner fuels such as LPG or electricity for the sake of health. However, for billions of poorer households, this will not be a realistic scenario for years to come. We have to accept the fact that solid biomass will be the cooking fuel of choice for many of these households for the future decades. On account of their clean and efficient *combustion* of biomass, gasifiers do have the potential to bridge this gap and offer users the convenience of cooking with gas derived from the solid biomass fuels (Christa Roth, 2013).

Gas cooking is advantageous compared to direct combustion improved cook stoves (ICS) by providing cleaner burning of solid biomass (considerable reduction of soot, black carbon and indoor / outdoor air pollution), fuel efficient due to more complete combustion (less total biomass consumption), use a variety of small-sized biomass residues (no need for stick-wood or charcoal) and easy lighting allows for cooking to commence within minutes (T.B.Reed and Ronal Larson, 1996).

The gasifiers available, an inverted (top burning) downdraft gasifier can be used for indoor cooking practice because it can be made in different sizes. The major advantage of the inverted downdraft gasifier is that the rate of gas production depends on the amount of primary air admitted to the bottom and it can be practiced indoor cooking purpose.

To minimize above stated problem and avail technology Asela Agricultural Engineering Research Center fabricated and evaluated wood Gas Stove that can improve the thermal efficiency by 54% during high power tests and 36% in low power test when compared with Traditional three stone cooking stove (TSCS). Comparing the mean the power controllability of the tested stove WGS performs better than TSCS by 26%. The stove performed better than TSCS for all performance indicators of thermal parameters.

Therefore, this study was initiated with the objectives of demonstrating wood Gas Stove technology to farmers of selected districts.

Objective

- To demonstrate and evaluate wood Gas stove technology under farmers' management
- To create awareness on the importance of the technology
- To estimate cost-benefit of the technology

Material and methods

Materials

Materials and apparatus used for this experiment were: Wood Gas Stove- fabricated in AAERC work shop from different size and type mild steel materials purchased from local market, Three stone cooking stove (TSCS)-locally prepared, Stainless steel Cooking vessel-purchased from local market, stopwatch, Balance and Fuel wood.

Method

Site selection

Demonstration of Wood gas stove, selection of PAs and participant farmers should follow certain procedures. The first step was contact zone's office of agriculture. Then contact district's office of agriculture. Finally discussion was held on objectives of the demonstration, criteria for the selection of district, and explains the criteria to select representative PAs. For the purpose of this study Tiyo, Munessa and Digelu Tijo districts were purposively selected because of their biomass potential and accessibility from Arsi zone.

Kebele selection: Selection of appropriate kebele was taking into consideration applicability of technology, accessibility of kebeles to the road for implementation of the activity, demonstration/result diffusion to other non-participant farmers and representativeness of PAs to other similar PAs around the selected PA for further diffusion of the technology through field days. Taking into consideration these criteria six kebeles two from each district were selected for the accomplishment this study.

Farmers Selection: two types of farmers had been selected as hosting and participant farmers. Selection of hosting farmers was undertaken with the involvement of all member farmers, DAs and representative district expert after thorough discussion. Selections of demonstration member farmers were done in collaboration with respective Development Agents (DAs). Farmers were selected based on willingness to participate on every stage of the demonstration, innovativeness of the farmer willingness to allocate resource for the demonstration purposes, willingness for cost sharing, willingness to share knowledge and experience among others and gender balance. For the purpose of this study six hosting one from each kebele with ninety members were selected.

Technology evaluation and demonstration method/techniques

Demonstration of wood gas stove technology was undertaken in comparison with traditional three stone Cooking stove. The study was done on two treatments which were wood gas stove and traditional three stone stoves. Then the process was replicated on six experimental sites. To facilitate further dissemination result demonstration method was followed to enables farmer`s to quickly compare demonstration`s result with those traditional practice and also method demonstration was used to show farmers step by step how technology work. In demonstration process the mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day.

Method of data collection

The 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, fuel consumption, 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, skill of farmers and 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

Based on data to be collected, the study was employed simple statistical analytical tools like mean values for data analysis.
Economic return/profitability of the technology was analyzed using partial budgeting

Results and Discussions

Training for farmers and extension workers

The implementation of this research activity use training on knowledge, skill and attitude was the main methods that used to create awareness on wood gas stove technology among farmers, to enable farmers', DAs' and experts' on wood gas stove technology. Thus, multidisciplinary team consists of Engineers`, Extensionist and Socio-economist was organized to deliver the training in capacity building and facilitating extension efforts of wood gas stove technology.

On organized training on wood gas stove technology; a total of 205 participant of which 60 (29.27%) were male and 145 (70.73%) female from three districts participated on both theoretical and practical training on wood gas stove technology. The training was mainly focused on how to operate technology, relative advantage of technology over local practice.

Table1. Training given to farmers and extension workers

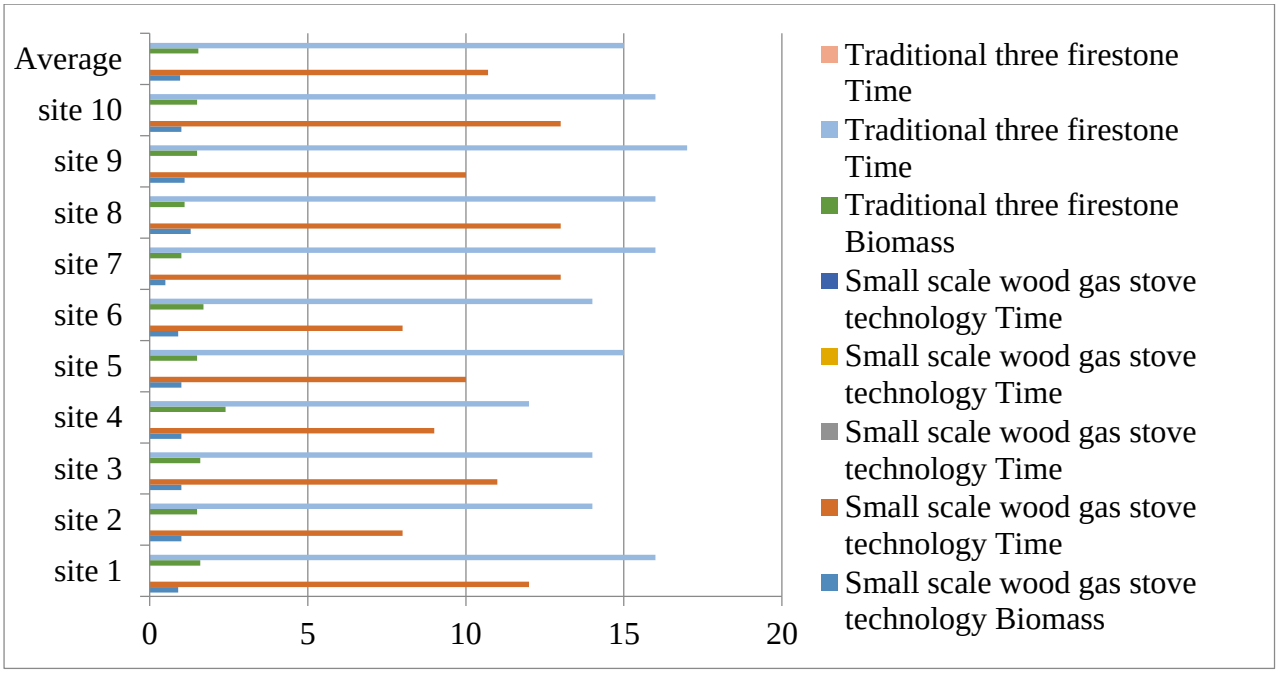
Districts		Male	Female	Total
Digelu-Tijo	Farmers	10	50	60
	Development agent	3	1	4
	Supervisors	2	-	2
	Expert	3	1	4
Munessa	Farmers	15	45	60
	Development agent	2	2	4
	Supervisors	2	-	2
	Expert	4	-	4
Tiyo	Farmers	10	45	55
	Development agent	4	-	4
	Supervisors	2	-	2
	Expert	3	1	4
Grand Total		**60**	**145**	**205**

Source: Own computed data 2022

Biomass use efficiency of the technology

Biomass use efficiency of small scale wood gas stove technology was done in comparison to traditional three stone Cooking stove (TSCS). The result of this finding indicated that mean biomass consumption of small scale wood gas stove was 0.96 kg to boil five liters of water in metal pan. Whereas mean biomass consumption of traditional three stone cooking stove (TSCS) was 1.54 kg which was significant number. To boil the amount of water; small scale wood gas stove took 10.7 minutes. Whereas traditional three stone cooking stove (TSCS) took 15 minutes.

Graph 1. Mean comparison of biomass and time for small scale wood gas stove and traditional three fire stone stove



Source: Own computed data 2022

Profitability analysis of Small scale wood gas stove

The Profitability analyses of Small scale wood gas stove was calculated using partial budget analysis which is useful tools in the decision process and manage to decide on alternative uses of resources. As result shown in the following table the net return obtained from deduction of increased income from increased cost due to introduction of Small scale wood gas stove technology. Thus, because of these farmers obtained net benefit of fifty birr per month.

Table 2: Economic analysis using partial budget analysis

Column 1 **ısed income due to change**:	**Column 2** **ısed costs due to change:**
Income increased due to decreased biomass: 2 Bundles X 200 Birr=400 Birr/month Subtotal = 400 Birr Reduced costs due to change: Reduced labor cost: 1 Person X 2 weeks X 200 Birr = 400 Birr/month. Subtotal = 800 Birr **Change in income:** **(subtotal from Column 1 minus subtotal Column 2)** **800 – 7500 = (50)**	**Cost increased due to purchase of machine:** **750 Birr** Subtotal = **750** Birr Reduced income due to change: **Subtotal = 750 Birr**

Source: Own computed data 2022

Farmer perception

Five scales likert scale method was used to measure respondent's opinion/views towards the new technology with respect to traditional practice. Among the farmer interviewed about 75.6%, 19.5%, & 4.9% of participant farmers were responded that the operation of machine was very simple, simple and medium to operate the small scale wood gas stove technology respectively. Whereas none of the participant respondents were responded that it was difficult and very difficult to operate the technology. As far as maintenance of the technology was concerned; about 65.8%, 30.7% & 3.4% of respondent farmers were responded that the maintenance of technology was very simple, simple and medium respectively. Whereas about none of the participant respondents were responded that it was difficult and very difficult to maintain technology. In addition to that about 31.7%, 27.3%, 24.9% and 8.8% of the respondent farmers also indicated that the affordability of the technology was low, medium, very low and high respectively. Whereas only 7.3% of respondents were responded that it was very high to afford technology.

Table 3. Farmer's response towards the technology

No	ria	Attributes	No of respondent	Percentage (%)
1	of operation	Very simple	155	75.6
		Simple	40	19.5
		Medium	10	4.9
		Difficult		-
		Very difficult		-
2	Maintenance	Very simple	135	65.8
		Simple	63	30.7
		Medium	7	3.4
		Difficult	-	-
		Very difficult	-	-
3	Price to afford technology	Very high	15	7.3
		High	18	8.8
		Medium	56	27.3
		Low		31.7
		Very low		24.9

Source: Own computed data 2022

Conclusion and Recommendation

The demonstration of small scale wood gas stove technology was conducted to evaluate and demonstrate the technology. Demonstration of small scale wood gas stove was undertaken in comparison with traditional three stone cooking stove. Then the process was replicated on six experimental sites. To facilitate further dissemination result demonstration method was followed to enable farmer`s to quickly compare demonstration`s result with those traditional practice and also method demonstration was used to show farmers step by step how technology work. Training was organized on wood gas stove technology; a total of 205 participants of which 60 (29.27%) were male and 145 (70.73%) female from three districts participated on both theoretical and practical training on wood gas stove technology. Biomass use efficiency of small scale wood gas stove technology was done in comparison to traditional three stone Cooking stove (TSCS). The result of this finding indicated that mean biomass consumption of small scale wood gas stove was 0.96 kg to boil five liters of water in

metal pan. Whereas mean biomass consumption of traditional three stone cooking stove (TSCS) was 1.54 kg which was significant number. To boil the amount of water; small scale wood gas stove took 10.7 minutes. Whereas traditional three stone cooking stove (TSCS) took 15 minutes. Feedbacks obtained from participant farmers, DAs and experts also asserted that the small scale wood gas stove has additional advantages of reducing energy consumption and time. Thus, based on these evidences the small scale wood gas stove technology was recommended for further scaling up.

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Pre-Extension Demonstration of Early Maturing Coriander Variety at Selected Districts of East Shewa Zone, Central Rift Valley of Oromia, Ethiopia

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Abstract

Participatory demonstration and evaluation of newly released early maturing coriander variety named Batu has been conducted in selected districts of East Shewa zone, Oromia, Ethiopia for creating awareness on the early maturing coriander variety and to evaluate the yield and financial performance of the variety under farmers condition and to improve farmers knowledge on coriander production and management. Trial farmers were selected in two districts Dugda and Adami Tulu districts based on interest and willingness to allocate required amount of land size. Thus, the variety was sown along with its standard check side by side on 12 trial farmers' fields. Accordingly, the combined analysis results of the independent sample t-test indicate that there is a statistically significant yield difference at ($p<0.05$) between the varieties. Better yield of 8.6 qt/ha was obtained from Batu variety followed by the standard check walta'i which was, 7.05qt/ha. Furthermore, Batu variety has shown better yield advantage of 16.7% and financial return of 73,300 Ethiopian birr when compared with its check. In-terms of yield gap there is a minimum yield between the demonstration yield (1.35qt/ha) and the potential yield expressed during the variety release. Revealing a comparable performance between on-station and on farm yields. Thus, further scaling up works on Batu variety is recommended for similar agro ecologies.

Key words: Coriander, Batu , Demonstration , Early Maturing **,** East shewa

Introduction

Coriander (Coriandrum sativum L) is an annual and herbaceous plant, belonging to the Apiaceae family (carrot family) is mainly cultivated from its seeds throughout the year (Mhemdi et al., 2011 It was originated from the Mediterranean and Middle Eastern regions and known as medicinal plants. It contains an essential oil (0.03 to 2.6%) (Nadeem et al., 2013). All parts of this herb are in use as flavouring agent and/or as traditional remedies for the treatment of different disorders in the folk medicine systems of different civilizations (Sahib et al., 2012). Coriander closely resembles flat leaf parsley. This resemblance makes many people confused between the two however, coriander has strong fragrance and parsley has mild fragrance. It grows best in dry climates however it can grow in any type of soil like light, well drained, moist, loamy soil, and light to heavy black soil (Verma et al., 2011). Coriander is the most important seed spice crop cultivated throughout the world both for seed and leaf purpose (Morales Payan, 2011). Coriander has been used in medicines for thousands of years (Mathias, 1994). Various parts of this plant such as leaves, flower seed, and fruit, possess antioxidant activity, diuretic, anti-diabetic, sedative, anti-microbial activity, anti-convulsant activity, hypnotic activity and anthelmintic activity and anti-mutagenic (Pathak et al., 2011;Rajeshwari and Andallu, 2011).

The mature fruits, commonly named as seeds and the fresh green herb are the economically important parts of the coriander plant. These may be consumed directly or indirectly used for other purposes after processing; however, the two products are different in odor and flavor

(Williams et al., 1991). Coriander seed is widely used as a spice in diversified societies of the country and its seed is found in every market at a high price.

India is the biggest producer, consumer and exporter of coriander in the world with an annual production of around three hundred thousand tonnes. In Ethiopian Context, the leaves and the immature fruits of coriander, are used as an ingredient for the preparation of ‘‘data’’, a traditional spice eaten together with meat and fish. Due to the mild sweet test of the essential oil, it can be used as a starting material in many products (Diederichsen, 1996), the fatty oil is used as an ingredient for the manufacturing of high grade engineering plastics (IENICA Summary Report for the European Union, 2000). In addition, it can be used in honey bee production due to its reproductive biology which produces huge amount of nectar (Romanenko et al., 1991).

Coriander also plays an important role in the Ethiopia domestic spice trade and its seed used for the flavouring of berbere ,injera ,cakes and bread and its leaves added as an aromatic herb to ‘wot’ and tea (Jansen,1981). Yet, the cultivation of coriander is limited to the highlands (1500-2500m.a.s.l), although it can be cultivated in the lowlands if the rain fall is sufficient and it can be grown in the same areas as wheat, barley, sorghum and teff (Jansen.1981). To this end, in its effort to release new spice varieties Adami Tulu Agricultural Research Center has released in 2018 two coriander varieties which are early and middle maturing are as described in the following table.

Characteristics	**Tulu**	**Batu**
Days to Maturity	120	97
Altitude (m.a.s.l.)	1600-2500	1500-2000
Rainfall (mm)	750-1500	700-1200
Yield (qt/ha)	13.5	7.95

The varieties released are, high yielding, disease resistant, have less fertilizer requirement, and moderate lodging ability. Given these characteristics, this proposal was initiated to demonstrate one of the varieties named as Batu, (Early maturing one) to the farming communities in the lowland agro-ecologies of selected districts of East Shewa zone, central rift valley of Oromia, Ethiopia.

Objectives

- To create awareness on the early maturing coriander variety
- To evaluate yield performance of the variety under farmers’ condition
- To improve farmers knowledge on coriander production and management
- To see the financial return of the coriander production in the study area

Materials and methods

Description of the study areas

The study was conducted in selected districts 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 10 districts within the zone. among which Dugda and Adami Tulu Jiddo Kombolcha districts are the study districts where this demonstration activity took place.

Dugda district is located at 135km from the capital city of Ethiopia, Addis Ababa and 100km from Oromia region and East Shewa’s zonal capital Adama. The district covers 5.2% of East Shewa zone with area of 751km2. Dugda has 18 Kebele’s among which one kebele was used

for this study. The district has an average 636mm annual rainfall and 26ocaverage temperature. The major crops produced are wheat, teff and maize

Adami Tulu Jido Kombolcha district is located at 160 km from the capital city of Ethiopia, Addis Ababa and 115 km from Oromia region 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.

Map of the study area (Dugda and Adami Tulu Jiddo Kombolcha)

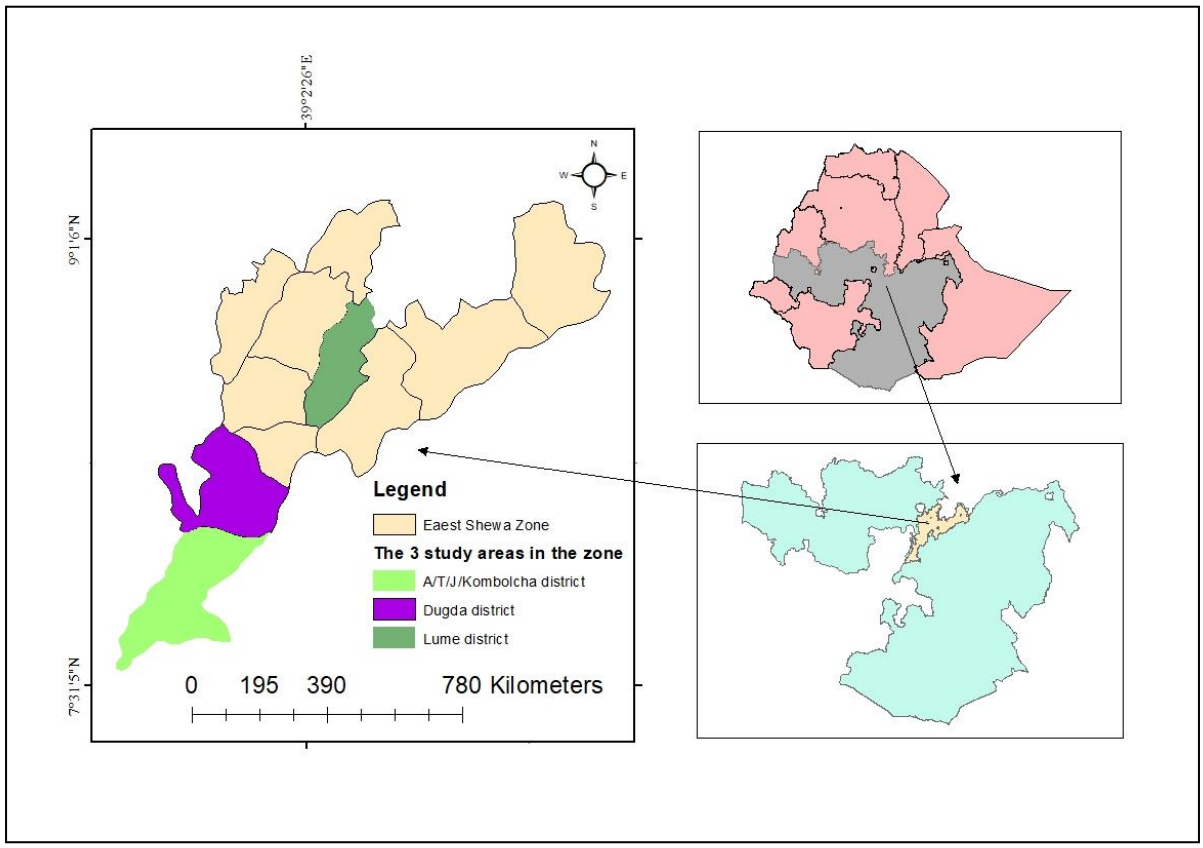

Figure: Map of the study area

Site and Farmers selection

Sites were selected in collaboration with district offices of Agriculture. Two districts were involved (Dugda and Adami Tulu Jiddo Kombolcha). In each district 2 Kebele's were selected, so a total of 4 Kebele's were selected in the two districts. One FRG (Farmers research group) having 15 farmers was organised in each Kebele among which 3 were trial farmers. Totally, the demonstration activity involved twelve (12) trial farmers.

Planting materials: From the Two previously released coriander varieties one (Batu Variety) was used which is early maturing and required amount of seed was multiplied.

Agronomic management
The variety was on a land size 10x10 per farmer along with standard check for comparison. Land was ploughed using oxen and packaged production and management technologies and practices (seed rate, spacing and weed management, fertilizer rate) recommended for coriander production were used as Seed rate of 10kg/ha, Fertilizer rate 100kg NPS, Spacing of 30cm between rows and Hand weeding/twice/ were used.

Awareness Creation
Training about coriander production and management was provided before commencing the activity.

Data collected
Grain yield, costs incurred and revenues gained, total number of farmers by gender participated in trainings, and Farmers' feedbacks were collected.

Data analysis
The collected grain yield was analyzed using descriptive statistics. Independent t-test was used. Other quantitative gender disaggregated data were described using tables. Farmer feed backs were summarized qualitatively and described using tabular presentations.

Furthermore, Yield advantage was calculated using the formula

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

The technology gap (Yield gap) and technology index was also calculated using the formulas as given by (Samui et al., 2000). The technology gap (Yield gap) shows the gap in the demonstration yield over potential yield. The yield gaps can also be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the value of technology index the more the feasibility of the varieties. The following is the formula used for yield gap/ technology gap and technology index calculations

$$\text{Technology gap} = \text{Potential yield qt/ha} - \text{demonstration yield}$$

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

Result and Discussion

Awareness Creation

Before planting training was provided for all participating farmers including host and non-host/ follower farmers, DA's and district experts. To this end, a total of 98 farmers, 12 DA and 4SMS and 22 other stakeholders participated

Table 1: Number of farmers and other participants trained

Parameter		Farmers	DA's	SMS	Others	Total	
						Frequency	Percent
Sex	M	81	7	4	19	111	78.4
	F	17	5	0	2	24	21.6
	Total	98	12	4	21	135	100.0

Yield performance

The demonstrated varieties were compared in terms of their yield performances across the two districts. The yield data was collected from the demonstration fields of all involved trial farmers. Accordingly, the combined analysis results of the independent sample t-test indicate that there is a statistically significant yield difference at ($p<0.05$) between the varieties). To this end, better yield was obtained of 8.6 qt/ha from Batu variety followed by the standard check walta'i 7.05qt/ha(Table 2). The yield result found has similarities with what is reported by (Geremew et.al, 2015) and lower than yield reported by (Arega et.al, 2021) in different study areas. The following table describes the result

Table 2: Yield performance of demonstrated coriander varieties

Variety	Mean yield (Qt/ha)	N	SD	Min	Max	t-test
Batu	8.62 ± 0.30	12	1.0402	7.00	10.75	4.114
Walta'i	7.05 ± 0.23	12	.80505	6.25	8.50	

Yield advantage, gap and technology index

Apart from identifying the yield performances of the demonstrated varieties, the study has also tried to further see the variety in terms of yield gap, yield advantage and technology index it has over the standard check. This serves to see whether the variety demonstrated has a better chance or feasibility to the study area. Thus, the demonstrated Batu variety has shown better results. Accordingly, the technology gap which shows the yield gap between the demonstration yield and the potential yield expressed when the variety was released was found to be 1.35qt/ha. Subsequently, the technology index for the variety was 13.5%. Moreover, Batu variety has also shown 16.7 % Yield advantage over the standard check walta'i. The following table describes the result

Table 3: Technology gap, technology index and yield advantage

Parameter	**Result**
Technology gap	1.35 qt/ha
Technology index	13.5%
Yield advantage (over the check)	16.7 %

Financial Return of coriander production

The demonstration activity further evaluated the financial return of coriander production in the study area with the two demonstrated varieties. As the crop is new to the farming system of the area knowing this information could contribute to the demand creation for the production of the crop. Thus, the calculations were done using Ethiopian birr on hectare basis using the current market price of coriander in the study area. All inputs and labor costs were also calculated based on the market price during the production season. Accordingly, the results indicate that a total of 73,300 and 51,550 ethiopian birr can be gained by producing Batu and walta'i varieties respectively.

Table 4: Financial analysis of Coriander varieties in Dugda & Adami Tulu districts

Parameters		Varieties	
		Batu	Walta'i
Yield (Y) qt/ha		8.65	7.2
Price (P) per quintal		15000	15000
Total Revenue (TR)= TR= YxP		129750	108000
Variable costs	Land preparation	5600	5600
	Seed cost	2000	2000
	Fertilizer cost	3425	3425
	Chemicals	0	0
	labor cost	25000	25000
	harvesting	4425	4425
Total variable costs (TVC)		40450	40450
Fixed costs	Cost of land	16000	16000
Total fixed costs (TFC)		16000	16000
Total Cost (TC) = TVC+TFC		56450	56450
Gross Margin (GM) = TR-TVC		89300	67550
Profit= GM-TFC		**73300**	**51550**

Farmers' variety ranking and reason

The following table describes farmers' feedbacks after observing the performances of the varieties across different growth stages. Accordingly, the participating farmers have selected *Batu* variety in terms of its preferred characteristics.

Table 5: Farmers' variety ranking and reason

Variety	Rank	Reasons
Batu	1	Very good yield, good plant height and moderate lodging ability
Walta'i	2	Lower yield, lower lodging ability

Conclusion and Recommendation

The demonstration activity created an opportunity for farmers to evaluate the performance of the coriander varieties. The results indicated that there is a statistically significant difference with the varieties compared. Batu varieties have higher yield, better yield advantage and financial return when compared with its check. In-terms of yield gap there is a minimum yield between the demonstration yield and the potential yield expressed during the variety release. Revealing a comparable performance between on-station and on farm yields, the results also indicated the feasibility of Batu variety under farmers' circumstances in terms of its technology index parameter. Therefore, further scaling up works on Batu variety is recommended

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Pre-extension Demonstration of Medium Maturing Coriander Variety at Negele Arsi districts of West Arsi zone, Central rift valley of Oromia, Ethiopia

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Abstract
Pre-extension demonstration activity was conducted with objectives of creating awareness on newly released medium maturing coriander variety named Tulu. It was also done to evaluate yield performance of the variety under farmers' condition, to improve farmers' knowledge on coriander production and management and to see the financial return of the coriander production in the Negelle Arsi district of West Arsi zone, central rift valley of Oromia, Ethiopia. The variety was compared with standard check variety walta'i planted side by side on three selected trial farmers' fields based on their interest. Accordingly, the results indicated that there is no statistically significant difference (P<0.05) with the varieties compared. Yet, Tulu variety gave higher yield of 11.75 ± 0.41 qt/ha followed by its check 8.58 ± 0.26 qt/ha. *Moreover, Tulu variety has shown better financial return in Ethiopian birr when compared with its check. In-terms of yield gap a minimum yield between the demonstration yield (3.25qt/ha) and the potential yield expressed during the variety release was found Revealing a comparable performance between on-station and on farm yields. The results also indicated the feasibility of Tulu variety under farmers' circumstances in terms of its technology index (21.6 %) parameter and yield advantages (26.9%) in Negelle Arsi district. Therefore, further scaling up works on Tulu variety is recommended for similar agro ecologies.*

Key words: Medium maturing, Coriander, Tulu, Negelle Arsi,

Introduction

Agriculture remains the main activity in the Ethiopian economy. Agricultural growth is not only required to feed the country, but is also the driving force to generate foreign exchange. About 80 % of Ethiopia's foreign exchange is derived from agricultural exports (Gebisa, 2021). Enhancing agricultural production and export trade is the current strategy followed by the country to curtail the critical capital shortage and to enhance economic growth. Spices have major stake in the production system and in the foreign earnings of the country. Spices have great role in transforming farmers as producers for market instead of producing merely for subsistence (Dessalegn, 2015). Spices are important additives to Ethiopian dishes. The production and use of spices in Ethiopia go back to time immemorial. Ethiopia has become one of the largest consumers of spices in Africa. People use spices to flavor bread, butter, meat, soups, and vegetables. They also use spices to make medicines and perfumes (Habtewold et.al. 2017). Ethiopia is a homeland for many spices, such as korarima (Aframonum korarima), long red pepper, black cumin, white cumin /bishops weed, coriander, fenugreek, turmeric, sage, cinnamon, and ginger (International Trade Centre, 2010).

Coriander (Coriandrum sativum L) is an annual and herbaceous plant, belonging to the Apiaceae family (carrot family). Coriander is the most important seed spice crop cultivated throughout the world both for seed and leaf purpose. It is grown in more than fifty countries with India at ranking 1st, both in area and production followed by Mexico, China, former Soviet Union, Central America and South America. It is the most important seed spice crop

cultivated throughout the world both for seed and leaf purpose (Morales Payan, 2011). Coriander has been used in medicines for thousands of years. Various parts of this plant such as leaves, flower seed, and fruit, possess antioxidant activity, diuretic, ant-diabetic, sedative, anti-microbial activity, anti-convulsant activity, hypnotic activity and anthelmintic activity and anti-mutagenic (Pathak et al., 2011; Rajeshwari and Andallu, 2011).

In Ethiopia cultivation of coriander is limited to the highlands (1500-2500m.a.s. l), although it can be cultivated in the lowlands if the rain fall is sufficient and it can be grown in the same areas as wheat, barley, sorghum and teff (Jansen.1981).

Coriander plays an important role in the Ethiopia domestic spice trade and its seed used for the flavouring of berbere, injera, cakes and bread and its leaves added as an aromatic herb to 'wot' and tea (Jansen, 1981). In the past few years ATARC has been conducting variety development work with this spice crop. In its effort two varieties (Batu and Tulu) have been released; one serving for lowland areas and the other for mid land areas. To this end, this concept note is written to demonstrate the middle maturing variety (Tulu) in potential districts of West Arsi Zone. This medium maturing variety have a yield advantage of 57.8% over the local variety (waltai). It has similarity in terms of general agronomic characters such as plant height, number of umbels per plant, lodging resistance and level of maturity, and wider adaptation. It also has high essential oil and fatty acid than the local one

Objectives

- To create awareness on the medium maturing coriander variety
- To evaluate yield performance of the variety under farmers' condition
- To improve farmers knowledge on coriander production and management
- To see the financial return of the coriander production in the study area

Materials and methods

Description of the study areas

The study was conducted in Negele Arsi districts of West Arsi Zone zone.

Site and Farmers selection

Sites were selected in collaboration with district offices of Agriculture. In the district one Kebele was selected and One FRG (Farmers research group) having 15 farmers was organised. Among the FRG farmers 3 trial farmers were selected for the demonstration trial establishment.

Planting materials: From the Two previously released coriander varieties one (Tulu) Variety was used which medium is maturing.

Agronomic management

The variety was on a land size 10x10 per farmer along with standard check for comparison. Land was ploughed using oxen and ppackaged production and management technologies and practices (seed rate, spacing and weed management, fertilizer rate) recommended for coriander production were used as Seed rate of 10kg/ha, Fertilizer rate 100kg NPS, Spacing of 30cm between rows and Hand weeding/twice/ were used.

Awareness Creation

Training about coriander production and management was provided before commencing the activity.

Data collected

Grain yield, costs incurred and revenues gained, total number of farmers by gender participated in trainings, and Farmers' feedbacks will be collected.

Data analysis

The collected grain yield was analyzed using descriptive statistics. Independent t-test was used. Other quantitative gender disaggregated data were described using tables. Farmer feed backs were summarized qualitatively and described using tabular presentations.

Furthermore, Yield advantage was calculated using the formula

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

The technology gap (Yield gap) and technology index was also calculated using the formulas as given by (Samui et al., 2000). The technology gap (Yield gap) shows the gap in the demonstration yield over potential yield. The yield gaps can also be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the value of technology index the more the feasibility of the varieties. The following is the formula used for yield gap/ technology gap and technology index calculations

$$\text{Technology gap} = \text{Potential yield qt/ha} - \text{demonstration yield}$$

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

Result and Discussion

Awareness Creation

Before planting training was provided for all participating farmers including host and non-host/ follower farmers, DA's and district experts. To this end, a total of 98 farmers, 12 DA and 4SMS and 21 other stakeholders participated

Table 1: Number of farmers and other participants trained

Parameter		Farmers	DA's	SMS	Others	Total	
						Frequency	Percent
Sex	M	81	7	4	19	111	78.4
	F	17	5	0	2	24	21.6
	Total	98	12	4	21	135	100.0

Yield performance

The demonstrated varieties were compared in terms of their yield performances. The yield data was collected from the demonstration fields of all involved trial farmers. Accordingly the combined analysis results of the independent sample t-test indicate that there is no statistically significant yield difference at ($p<0.05$) between the varieties. Better yield was obtained from Tulu Variety 11.75 ± 0.41 qt/ha). The result is in line with yield reported by (Arega et.al., 2021). The following table describes the result

Table 2: Yield performance of demonstrated coriander varieties

Variety	Mean yield (Qt/ha)	N	SD	Min	Max	t-test
Tulu	11.75 ± 0.41	3	2.63391	9.25	14.50	2.084
Walta'i	8.58 ± 0.26	12	.38188	8.25	9	

Yield advantage, gap and technology index

Apart from identifying the yield performances of the demonstrated varieties, the study has also tried to further see the variety in terms of yield gap, yield advantage and technology index it has over the standard check. This serves to see whether the variety demonstrated has a better chance or feasibility to the study area. Thus, the demonstrated Tulu variety has shown better results. Accordingly, the technology gap which shows the yield gap between the demonstration yield and the potential yield expressed when the variety was released was found to be 3.25qt/ha. Subsequently, the technology index for the variety was 21.6%. Moreover, Tulu variety has also shown 26.9 % Yield advantage over the standard check walta'i. The following table describes the result

Table 3: Yield advantage, gap and technology index

Parameter	**Result**
Technology gap	3.25 qt/ha
Technology index	21.6%
Yield advantage (over the check)	26.9 %

Financial Return of coriander production

The demonstration activity further evaluated the financial return of coriander production in the study area with the demonstrated varieties. As the crop is new to the farming system of the area knowing this information could contribute to the demand creation for the production of the crop. Thus, the calculations were done using Ethiopian birr on hectare basis using the current market price of coriander seed/grain in the study area. All inputs and labor costs were also calculated based on the market price during the production season. Accordingly, the results indicate that a total of 111,600 and 63,750 Ethiopian birr can be gained by producing *Tulu* and *walta'i* varieties respectively.

Table 4: Financial analysis of Coriander varieties at Negelle Arsi District in

Parameters		Varieties	
		Tulu	Walta'i
Yield (Y) qt/ha		11.75	8.58
Price (P) per quintal		13000	13000
Total Revenue (TR)= TR= YxP		152750	11540
Variable costs	Land preparation	4800	4800
	Seed cost	2100	2100
	Fertilizer cost	3425	3425
	Chemicals	0	0
	labor cost	25000	25000
Total variable costs (TVC)		35325	35325
Fixed costs	Cost of land	24000	24000
Total fixed costs (TFC)		24000	24000
Total Cost (TC) = TVC+TFC		59325	59325
Gross Margin (GM) = TR-TVC		117425	79750
Profit= GM-TFC		111,600	63,750

Farmers' variety ranking and reason

The following table describes farmers' feedbacks after observing the performances of the varieties across different growth stages. Accordingly, the participating farmers have selected *Tulu* variety in terms of its preferred characteristics.

Table 5: Farmers' variety ranking and reason

Variety	**Rank**	**Reasons**
Tulu	1	Very good yield, good plant height and moderate lodging ability
Walta'i	2	Lower yield, lower lodging ability

Conclusion and Recommendation

The demonstration activity created an opportunity for farmers to evaluate the performance of the coriander varieties. Furthermore, through the trainings, awareness has been created for all participating farmers, DA's and other stakeholders on how to produce and manage coriander varieties. The results indicated that there is no statistically significant difference ($P<0.05$) with the varieties compared. Yet, Tulu variety gave higher yield. Moreover, it has better financial return in birr when compared with its check Furthermore, Tulu variety has 26.9% yield advantage. In-terms of yield gap there is a minimum yield between the demonstration yield (3.25qt/ha) and the potential yield expressed during the variety release. Revealing a comparable performance between on-station and on farm yields. The results also indicated the feasibility of *Tulu* variety under farmers' circumstances in terms of its technology index parameter in Negelle Arsi district. i.e. the lower the technology index the better its feasibility.

Therefore, further scaling up works on Tulu variety is recommended for similar agro ecologies

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Pre-extension Demonstration of Adaptable Mung bean (Vigna radiata L. Wilczek) Varieties in Selected Districts of East Shewa zone

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Abstract
Adaptable Mung bean varieties to East Shewa zone of central rift valley of Oromia, Ethiopia were demonstrated to the farming communities in selected districts of Dugda and Adami Tulu Jiddo Kombocha. Varieties namely shewarobit, Beroda and Rasa N-26 were demonstrated with objectives of evaluating the yield performances of adaptable mung bean varieties under farmers' conditions, to analyse the financial return of Mung bean production under farmers circumstances in the study areas, to improve farmers knowledge and skills on mung bean production and management and to create awareness about the importance of the technology to different stakeholders. Accordingly, twelve trial farmers were selected to establish the demonstration trials. The results indicate that there is no statistically significant yield difference at ($p<0.05$) between the varieties. Better yield was obtained from shewarobit Variety 12.1 ± 1.34 qt/ha followed by Beroda (12.1 qt/ha) and Rasa N-26 (10.4) qt/ha respectively. Furthermore, In-terms of yield gap and technology index a minimum gap between the demonstration yield and the potential yield was recorded for all varieties, revealing a comparable performance and the feasibility of all demonstrated varieties under farmers' circumstances in the study area. Yet, basing other parameters (Financial return, its yield advantage and farmers preference) further scaling up works on Shewarobit variety is recommended for similar agro ecologies Shewarobit variety has also less yield gap when compared with Rasa N-26 Variety.

Key Words: Adaptable, Mungbean , East shewa, Demonstration

Introduction

Mung bean, Vigna radiata (L.) Wilczek, which is also called Green gram or maash is an annual food legume belonging to the subgenus Ceratotropis in the genus Vigna (Jood et al., 1989). Mung bean is originated from India and it has diversified to East, South, Southeast Asia (China) and some countries in Africa. It is a warm season annual legume which is a drought resistant crop with an optimum temperature range of 27- 30°C for good production. It is early maturing crop, requiring 75–90 days to mature. Best adaptation areas for Mung bean are at 1,000-1,650 meters above sea level; with annual rainfall of 600-750mm. (ECX 2023)

Mung bean can be produced for food and fodder purposes varying from place to places (Lee et.al., 1997). It is a nutritionally rich crop with significant protein and carbohydrate contents important for human beings. According to Prakit and Peerasak (2007) the crops is utilized in several ways, where seeds, sprouts and young pods are consumed as sources of protein, amino acids, vitamins and minerals, and plant parts are used as fodder and green manure. Furthermore, mung bean has a potential to make up the gap of protein shortage since its seeds are rich in protein and amino acids, thus serve as a protein source for human consumption.

In Ethiopian context it is a recently introduced pulse crop produced majorly in the north eastern part of Amhara region (North Shewa, Oromiya special zone and Southern Wollo, Gonder), SNNPR (Gofa area) and pocket areas in Oromiya region (Hararge, Ilubabor), Tigray (Gereziher, et.al. 2017, Birhanu et.al., 2018, Habte U, 2018). Mung bean productivity

in Ethiopia is estimated to be on average 0.9 ton/ha−1) with a volume of production is increasing year to year; whereas the world average productivity is 1.2ton/ha−1 (Birhanu et. al., 2018).

It is majorly produced as a cash crop to generate income by selling it to exporters (ECX, 2019). Currently, the Ethiopia Commodity Exchange (ECX) also announced the entrance of the crop, Green Mung Bean, into its trade floor. Green Mung bean is the sixth product that ECX is trading. According to ECX In 2015/2016, Ethiopia exported a total of 30,694 MT of green Mung bean with a value of 35.8 million USD. Compared to export performance of to 2014/2015, the export volume and value grew up by 21% and 23%, respectively. The major export destinations for Ethiopian green Mung bean are: Indonesia, India, Belgium, UAE, and Singapore. Other major global players in Mung bean import comprises: USA, Netherlands, UK, Canada, France, Germany, Norway, Sweden, and Malaysia (ECX 2023)

Despite increases in potential export markets as well as internal markets, the production is limited to certain areas with no considerable improvement in quantity. Yet, the crop has adaptability to different areas serving both the nutritional benefits as well as cash crop. To this end, adaptability trial of released varieties of mung bean has been conducted by Adami Tulu Agricultural Center for a possible introduction in the farming system of East Shewa zone, the central rift valley area of Oromia, Ethiopia. The study was conducted for two consecutive years across three locations. Accordingly, promising results with no significantly varying productivity have been found indicating adaptability. The results indicated that Shewa Robit variety had higher grain yield (1607.4 kg/ha) followed by N-26 (1542 kg/ha) and Beroda (1466.1 kg/ha). Thus, based on the results, a follow up demonstration and evaluation has been recommended.

Thus, this proposal activity was initiated to evaluate and demonstrate these adaptable mung bean varieties to the farming community of East Shoa zone with the following specific objectives.

Objectives

- To evaluate the yield performances of adaptable mung bean varieties under farmers' conditions in selected districts of East shewa zone.
- To analyse the financial return of Mung bean production under farmers circumstances in the study areas
- To improve farmers knowledge and skill on mung bean production and management
- To create awareness about the importance of the technology to different stakeholders

Materials and methods

Description of the study areas

The study was conducted in selected districts of East shewa zone. East shewa zone is one the administrative zones of Oromia regional state, Ethiopia. The zone has an area of 10241km2and Adama town is serving as the capital town of the zone. There are 10districts within the zone. among which Dugda and Adami Tulu Jiddo Kombolcha districts are the study districts where this demonstration activity took place.

Dugda district is located at 135km from the capital city of Ethiopia, Addis Ababa and 100km from Oromia region and East Shewa's zonal capital Adama. The district covers 5.2% of East Shewa zone with area of 751km2. Dugda has 18 Kebele's among which one kebele was used

for this study. The district has an average 636mm annual rainfall and 26ocaverage temperature. The major crops produced are wheat, teff and maize

Adami Tulu Jido Kombolcha district is located at 160 km from the capital city of Ethiopia, Addis Ababa and 115 km from Oromia region 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.

Map of the study area (Dugda and Adami Tulu Jiddo Kombolcha)

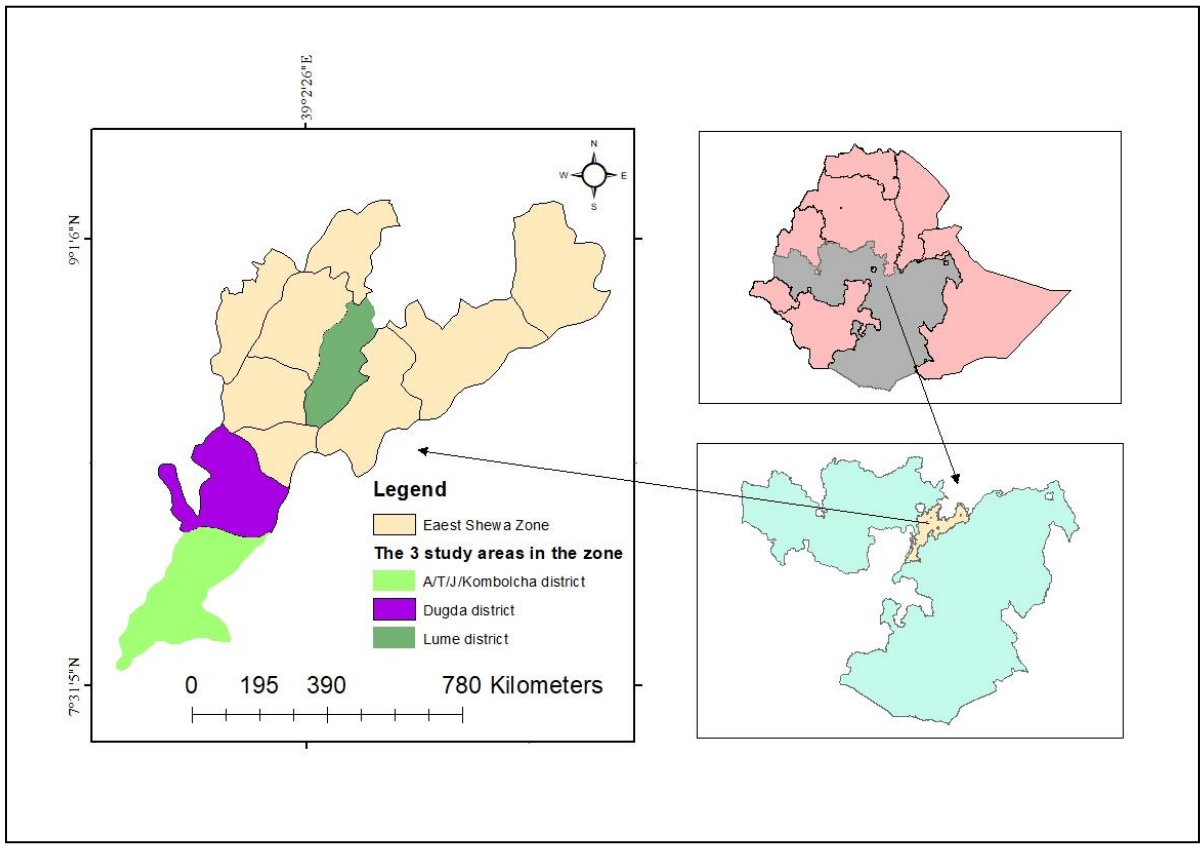

Figure 1: Map of study area

Site and Farmers selection

Sites were selected in collaboration with district offices of Agriculture. Two districts were involved (Dugda and Adami Tulu Jiddo Kombolcha). In each district 2 Kebele's were selected, so a total of 4 Kebele's were selected in the two districts. One FRG (Farmers research group) having 15 farmers was organised in each Kebele among which 3 were trial farmers. Totally, the demonstration activity involved twelve (12) trial farmers.

Planting materials: Three of the adaptable mung bean varieties (Shewa robit, Rasa (N-26) and Beroda) were used

Agronomic Management

The demonstration was laid out on 12 (Twelve) adjacent (neighbouring farmers' fields) in the 4 kebele's on a land size 10 x 10 per farmer/ per variety. Packaged production and

management technologies and practices (seed rate, seed treatment, spacing and weed management) recommended for mung bean were used. Land was prepared by farmer using oxen plow. Seeds were sown at the recommended rate of 25-35 kgha-1 in rows (40cm between rows and 10cm between plants). Plots were kept free of weeds to produce a successful mung bean crop. Fertilizer rate of 100 kg NPS per ha at planting was used. Other agronomic managements were done as per the recommendation.

Knowledge improvement and awareness creation

Training about mung bean production and management was provided before commencing the activity. Field visits and field days among trials farmers were conducted to observe and share their knowledge and experience about the activity as well as mung bean production and management.

Data collected

Grain yield, costs incurred and revenues gained, total number of farmers by gender participated in trainings, and Farmers' feedbacks were collected.

Data analysis

The collected agronomic data was analyzed using SPSS statistical software for possible variances using one way ANOVA.

The collected agronomic data was also analyzed for yield advantage. Yield advantage of the varieties over the other was calculated using the following formula.

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

Furthermore, technology gap and technology index were calculated using the formulas as given by (Samui et al., 2000). The technology gap shows the gap in the demonstration yield over potential yield i.e. the yield expressed during the adaptation trials. The yield gaps can also be further categorized into technology index which is used to show the feasibility of the varieties at the farmer's field. The lower the value of technology index the more the feasibility of the varieties. The formulas are as follows

Technology gap = Potential yield qt/ha – demonstration yield

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

Result and Discussions

Knowledge improvement and awareness creation training

It is understandable that training is a very important tool for improving farmers' awareness and knowledge. This in turn would contribute to the improvement in productivity. Thus. Before commencing on the actual field planting of the mung bean varieties training was provided for all participating farmers including host and non-host/ follower farmers, DA's and district experts about the overall mung bean production and management. Thus, a total of 98 farmers, 12 DA and 4SMS and 21 other stakeholders participated. Accordingly, from the total of training participants 21.65 % were women.

Table1: Number of farmers and other participants trained on Mung bean production and management.

Parameter		Farmers	DA's	SMS	Others	Total	
						Frequency	Percent
Sex	M	81	7	4	19	111	78.4
	F	17	5	0	2	24	21.6
	Total	98	12	4	21	135	100.0

Yield performance

The demonstrated varieties were compared and evaluated in terms of their yield performances. The yield data was collected from the demonstration fields of all involved trial farmers. The collected data then entered into SPSS and analysed using one way ANOVA. Accordingly the combined analysis results indicate that there is no statistically significant yield difference at ($p<0.05$) between the varieties. Better yield was obtained from shewarobit Variety 12.1 ± 1.34 qt/ha followed by Beroda (12.1) and Rasa N-26 (10.4) qt/ha respectively. The following table describes the result

Table 2: Yield performance of demonstrated coriander varieties

Variety	Mean	N	Std. Deviation	Minimum	Maximum	Sig
Beroda	11.21 ± 2.15	7	5.67969	6.00	21.50	
Shewarobit	12.1 ± 1.34	7	3.55861	7.50	18.00	ns
Rasa (N-26)	10.4 ± 1.16	7	3.07108	6.25	15.50	

Yield advantage, gap and technology index

Apart from identifying the yield performances of the demonstrated varieties, the study has also tried to further see the variety in terms of yield gap, yield advantage and technology index. This serves to see whether the varieties demonstrated have better chance or feasibility to the study area. Thus, the following table 3 describes the result

Table 3: Yield gap, yield advantage and technology index of demonstrated Mung bean varieties

Varieties	Potential yield/adaptation yield (Qt/ha)	Demo-yield (Qt/ha)	Parameters			
			Yield gap (Qt/ha)	Technology index (%)	Yield advantage over the other varieties (%)	
Shewarobit	16.01	12.1	3.974	24.73	Over Rasa N-26	7.35
					Over Beroda	14.04
Rasa N-26	15.42	11.21	5.02	32.55	Over Beroda	7.22
Beroda	14.66	10.4	3.45	23.53		

According to the results shown on the above table 3 Shewarobit variety has the better yield advantage of 14.4% and 7.35% over *Beroda* and *Rasa N-26* varieties respectively. *Rasa N-26* has also better yield advantage of 7.22% over *Beroda* variety. Interms of technology index lower technology index percentage was recorded from shewarobit variety with 24.73%. Shewarobit variety has also less yield gap when compared with *Rasa N-26* Variety.

Financial Return of coriander production

The demonstration activity further evaluated the financial return of mungbean production in the study area with the demonstrated varieties. As the crop is new to the farming system of the area knowing this information could contribute to the demand creation for the production of the crop. Thus, the calculations were done using Ethiopian birr on hectare basis using the current market price of mung bean grain in the study area. All inputs and labor costs were also calculated based on the market price during the production season. Accordingly, the results indicate that a total of 40200, 37200 and 33,450 Ethiopian birr can be gained by producing *Shewarobit Beroda* and *Rasa (N-26)* varieties respectively.

Table 4: Financial analysis of Mung bean varieties in the study areas

Parameters		Varieties		
		Shewarobit	Beroda	Rasa (N-26)
Yield (Y) qt/ha		16.01	15.42	14.66
Price (P) per quintal		5000	5000	5000
Total Revenue (TR)= TR= YxP		80,050	77,100	73,300
Variable costs	Seed cost	3000	3000	3000
	Fertilizer cost	3425	3425	3425
	Chemicals	0	0	0
	labor cost	10000	10000	10000
	harvesting	4425	4425	4425
Total variable costs (TVC)		23850	23850	23850
Fixed costs	Cost of land	16000	16000	16000
Total fixed costs (TFC)		16000	16000	16000
Total Cost (TC) = TVC+TFC		39,850	39,850	39,850
Gross Margin (GM) = TR-TVC		56200	53250	49,450
Profit= GM-TFC		**40200**	**37200**	**33,450**

Participating farmers' feedback and preference among the demonstrated varieties

The participating farmers were let to rank the varieties according to their own selection criteria's which could be suitable for the farming system of their area. Accordingly, farmers have selected shewarobit variety as their first choice basing its better grain yield, tolerance to diseases. The following table 5 describes the results.

Table 5: farmers' feedback and preference among the demonstrated varieties

Variety	Rank	Reasons
Shewarobit	1	Very good grain as yield, Very good disease tolerance Good plant height, , better uniformity
Rasa (N-26)	2	Better grain yield, good disease tolerance,
Beroda	3	Lower yield, lower disease tolerance

Conclusion and Recommendation

The demonstration activity created an opportunity for farmers to evaluate the performance of the adapted mung bean varieties. Furthermore, through the trainings, awareness has been created for all participating farmers, DA's and other stakeholders on how to produce and manage mung bean varieties. The results indicated that there is no statistically significant difference ($P<0.05$) with the varieties compared. Yet, numerically Shewarobit variety gave higher yield. Which resulted in higher yield advantage and financial return. In-terms of yield gap and technology index a minimum gap between the demonstration yield and the potential yield was recorded for all varieties, revealing a comparable performance and the feasibility of all demonstrated varieties under farmers' circumstances in the study area. Yet, basing other parameters (Financial return, its yield advantage and farmers preference) further scaling up works on Shewarobit variety is recommended for similar agro ecologies

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Participatory Demonstration of Improved Fishery Technologies on Belbela Reservoir East Showa Zone, Oromia Region, Ethiopia

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Abstract

Participatory demonstration of improved fishery technologies were implemented on Belbela reservoir to demonstrate improved fishery technologies, to enhance farmers, DAs and agricultural experts' knowledge and to collect feedback information for further technology improvement/development. Belbela reservoir is located at 8°50'1"N and 39°2'49"E with the catchment area of 105 hectors and 12m maximum depth. Nile tilapia is the only species used as production by Beach Sine and Gill-net fishing gears. Participatory approach such as FRG was used for technology demonstration and data were collected through observation, interview and group discussion. Quantitative data were analyzed through descriptive statistics and qualitative data were used through narration. In capacity building a total of 116 participants attended training at different time on demonstrated technology utilization package, resource monitoring and on sustainable fishing. Technology demonstration was done through establishing two FRGs from active fishermen. One Beach sine, two retaining cage and six fish processing table was prepared and demonstrated on selected site. On organized Mini field day a total of 45 participants were participated and provided feedback reaction for further technology demonstration or improvement. From demonstrated technologies and exchange information, 500gm of standard table size fish was collected and generate a total of 30,000.00 birr in two month with improved handling system. Overall, all participants provide a positive feedback and confirmed as technology help in fishermen income improvement, minimize loss of production and insuring resource sustainability.

Key words: Demonstration, Belbela reservoir, Technology, Beach sine, Retaining cage, Processing Table

Introduction

Fish is an aquatic animal that serves as the source of food, nutrition, income, and livelihood for millions of people in the world (FAO, 2018). Fishery is animal-based food production that has quickly grown sector since the ancient civilization of Egypt and China (Amare *et al*., 2018). The world fisheries are dominated by marine production which has been a vital to the support of human well-being and economic development. Inland fisheries also deliver substantial contributions to nutritional security and income to hundreds of millions of rural households and support livelihood for many families, particularly in developing countries where other option are limited.

Fishery sector is mainly important for locally important sources of food, trade, income and employment opportunities for considerable numbers of people in many developed and developing coastal nations. In developing countries, the livelihood of more than 500 million people is directly or indirectly tied to fisheries (FAO, 2020). Historically, Africa's fisheries are increasingly contributing to food and nutrition security, foreign exchange, employment, and livelihood support services (De Graaf & Garibaldi, 2019). The New Partnership for Africa‟s Development (NEPAD) estimates that total fishery production in the region stands at 10.4 million tons (NEPAD, 2014) comprising of 6.0 million tons from marine capture

fisheries, 2.8 million tons from inland water fisheries, and about 1.6 million tons from aquaculture.

Ethiopia is endowed with several water bodies that contain a high diversity of aquatic fauna. The country fishery production is mostly practiced and collected from Lake, reservoirs, rivers and other small water bodies. Illegal fishing activities, lack of awareness of the community in sustainable fisheries management, and lack of post-harvest technology like fish processing techniques are the major challenge in Ethiopian fishery. Additionally, in newly established fishing site, fishermen suffered with lack of improved fishing gears (Temesgen and Getahun, 2016).

Belbela reservoir is established in Ada'a district in East Showa zone of the Oromia region by damming along the course of Belbela River. It is one of the two storage dams constructed in 1980 by a Cuban Civil Mission in collaboration with Ethiopian Water Resources Authority (EWRDA). The protection works, canals, and on-farm structures for the dam were later constructed by the Ethiopian Water Works Construction Authority (EWWCA) with an objective of irrigating land area to be used by State Farms.

As information gained from district livestock office, the reservoir is used for watering livestock, sanitation and as the primary source of drinking water supply for local people. The same report confirmed that, it also supports commercial fishery, which is based on introduced fish species primarily Nile Tilapia (*Oreochromis niloticus).* However, on the water body fishermen were performing fishing with inefficient fishing material and inadequate knowledge on overall fishing activities from collecting to processing. But, there are technologies that are release by the Batu Fish and other Aquatic Life Research Center which contributes to the fishermen income improvement, minimize loss of production and insuring resource sustainability. Thus, this activity was initiated with the following objectives.

Objectives of the Study

- ✓ To demonstrate improved fishery technologies at selected site
- ✓ To enhance fishermen, DAs and agricultural experts' knowledge on improved fishery technologies
- ✓ To collect feedback information for further technology improvement/development

Material and Methods

Description of the study area

Belbela reservoir is found in East Showa zone, Ada'a district Koftu Kebele. In the district fishing activities are performed in both human made reservoirs and ponds in addition to a few river. The area have good demand of fish in the market at different production site. Belbela reservoir is primary established for irrigation purpose and local utilization for human and animal. On the current situation, the reservoir provide as watering for animals, home consumption and fishing in addition to irrigation activities.

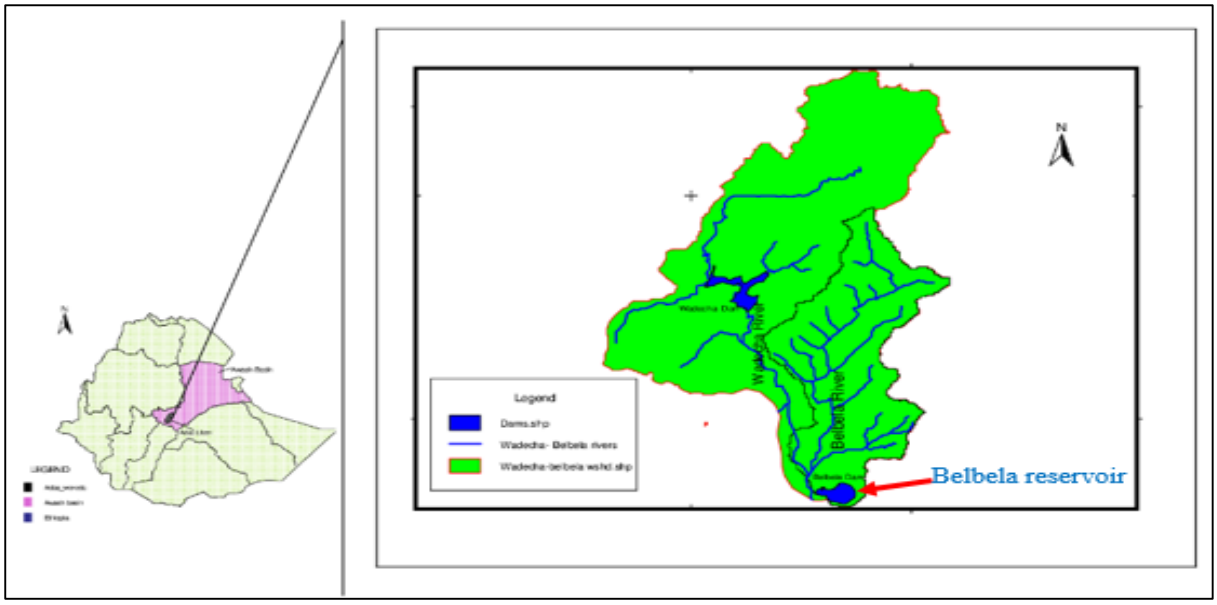

Figure 1. Google map of Belbela Reservoir

It is located at 8°50'1"N and 39°2'49"E with the catchment area of 105 hectors and 12m maximum depth. From our observation Nile tilapia is the only species used as production by Beach Sine and Gill-net fishing gears. Fishing activities were performed through cooperative form that managed by District Agriculture Office. Again, fishing Households were participating in agricultural production trough rain feed and irrigation system.

Site and fishermen selection

Site were selected based on fish production potential and fishing activities status (active), demand of fishery technologies, accessible to market and road for fishing, suitability for technology demonstration and shade construction, and high number of fishermen slips in and out. Finally, with above criterial Belebela reservoir was selected with DAs and District Experts for technology demonstration.

Technology demonstration techniques

Participatory approach such as FRG was used for technology demonstration at Belebela reservoir. Two FRGs having a total of 24 members were established in the study area for technology transfer. Additionally, Training, mini filed day, joint monitoring and evaluation were used as mechanism for information exchange among fishermen's.

Data collected and Methods of data collection

Type of Technology demonstrated, Total number of fishermen and local farmers participated in training and Mini field day, Role of farmers and other stake-holders in technology demonstration, Feedback and Secondary data were collected using different appropriate data collection methods such as filed observation, participant interview and focus group discussion.

Roles and responsibilities of participants

In this study three Research Team, Fishermen and Extension worker/experts are the main active participants and have their own responsibility. Research Team from center was performed many tasks like Site selection, provide awareness creation at different stage, prepare and deliver recommended technologies with package, facilitating and organizing, information transfer, provide technical support as local condition, continuous follow up and monitoring, output and data collection and analysis (table 1).

Table 1: Role of stakeholders in technology demonstration

Actors	Roles and Responsibility
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, output and data collection and analysis
Extension worker	Facilitating and organizing, information transfer, provide technical support as local condition, continuous follow up and monitoring

Land provision, participation, evaluation technologies, utilize from technology and providing feedback were the main role and responsibility of farmers/fishermen on the study area (table 1). Extension experts also contributed through providing continues communication with research team, facilitation and mobilizing fishermen, monitor and feedback.

Data Analysis

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

Results and Discussions

Training of fishermen and other stakeholders

Capacity building was the primary and first section in technology demonstration. It help to create awareness on new method and packages for selected stakeholders to improve the existing system. The training was delivered for fishermen, DAs and expert. Multidisciplinary team including Capture fishery, Socio-economics, Agricultural extension researchers and Office of agriculture and natural resource heartily participated on awareness creation to promote utilization of recommended fishing technology for sustainable production. Continues awareness creation was given for 116 participants on demonstrated technologies, fish collection, handling and processing methods that mainly help to reduce post-harvest mislay (table 2).

Table 2: Training provided for stakeholders on demonstrated technology

Participants	Male	Female	Total
Fishermen	90	11	101
DAs	6	-	6
SMS	9	-	9
Total	105	11	116

Source: Own data, 2022

From the participants, about 95% were male category due the nature of activity that mainly performed by male. This data is similar with many finding which confirmed as fishing activity done at night time and early morning. 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.

Demonstration and Technology transfer

Technology demonstration was performed in Ada'a district on Belebela reservoir. Before demonstration necessary training and technologies were prepared by participatory approach with all main stakeholders. Firstly, processing shade was constructed by locally available materials with fishermen near to reservoir at main landing site. It has a total area of $20m^2$ (5mx4m) that used to fix processing table technology. Totally, six processing tables were prepared and fixed in processing shade at landing site.

On this reservoirs research recommend to use 6 to 10cm mesh size of net based on fish species available in the water bodies. Such amount of net mesh size is mainly recommended for closed and small water bodies that mostly controlled by a few fishery cooperative. As fishery technology two Beach sine (8cm mesh size), two retaining cage and six processing table were used as improved technology and demonstrated at selected site with fishermen and districts experts. On demonstration fishermen (FRG), experts from district, Kebele leader and other local community were attend the demonstration.

Table 3: Number of Participants attend Technology Demonstration on Belbela reservoir, 2022

Participants	Male	Female	Total
Fishermen	22	8	30
DAs	3	-	3
Researchers	3	-	3
Local farmers (Non-FRG)	5	4	9
Total	33	12	45

During technology demonstration about 30, 3, 3 and 9 fishermen, DAs, researchers and other Non-FRG were participate on demonstration respectively. Accordingly, a total of 45 participate were participated on demonstration at selected research site.

Fishermen feedback and reaction

After technologies demonstration fishermen provide feedback based on different criteria's including income contribution, improve fish catch per effort, simple to prepare and installed, improve hygienic status of fish and minimize lose at landing site. Based on fishermen reaction, the majority of them have a positive response on demonstrated technology. At the study area, fish is processed on the ground contribute for physical lose and contamination of the product at landing site. Related with processing table, all respondents (100%) positively responded that the technology is simple to prepare and has high contribution to improve hygienic status during processing stage. This study result is in line with

On the other hand, from all farmers about 38 (84.44%) participants had responded as the technology mainly contribute in household income improvement as to minimizing lose during processing time. This result of the study is in line with Alemayehu and Adisu, (2022), which confirmed that fish processing tables help to produce top quality of fillet than traditional methods that minimize loss of production from 2.5kg to 5%kg/boat/day at landing site. Again, the majority of fishermen responded that, fish processing on processing table minimize time by 10-15 minute that processing on the ground that in line with the previous study result.

Table 4: Farmer's feedback and reaction to wards technology (n=45)

Name of technology	Criteria	Attribute	No of respondent	Percentage (%)
Processing table	Simple to prepare and installed	Yes	45	100
		No	-	-
	Improve hygienic status of fish	Yes	45	100
		No	-	-
	Increase household income	Yes	38	84.44
		No	7	15.56
	Minimize time for processing	Yes	36	80
		No	9	20
Beach Sine	Improve income	Yes	40	88.88
		No	5	11.12
	Help to catch table size fish	Yes	45	100
		No	-	-
	Insure sustainability	Yes	45	100
		No	-	-
Retaining cage	Minimize loss at landing site	Yes	45	100
		No	-	-
	Improving income	Yes	35	77.77
		No	10	22.23

From Focus Group Discussion result, Gill-Net, Beach seine with local wood boat were the main fishing materials used on the study area. As they confirmed that, the majority of them used with 6cm and sometimes use 4cm mesh size for both net type which is out of research recommendation. This directly have a negative impact on resource management and sustainability. At the end the majority used fishing material Beach sine with 8cm mesh size was demonstrated and transfer for fishing households. Finally, demonstrated Net was evaluated and provide feedback on its contribution on improving income, improving production and insure resource monitoring.

As different literature confirmed that, fish is the most nutritious but highly perishable product. With this fact, at Belbela reservoir fish activities is not managed with appropriate preservation methods which expose to spoilage. For this gap, the research recommended Retaining Cage that used to design to prolog fish from spoilage. It is simply installed in water that help to stay fish alive until presented to market. So, in the study area Retaining cage was demonstrated and evaluated by fishermen at selected research site. About 45 (100%) and 35 (77.77%) respondents responded that retaining cage help to Minimize loss and improve income respectively. From demonstrated technologies 500gm of standard table size fish was collected from the reservoir and possessed on fish processing tables. In consecutive two months of fishery activities fishermen generated a total of 30,000.00 birr with improving handling system.

Challenge encountered

- Poor coordination among fishery cooperative members in the study area
- Weak linkage between District Agricultural Office and fishermen

Conclusion and Recommendation

Participatory Demonstration of Improved fishery technologies Processing Table, Beach Sine and Retaining Cage were conducted in East Showa Zone, Ada'a district on Belebela reservoir. Beach sine, Retaining cage and fish processing table technologies were demonstrated through participatory approaches with fishermen and other stakeholders. Awareness creation was given for fisherman and experts on technology utilization and resource monitoring at the study area.

From the fishermen feedback, demonstrated Beach sine, Retaining cage, and Processing table had positive response as they contribute to improve income and insure resource management and sustainability. So, these demonstrated technologies were preferred by stakeholders and recommended for pre-scaling up on fish production potential site of Oromia Region.

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Pre-Extension Demonstration and Evaluation of Improved Tef Technology in Chora District of Buno Bedele Zone, Southwestern Ethiopia

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Abstract

Pre-extension demonstration of improved tef technology was conducted in Chora district of Buno Bedele Zone Southwestern Ethiopia. The main objective of the study was to demonstrate and evaluate the yield performance and economic profitability of previously adapted improved tef variety compared with standard and local check in the study area. The activity was under taken in three kebeles where eight demonstration sites including on-farmers' field and their training center were used. The total land size used for the activity was 300 m^2 where 10 m x 10 m plot size was allotted for each tef varieties sown through broadcasting method. The recommended seed rate of 15 kg ha-1 and fertilizer rate of 100/50 kg ha-1 NPS/urea were used. Mini-field day involving different stakeholders was organized at each respective site. Yield and cost incurred related data per plot was recorded and analyzed using descriptive statistics, while farmers' preference to the demonstrated tef varieties was identified using focus group discussion and summarized using pair wise ranking methods. The demonstration result revealed that, Dursi which is the improved tef variety was performed better than the standard and local check (Dukem and Dabi tef varieties respectively) with the yield advantage of 22.8% and 13% over local and standard check varieties respectively. Cost benefit analysis revealed that, Dursi variety had higher rate of return (1.18) and profitable than Dukem (0.93) and Local (0.4) varieties. Moreover, Dursi variety was selected by farmers and thus, it was recommended for further scaling up.

Key words: Demonstration, Farmers' preference, tef, Dursi, Selection criteria,

Introduction

Cereals are the major food crops both in terms of the area coverage and volume of production and accounts for 95 percent of agricultural production in Ethiopia and contributed 87.48 percent of the grain production (CSA, 2018). Of them, tef is an indigenous cereal consumed daily by a majority of the population in Ethiopia and is known to be gluten-free and more nutritious over maize and wheat (Kibatu *et al.*, 2017; Dame, 2018). It accounted for about first of the nationwide agricultural area cultivated by more than 40% of smallholder farmers in 2020 (CSA, 2021). Tef is a self-pollinated and warm season cereal crop originated in Ethiopia and have been domesticated and used throughout the world due to its excellent nutritional value as grains for human consumption and as forage for livestock (Baye, 2014).

Ecologically, tef is adapted to diverse agro-ecological regions of Ethiopia and grows well under stress environments better than wheat, barley and other cereals known world-wide (Refissa, 2012). Because of this, it is said to be a "low-risk" crop for farmers (Adera, 2016). Tef is the most important economic crop cultivated by 43 percent of small holder farmers in Ethiopia, covering around 32 percent of the total annual acreage and 21 percent of the total grain production (Birrara, 2017).

Tef has both cultural and economic value for Ethiopian farmers. In recent days it is among the cash crops and has been attracting an export market due to its nutritional value and is believed to be gluten free. Nutritionally, 100 gram of tef grains has 357 kcal, similar to that of wheat and rice (Cheng *et.al.,* 2017). In terms of income generation, it is the second most

important cash crop next to coffee, which generates about 500 million USD per year for local farmers in Ethiopia (Minten *et al.,* 2013). Tef straw, besides being the most appreciated feed for cattle, is also used to reinforce mud and plaster the walls of house and local grain storage facility called gotera (Adera, 2016; Minten *et al.,* 2016; Ayalew *et al.,* 2017).

Tef is one of the major crops produced for household consumption, cash, house construction and cattle feed in Buno Bedele zone. Despite the importance of tef, the yield of the crop is low in the area; due to lack of improved seeds, disease, lodging, low application of the recommended packages of tef with management practices. To over-come these problems, cereal crop research team of Bedele Agricultural Research Center has been conducted the adaptation study on different improved varieties and recommended the best fitted tef variety in the study areas. However, adaptation trials were from the viewpoints of crop biological adaptability on small land size disregarding crop economic profitability and farmers' preference of the crop. Therefore, the activity initiated with an objective to demonstrate and evaluate previously recommended improved tef variety alongside the standard and local check tef varieties under farmers' circumstances in Chora district.

Objectives:-

1. To evaluate yield performance and economic profitability of improved tef varieties in the study area.
2. To improve farmers` knowledge and skills toward tef production and management packages.
3. To identify farmers' tef varietal selection criteria in the study area.

Material and Methods

Description of study area

The study was conducted in Chora district of Buno Bedele zone. Chora is one of the districts in Oromia Regional State of Ethiopia. The district 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 districts. The current capital town of the district is Kumbabe. The district is located at 36 km and 519 km from Bedele and Addis Ababa which are the capital twon/city of Buno Bedele zone and Ethiopia respectively. It is located at an average elevation of 2000 masl 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^0 and a mean annual minimum temperature of 12.5 C^0. The annual rainfall ranges from 1000-1500 mm. The economy of the area is based on mixed cropping system and livestock raring agricultural production system among which dominant crops are maize, tef, sorghum and wheat.

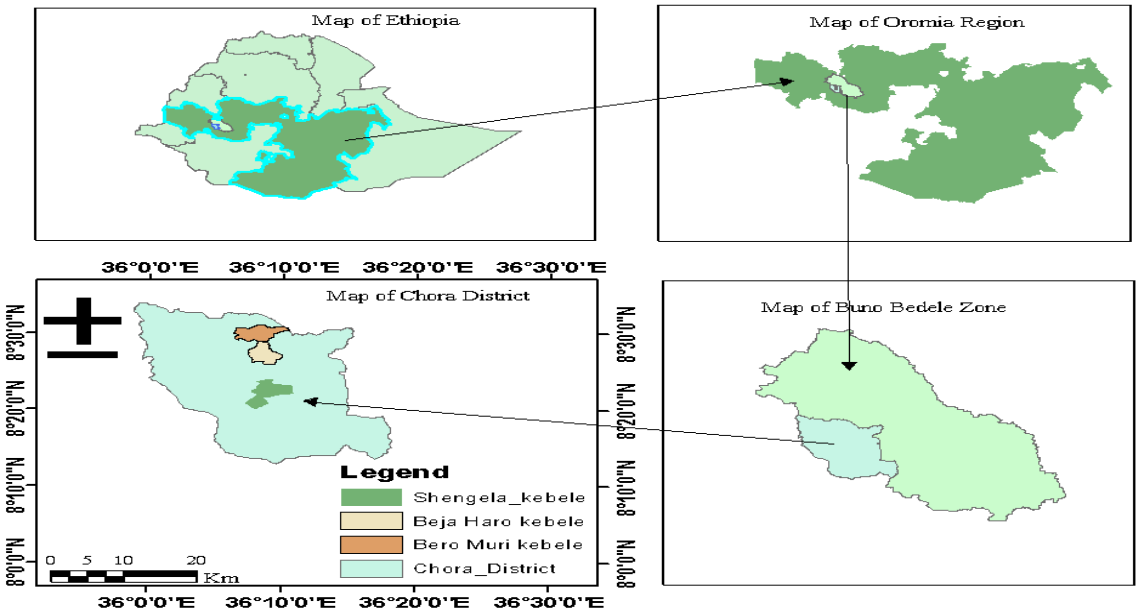

Figure 1. Map of Chora district

Site and farmer selections

Based on tef production potential and road accessibility, three representative kebeles namely; Shengela, Bero muri and Beja haro were selected from the district. Eight demonstration sites (seven on-farmers' fields in Bero muri and Beja haro kebeles and one FTC in Shengela kebele) were used for the activity. Farmers' research group (FRG) approach was followed to select trial farmers. In each three kebeles, one FRG's having 15 members were established. At least two to four hosting/experimental farmers were found in a single FRG member. The trial farmers were selected based on their willingness to contribute land for activity implementation and its management.

Materials and field design

Adapted improved tef variety (Dursi) was demonstrated alongside with Dukem as standard and Dabi as local check varieties. Dursi and Dukem were released from Bako Agricultural Research Center (IQQO) and Debrezeit Agricultural Research Centre (EIAR) respectively. Eight demonstration sites were replicated using hosting farmers' field and FTC as replication site. Accordingly, eight demonstration sites having a plot size of 300 m^2 were implemented in three kebeles. All the recommended agronomic practices like seed rate of 15 kg per hectare and fertilizer rate of 100/50 kg of NPS/UREA per hectare were applied with two hand-weeding for all plots across eight demonstration sites.

Technology promotion events

Training was given to farmers and agricultural experts before the implementation of the activity in order to build knowledge and skills of the participants toward the technology. Mini field day was organized as technology promotion event at representative demonstration site during physiological maturity of the technology so as to enrich a number of neighbor farmers.

Technology evaluation and selection methods

Variety evaluation and selection were conducted on demonstration sites by the farmers through setting their own varietal selection criteria. Before the varietal evaluation and selection, the farmers were sensitized about the attributes of variety selection. The variety evaluation and selection method was conducted with the established FRGs, at different growth stage of the crop.

Method of data collection

Yield data, cost incurred, rate returns, total number of farmers and agricultural experts participated in the training and field days by gender, farmers' preference and farmers' feedback towards the technology were collected using field observation/measurements, key informant interview and Focus group discussion (FGD) methods.

Method of data analysis

Statistical tools/techniques which are different descriptive statistics were used to analyze yield data and number of participants partaken in technology promotion events, whereas economic cost and return were computed using cost-benefit analysis. Farmers' preference to varietal attributes was prioritized and ranked using pair wise and simple matrix ranking methods (Boef and Thijssen, 2007) while farmers' feedback was analyzed in narrated form.

Result and discussions

Yield performance of the demonstrated tef varieties

The descriptive result revealed that, the mean yield in qtha^{-1} of previously adapted improved Dursi variety was better than that of standard check (Dukem) and local check (Dabi) varieties (Table 1). Tefera and Belay (2006) reported, using improved cultivars and management practices, farmers can obtain yields up to 2500 kg ha^{-1}, while the yield potential under optimal management and prevented lodging is as high as 4500 kg ha^{-1} (Teklu and Tefera 2005). Likewise, a good physiological performance of the demonstrated technologies was observed during training, monitoring and evaluation, and farmers varietal selection period but the yield was reduced and below the recommended due to frost and heavy rains before tef harvesting time. Yet, the improved tef (Dursi) variety was performed best compared to standard and local check tef varieties with a yield advantage of 22.8% over local variety. The yield advantage of improved variety over local variety was computed using the following formulas:

$$Yield\ advantage\ \% = \frac{Yield\ of\ improved\ variety - Yield\ of\ local\ check}{Yield\ of\ local\ check} x\ 100$$

Table 1. The mean yield performance of improved tef variety over standard and local checks

Teff varieties	Mean yield qt/ha	Yield advantage (%)
Dursi	12.1	22.5
Dukem	10.7	8.3
Local Check	9.88	-

Source: Own computation 2021/22

Economic analysis of the demonstrated tef varieties

Cost-benefit analysis was employed to ensure the economic profitability of improved tef production. Thus, different variable costs incurred during activity implementation and benefits obtained were recorded for economic profitability analysis (Table 2). Accordingly, the cost benefit ratio analysis showed that, the net of return obtained from improved (Dursi), standard (Dukem) and Local (Dabi) tef varieties were 29,432.5, 23,188.5 and 9797.7 ETB ha^{-1}, respectively. Any improved technologies are economically profitable if their cost benefit ratio is greater than one. Therefore, Dursi variety had cost benefit ratio of 1.18 and profitable compared to standard (0.93) and local (0.4) varieties with similar cost and benefit variables for all varieties per unit area across the demonstration sites.

Table 2. Cost benefit analysis of the demonstrated tef varieties in ETB ha^{-1}

			Varieties		
No	Variables		Dursi	Dukem	Local /Dabi
1	Yield obtained (qtha-1)		12.1	10.7	9.88
2	Sale price (ETB/Qt)		4500	4500	3500
3	Gross Returns (Price X Qt) TR (Birr)		54,450	48,150	34580
4	Opportunity cost of seed purchase (Birr)		750	750	600
5	Opportunity cost of fertilizer purchase	NPS	1718.2	1718.2	1718.2
6	(Birr)	UREA	855.3	855.3	855.3
7	Land preparation and planting		4000	4000	4000
8	Labor for weeding and other management		4800	4800	4800
9	Harvesting and threshing		4500	4500	4500
10	Packing and loading		394	338	308.8
11	Total Variable Costs TVC (ETB/ha)		17,017.5	16,961.5	16,782.3
12	Opportunity cost of land		8000	8000	8000
13	Total Cost (TC)		25,017.5	24,961.5	24,782.3
14	Net Return (GR-TC)		29,432.5	23,188.5	9797.7
15	Benefit cost ratio (NR/TC)		1.18	0.93	0.4

Source: Own computation 2021/22. ETB is Ethiopian Birr

Capacity building through training

The main intention of agricultural extension is to enhance the knowledge and skills of farmers on recommended agricultural technologies (Basha et al., 2021). Accordingly, training was given for different stakeholders including Farmers Research Group (FRGs) members, Development Agents (DAs) and Subject Matter Specialists (SMSs) in order to capacitate their knowledge and skill on improved tef production. The training was given by Bedele Agricultural Research Center multidisciplinary research team more focusing on tef agronomic practices, weeds and diseases control, importance and objectives of organizing farmers in FRGs, comparative advantages of improved tef varieties, variety evaluation and selection criteria and technology transfer approaches. Hence, training was given for about 54 participants.

Table 3. Stakeholders by professions and sex participated on the training at Chora district

District	Participants	Male	Female	Total
Chora	Farmers	39	6	45
	Das	7	-	7
	District Experts	2	-	2
Total		48	6	54

Source: Own computation 2021/22

Technology promotion event

Mini field day was organized to enhance farmer to farmer learning and experience sharing on the production and management practice of improved tef among and between FRGs members. On the technology demonstration event, extension materials like leaflet and small manuals were prepared in Afaan Oromoo and English languages and distributed to the participants those who can read. Mini-field day event was organized during maturity stage of the crops and as a result most farmers and other stakeholders were appreciated the performance of the crops and showed their high interest toward production of improved tef variety as compared to the local variety. Generally, all farmers were interested to have the technology for their future production and other field day participated experts were discussed on their responsibility towards the future technology wider scaling ups.

Table 4. Number of participants on the field day at Chora district

District	Participants	Male	Female	Total
Chora	Farmers	39	6	45
	Das	7	-	7
	Others Stakeholders	8	1	9
Total		54	7	61

Source: Own computation 2021/22

Participatory technologies evaluation and selection

Participatory variety selection is a method in which a small number of finished or almost finished varieties are field-tested with the participation of the partners (Mkumbira, 2003). Participatory variety selections can be used effectively to select farmer-acceptable varieties that are superior to old and obsolete varieties that farmers have been using for a long time (Probst J, Jones K, 2016). To identify and select the best among the provided technologies farmers were facilitated to make important decisions on selection criteria. During PVES, participant farmers were organized to make small groups and were asked to make their own selection criteria. Farmers have their own preference to use certain technology next to recommended agronomic practice. The farmers consider different criteria in addition to the yield of the crop for variety selection. The multipurpose use and higher yield than locally disseminated tef variety increase farmer's motivation to grow the recommended and improved tef variety. Farmers selected the variety based on the criteria like; higher yield, lodging tolerance, disease tolerance, color, marketability, spike length, and straw yield. Based on the above criteria; farmers evaluated the varieties and ranked first Dursi variety.

Table 5. Ranks of the demonstrated tef varieties by farmers using their own varietal selection criteria

Crop varieties	Farmers rank	Reasons
Dursi	1st	High yielder, lodging tolerant, disease tolerant, white in color, marketable, longer spike, has more straw
Dukem	2nd	Relatively low yielder, disease tolerant, not lodge, white in color, marketable, has medium straw yield
Local check	3rd	Lower yield, not at all lodge, less tolerant to disease, red in color, few straw yield

Source: Researcher computation 2021/22

Conclusion and Recommendations

Pre-extension demonstration and evaluation of improved tef variety was carried out on eight demonstration sites of three kebeles in Chora district of Buno Bedele zone southwestern Ethiopia. The 300 m^2 total land size was used for three tef varieties where 10 m x 10 m plot size was allocated for each of improved (Dursi), standard check (Dukem) and local check (Dabi) tef varieties. All recommended agronomic practices were used. The descriptive result shown that, the adapted improved tef variety was performed better in-terms of yield, economic profitability and farmers' preferences than the standard and local check tef varieties with the yield advantages of 13.1% and 22.8% over standard and local varieties respectively. Moreover, the improved tef variety is profitable with promised rate of return. Higher yield, lodging tolerance, disease tolerance, color, marketability, spike length and straw yield are some of the farmers' varietal selection criteria used by farmer research group members on the demonstration site and so the improved tef variety was prioritized first. Therefore, Dursi which is best adapted and evaluated improved variety is recommended for further scaling up in the area and similar agro-ecologies.

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Cluster Based Pre-Scaling up of Soil Test Based Recommended Fertilizer Rate for Maize in Dabo Hana District of Buno Bedele Zone, Southwestern Ethiopia

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Abstract

Cluster based pre-scaling up of soil test based recommended fertilizer rate for maize was conducted in Dabo Hana district in 2020 and 2021 main cropping seasons with the objective to popularize soil test based recommended fertilizer rate for maize. Four kebeles were selected based on maize production potential and road accessibility and then 52 farmers (43 male and 9 female) were selected and organized as farmer clustered approach based on their adjacent land and willingness to participate in the activity. The total land size used for cluster based scaling up activity was 20 hectare (10 ha per year) and BH661 maize variety was planted using all recommended agronomic practice. The mean maize yield obtained across the kebeles was 86.4 qt ha-1 and about 290 different stakeholders were participated on technology popularization events like training and field day. Therefore, further scaling-up and commercialization of soil test fertilizer recommended rate for maize should be carried out in the study area and similar maize production potential agro-ecologies with strong stakeholders' commitment.

Key words: Cluster Approach, Pre-scaling up, Maize, Soil, Fertilizer Recommendation, Farmers

Introduction

Maize is the third most significant cereal crop in the world after wheat and rice and the most extensively grown crop from lowland to highland agro-ecologies in Ethiopia (Gebre *et al.,* 2019). It is the first and second crop in terms of volume of production and area coverage followed by and next to tef (Eragrostis tef) (CSA, 2017). It is grown for food and feed values and is one of the most important staples and cash crops and it is the main sources of calories (Wedajo *et al.,* 2015). The leaf stalk is used for animal feed and also dried stalk and cob are used for fuel. Maize is also used as industrial raw materials for oil and glucose production (MoANR, 2017).

The smallholder farmers that comprise about 80 percent of Ethiopia's population are both the primary producers and consumers of maize (Dawit *et al.,* 2008). The post-harvest crop production survey result in 2021 production season indicated that, about 10,538,342 hectares of the total land areas were covered by cereal crops. Out of the total cereal crop areas, 23.97% (2,526,212 hectares) was covered by maize production (CSA, 2021). Despite the large area under maize, the production and productivity of the crop is diminished. Low soil fertility and nutrient availability due to acidity and low level of input use are also among the major crop production constraints (Alemayehu *et al.,* 2011; Abreha *et al.,* 2013). Farmers are either entirely abandoning the traditional practice of using natural fallow to restore soil fertility, or are unable to leave land fallow for long enough for it to be effective (Corbeels *et al.,* 2000). However, achieving high maize yield requires adequate and balanced supply of plant nutrients (Barbieri *et al.,* 2008; Okoko and Makworo, 2012).

For more than half centuries, Ethiopian farmers used the national extension campaign recommendation, 100/100 kg ha^{-1} DAP/Urea which is not recommended based on soil fertility status and crop nutrient requirements. So many efforts have been made by the

government for smallholder farmers through making fertilizer available at affordable price and recommendations on the amount and type of fertilizers to be applied for most crops and soil types in the country. Unless there is an option for fertilizer recommendation based on soil fertility status and crop nutrient requirements, farmers are forced either to use excess or low amount of these inputs. Inappropriate and unbalanced nutrient addition not only reduces nutrient use efficiency and profitability (Krupnik *et al.,* 2004; Ladha *et al.,* 2005), but also increases environmental risks associated with the loss of unused nutrients through emissions, leaching or run-off (Sapkota *et al.,* 2014). Thus, soil testing is well recognized as a sound scientific tool to assess inherent power of soil to supply plant nutrients and have been established through scientific research, extensive field demonstrations, and on the basis of actual fertilizer use by the farmers on soil test based fertilizer use recommendations (Corbeels, 2000).

Soil test based crop response phosphorus calibration and verification, and NPS fertilizer rate for maize studies were conducted in Dabo Hana district by Bedele Agricultural Research Center and the promising yield result was obtained. Consecutively, pre-extension demonstration study revealed that, the mean grain yield obtained from soil test based NP-fertilizer recommendation rate for maize was higher than that of blanket recommendation by 51% yield advantage in the study area (Tilahun *et al.,* 2020). The technology demonstration activity benefited and covered a few number of farmers compared to large scale technology popularization. Therefore, this study was intended to popularize soil test based recommended fertilizer rate for maize through cluster-based approach in the study area.

Research Methodology

Description of the study area

Cluster based pre-scaling up of soil test based recommended fertilizer rate for maize was carried out in Dabo Hana district of Buno Bedele zone. Dabo Hana district is located at 388 km from the capital city of Ethiopia, Addis Ababa along main road of Nekemte town and 46 km from Buno Bedele zonal capital town, Bedele. Altitude of the district ranged from 1791 to 1990 m.a.s.l and located between 8^0 55’ 26.423” to 8o30‟044” N (latitude) and 36^0 5’ 32.953” to 36^0 26’ 23.781” E (longitude). The mean annual temperature of the district ranged from 15 C^0 to 31 C^0 whereas a mean annual rainfall range from 1000-1500 mm. The dominant type of the soil in district is nitisols. The economy of the area is based on mixed cropping system and livestock raring agricultural production system among which dominant crops are maize, tef, sorghum and wheat. Dabo Hana has 17 kebeles among which 4 kebeles were used for this study.

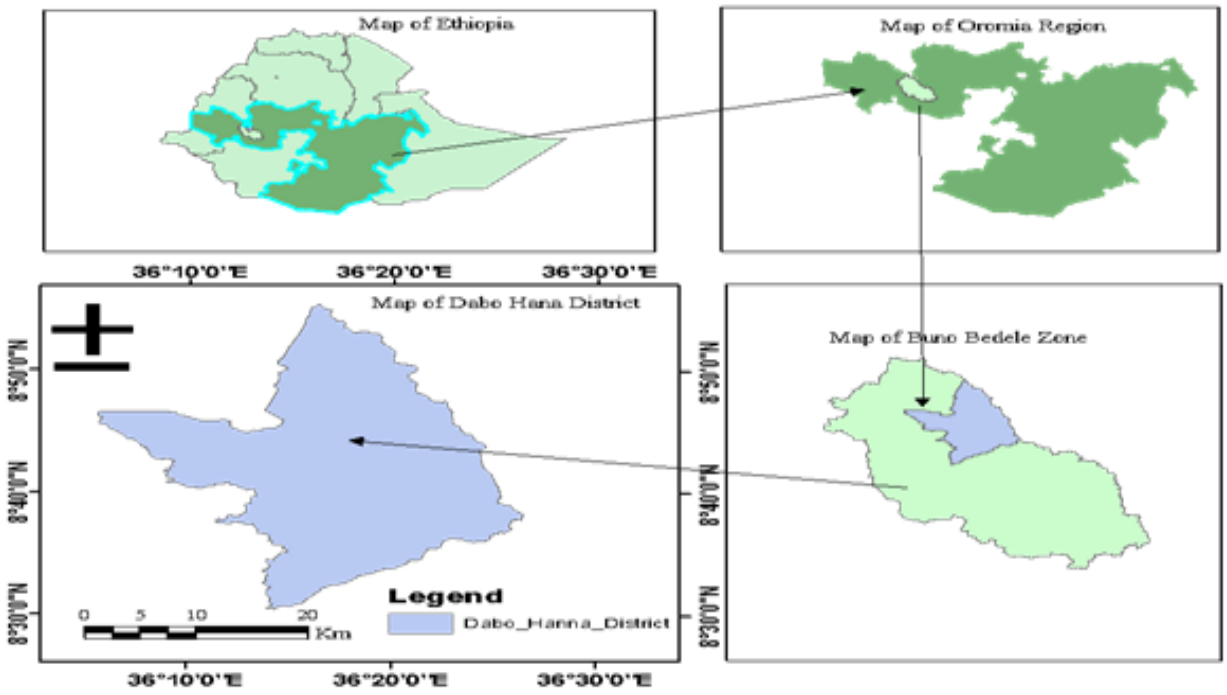

Fig. 1: Map of Dabo Hana district

Site and farmer selection

Dabo Hana district was selected purposively based on its maize production potential, previous history of calibration, verification and demonstration studies. From the district, four kebeles were selected based on adjacent land to establish clustered farmers, road accessibility and convenience of the surrounding areas to the technology promotion. Farmer clustered approach was followed in order to simplify technology promotion through strengthening the participation of clustered and non-clustered farmers and other concerned stakeholders during trainings, field visits/tours and field days. Farmers were selected in collaboration with community leaders, SMS and DAs based on farmers adjacent field, willingness to participate in cluster, commitment to share their ideas and the concept of gender disaggregation. Accordingly, about fifty two neighboring farmers were selected and organized as clustered farmers.

Materials and field design

Improved maize variety (BH661) was used for cluster based scaling up activity in four kebeles for two cropping seasons. About twenty hectares of land (five ha per kebeles) was used for activity implementation. The experimental land was prepared by clustered farmers following their own conventional farming practices. Based on pH status, about 337 qt (213 qt for the first cropping season and 124 qt for the second cropping season) of lime was applied manually on twenty hectares of experimental land. Maize (BH661 variety) was planted using the seed rate of 25 kg ha^{-1} with the recommended spacing of 80 and 50 cm between rows and seed respectively. Bedele Agricultural Research Center provides all agricultural inputs and evidence based information related to the technology. All crop management practices including planting, weeding, harvesting and threshing were done by clustered farmers with close supervision of DAs, Agricultural experts and researchers.

Soil sampling and analysis

During fallow period, surface composite soil samples were collected from the experimental fields at the depth of 0-20 cm using auger tool based on land gradient and cropping history of the fields to analyze the available phosphorus, nitrogen and pH of the soil with standard laboratory procedures. Based on the initial phosphorus status in the experimental land, rate of p-fertilizer to be applied was calculated by P (kg ha-1) = (Pc- Po)*Pf formula. The recommended N-fertilizer rate (138 kg ha^{-1}) for the district was applied in the split of 1/3 at planting time and the remaining two third was applied after the first weeding.

Technology dissemination methods

Training was given to clustered farmers, Das and SMS on technology dissemination and its exit strategy. In order to enrich huge number of maize producers and strengthened linkage within and between concerned stakeholders, mass field day that supported by media coverage was organized at maize maturity stage. Leaflets and poster that describe every step of the activities were distributed to participants on the events.

Data collected and method of analysis

The data like grain yield, number of participants on the training, field visit and field day by gender were collected. The collected quantitative data was analyzed using simple descriptive statistics; while qualitative data was narrated to crosscheck the quantitative data.

Roles and responsibilities of stakeholders during activity implementation

Oromia Agricultural Research Institute (IQQO) is one of the leading stakeholders and has a lion share in providing the research activity implementation budget and its evaluation and monitoring. Bedele agricultural research center (BeARC) is the second stakeholder who made site and farmers selection and then provides maize seed, fertilizer, training and organizing farmers. Moreover, monitoring and evaluation of the implemented activity was made by BeARC. Farmers were the end users and the third stakeholders in activity implementation. Farmers provide land, follow experimental field management, and participate on training and field day and share of gained experience to other non-clustered farmers. Dabo Hana district agricultural office also played a vital role in site and farmer selection in collaboration with the researchers.

Exit strategy

Technology exit strategy is the process of transferring the responsibility of disseminating the technology released or adapted by the research center to public agricultural extension system with the intension of technology commercialization. Mass field day is the technology promotion events that strengthen technology exit strategy between research center and public agricultural extension system. Hence, the responsibility of further technology dissemination has been given to Dabo Hana district agricultural office with minimal research center intervention in sustainable diffusion of the technology.

Result and Discussions

Training for stakeholders

Training is one of the means through which agricultural technologies, knowledge, and skills are conveyed to the small-scale farmers (Tolessa *et al.*, 2017). Accordingly, training was provided to stakeholders by the researchers from soil fertility improvement and agricultural extension research team of Bedele Agricultural Research Center on the importance of soil test based N and P-fertilizers recommendation rate for maize, acidity status, lime requirement and methods of activity implementation. A total of 83 participants were participated on the training (Table 1).

Table 1. Number of clustered farmers and other stakeholders take part in the training

District	Participants and their professions	Male	Female	Total
Dabo Hana	Clustered Farmers	43	9	52
	Das	10	1	11
	Other Stakeholders	18	2	20
	Total	71	12	83

Source: Own data, 2021

Field day

Field day is the technology promotion event that improves wide technology coverage, utilization/adoption and stakeholders linkage. Hence, field day was organized by Bedele Agricultural Research Center where other stakeholders like zone and district level agricultural expertise, development agents and farmers were participated at crop physiological maturity stage. A total of 290 participants were participated on the day and different technology promotion supporting materials were distributed to the participants.

Table 2. Number of clustered farmers and other stakeholders participated on field day

Participants	Male	Female	Total
OARI directorates and centers	32	-	32
Zonal and district agricultural and administration offices	43	7	50
Bedele agricultural research center staff	49	11	60
Clustered Farmers	87	19	106
Other participants	38	4	42
Total	249	41	290

Source: Own data, 2021

Yield performance

The descriptive result revealed that, the mean maize yield obtained in both 2020 and 2021 production seasons was 86.4 qt ha^{-1}. The mean yield obtained on these cluster based scaling up activity was greater than the yield obtained during technology demonstration study (74.90 qt ha^{-1}) in the study area (Tilahun *et al.,* 2020) and even the national maize yield obtained (46.99 qt ha^{-1}) in 2021 production season (CSA, 2021). This indicated that, soil test based fertilizer recommendation and comprehensive agronomic management practices are the ever promising production increment approach that should disseminate across similar maize producing areas. Site specific soil test based fertilizer recommendations ensure balanced nutrient application for crops, smallholder farmers' capacity to afford fertilizer, optimum use of recommended fertilizers and economic profitability.

Table 3. The mean maize yield obtained per cropping season

Location	Maize variety	The mean yield obtained by cropping seasons in qt ha^{-1}		The overall mean yield obtained in qt ha^{-1}
		First cropping season	Second cropping season	
Dabo Hana	BH661	87	85.75	86.4

Source: Own data, 2020/21

Conclusion and Recommendations

Scaling up of soil test based recommended fertilizer rate for maize through farmers cluster approach was implemented in four kebeles of Dabo Hana district. About 52 were organized in cluster approach and 20 hectares of land were covered by BH661 maize variety. Training was provided to 83 participants whereas about 290 different stakeholders were participated on field day so as to strength linkage between farmers, development agents, district and zonal agricultural offices and research center for the sustainable dissemination of soil test based recommended fertilizer rate for maize in the study area and similar agro-ecologies. The highest maize grain yield (86.4 qt ha^{-1}) was obtained compared to the yield obtained during technology demonstration and the national maize yield obtained in 2021 cropping season. Soil test based fertilizer recommendation through cluster approach and comprehensive agronomic management practices are the ever promising production increasing approach and therefore different agricultural stakeholders specifically research center, university, zone and district agricultural expertise, development agents and farmers should work collaboratively toward the sustainability and large coverage of this improved technology.

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Pre-Extension Demonstration of improved Bread Wheat technology at Midlands of Guji Zone, Southern Oromia, Ethiopia

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Abstract

*In Ethiopia wheat is strategic crop to solve food insecurity. However, there is lack of improved variety which can increase surplus production. Thus, demonstration and use of improved and new variety is important for producers. This demonstration was aimed to evaluate yield performance and profitability of Adola 1 bread wheat variety. Adola 1 and local variety was demonstrated on 10mx10m during 2021 production year at midland districts of Guji zone. Farmers were trained on wheat production. Interview and measurement was to collect the data. The collected data was analyzed by descriptive, net income and narrations. The result of demonstration showed that Adola 1 variety gave higher yield (36.41 qt/ha) than local variety (*23.21 qt/ha) *at Wadera district. The result showed It that Adola 1 variety gave more Net income (73266.79 ETB/ha) than local variety (26830.71 ETB/ha). Production of Adola 1 variety was profitable than local used varieties at midland. The color of Adola 1 was preferred by farmers for market and household consumption purposes. Adola 1 was early matured variety so that it was preferred by farmers. Adola 1 was easily threshed than local variety at Wadera district. Despite affected by birds the early maturity of Adola 1 variety was likened by experimental farmers. Farmers should use Adola 1 variety in their bread wheat production. For further promotion, pre scaling up of Adola 1 variety should be conducted in the midland districts of Guji zone.*

Key Words: Wheat, Adola 1, Demonstration, Guji

Introduction

Bread wheat (Triticum aestivum. L) is the most common cultivated wheat species-taking up to 95% of the wheat and staple food for consumers worldwide (Kasahun, 2020). In the World among 125 wheat-producing countries, Ethiopian wheat area coverage and productivity are ranked 25th (1.7 million hectares) and 63th (28,126 kg/ha), respectively. Its productivity is by far lower compared to wheat-producing countries such as Ireland (101,746 kg/ha), New Zealand (98,633 kg/ha) and Netherlands (90,936 kg/ha) (FAOSTAT, 2017) Empirical studies on assessment of wheat yield indicate that other African countries such as Egypt, South Africa and Kenya obtained 67, 35 and 30 quintals per hectare, respectively more than Ethiopia (28qt/ha) (Adugnaw and Dagninet, 2020; Goshu *et al.*, 2019; Tadesse *et al.*, 2018). In Guji zone wheat productivity was 32.24 qt/ha (Basha *et al.*, 2021).

Wheat is the most important grain crop for food security and is used as a source of income for developing countries (Tolasa *et al.*, 2022; Amentae *et al.*, 2017). In Ethiopia wheat is the most important cereal crops in terms of both production and use. Wheat grain is used for preparation of different traditional food staffs, such as "Injera", bread (Dabo), Local beer (tella), "dabokolo", "marqa" and "kinche". Besides, wheat straw is commonly used as roof thatching materials and as feed for animals (Temesgen *et al.*, 2022; Bezabih, 2020).

Ethiopia has huge potential and suitable agro ecology for growing wheat. In spite of the presence of wide agro-ecologies wheat production is left behind by 25 to 30% to its demand because of increased demand for wheat due to population growth, urbanization, and expansion of agro-industries (Hodson *et al.,* 2020). To feed the world's growing population, the global demand for wheat yield should increase by 50% in 2050 (Allen *et al.,* 2017). Demand of wheat for household consumption is achieved by popularizing and multiplying released wheat varieties on farmers' land (Basha *et al.,* 2021). Ethiopia is still importing about 1.6 million tons of wheat which estimated to 25% in deficit to fulfill domestic wheat demand by foreign currency (USDA, 2018). Hence, the Ministry of Agriculture and Natural Resource plans to increase wheat productivity from 2.7 metric ton/ha in 2019 to 4 metric ton/ha by 2023 and reduce wheat import from 1.7 million metric ton in 2019 to zero by 2023 (Getachew, 2020).

For surplus production the government of Ethiopia focused on wheat production both rain fed and irrigation aimed to bring household food security and income generating. However, the productivity of the crop is low mainly due to rust and lack of improved varieties. Breeders were intended to balance the wheat demand by releasing new bread wheat varieties suitable for different agro ecologies. Bore Agricultural Research Center had released new bread wheat variety for midland Guji zone. In line with government on wheat production demonstrating new variety is very important as entry point for surplus production and fulfill the demand of bread wheat for household consumption and export.

Objectives

1. To evaluate yield performance of Adola 1 wheat variety under farmers' conditions.
2. To estimate profitability of Adola 1 wheat variety production.
3. To assess farmers' feedback on Adola 1 bread wheat variety.

Research Methodology

Description of the study areas

Adola Rede District The district is located in Southern part of Oromia, Ethiopia, at a distance of 468km from Finfine, the capital city of Ethiopia. Astronomically, the district is located between $5^0$44'10"- $6^0$12'38" latitudes and $38^0$45'10"- $39^0$12'37" longitudes. In terms of the agricultural calendar, the rain fall pattern of the district is bimodal for lowlands and midland areas and monomodal 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. 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 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^o 39'5"-6^o 2'28" northing latitudes and 39^0 5'30"-$39^0$27'52" easting longitudes. It is an area where mixed farming economic activities take place, which is the major livelihood of the people. 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. The annual rainfall ranges between 915 mm and up to 1,900 mm. 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 soil of district is good for crop production. Generally, teff, maize, haricot bean, wheat, barley are the major crops produced in the district (Korji *et al.*, 2021). Adola Rede and Wadera district has mainly two seasons (Bona and Gana). Maize is produced during Gana season. Tef, barley, haricot bean and wheat can be produced both seasons.

Sites and experimental farmers' selection

The study was conducted at two midlands of Guji Zone during 2021 production year. Adola Rede and Wadara district were purposively selected based on their wheat production. Two kebele from each district were selected based their wheat production and accessible for monitoring. At each kebele one farmer research group was established. In one farmers research group there were 15 members. Out of one farmers research group there was three-four experimental farmers. With collaboration of district agricultural office, seven experimental farmers were selected from each district. Totally, the demonstration was conducted on 14 experimental farmers.

Materials and Methods

Adola 1 variety and local variety demonstrated during Gana season (April to June) on 14 experimental farmers and the activity was again repeated on 21 experimental farmers during Bona season (start early September) though it was not gave a good result due to lack of rainfall after milking stage. Hence, the result of data during Bona season was excluded from data analysis. There is no local variety used at Adola Rede district since the area was not producing wheat during demonstration. A seed rate of 150kg/ha was used on 10mx10m area. 20cm between rows and the seed was drilled in the line of rows. Inorganic fertilizers (NPS 121kg/ha and 50kg/ha of UREA) were used during demonstration. Weed was controlled by hand and herbicide application (2-4-D). Harvesting was done by hand and threshing was done by manual. Training was given on spot. The activity was monitored by researchers and Development Agents assigned at each kebele.

Methods of data collection

Data were collected through interview and measurement.

Methods of data analysis

The collected data were analysis by descriptive statistics and narrations of farmers' feedbacks. Net income was used to estimate profitability of demonstrated wheat in the area. Variable costs and fixed cost was collected. Total revenue (TR) was calculated as:

$$\mathbf{TR = Y * P} \quad \ldots\ldots\ldots 1$$

Y= yield obtained (qt/ha) and P farm gate price in birr

Net income (NI):

$$\mathbf{NI = TR - TVC - FC} \quad \ldots\ldots\ldots 2$$

Where TR= Total Revenue, TVC= total variable cost and FC= fixed cost

Results and discussions

Enhancement of farmers' knowledge and skills

One of extension methods used in technology transfer is training. It was used to enhance the knowledge and skills of farmers on aspects of technology demonstrated. Knowledge and skill based training was given on wheat production both during bona and gana seasons. 60 farmers, 8 Development agents (DAs) and 4 Subject Matter Specialist (SMSs) were trained during bona season. Training was given on demonstration sites. During monitoring of the performance of trial at each experimental farmers supervised and corrective measures (comments) which can enhance farmers' knowledge and skills was given by agricultural extension researchers.

Yield performance demonstrated varieties

The result of demonstration showed that Adola 1 variety gave higher yield (36.41 qt/ha) at Wadera district than Adola Rede district. Since farmers were not producing wheat at Adola district there is no local variety used as a check. However, with initiative on irrigation the production of wheat by irrigation was started at some irrigation schemes. As this demonstration was done by rain fed the result was not compared with irrigation production. The result of Adola 1 demonstration was (35.06 qt/ha) higher than during its releasing time (27.3 qt/ha) (Aliyi *et al.,* 2022) and national yield 30.46 qt/ha (CSA, 2021). This indicated that midlands of Guji zone were potential for wheat production.

Table 1 Yield performance of demonstrated varieties (qt/ha)

District	Varieties	N	Mean	Standard deviation
Adola Rede	Adola 1	7	33.71	1.729
Wadera	Adola 1	7	36.41	1.284
	Local	7	23.21	1.955
Total	Adola 1	14	35.06	2.025
	Local	7	23.21	1.955

Profitability analysis

The farm gate price Adola 1 variety was 28 birr/kg while it was 23 ETB/kg for local variety. Estimated seed cost of Adola 1 was 4000 ETB and mean cost of local variety at Wadera district was 2500 ETB. Total Revenue (TR) was obtained by multiplying yield by farm gate price Total Variable Costs (TVCs) included for cost benefit analysis includes costs of seed, fertilizer, land preparation, sowing, weeding, harvesting and threshing. Cost of fertilizer used for one hectare (121kg/ha) of NPS was 2500 ETB and 50kg/ha of UREA was 1300 ETB at Adola Rede district while NPS was 2600 ETB and UREA was 1375 ETB at Wadera district. Fertilizers were purchased at the mean of 3887.5 ETB at both districts. Net income was calculated as TR-TVCs-TFCs. It was observed that Adola 1 variety gave more Net income (73266.79 ETB/ha) than local variety (26830.71 ETB/ha). Production of Adola 1 variety was profitable than local used varieties at midland. Therefore, farmers should use Adola 1 variety for their wheat production at midland areas of Guji Zone.

Table 2.Net income of demonstrated varieties

Parameters	N	Mean	Std. Deviation
Yield of Adola 1 variety (quintal/ha)	14	35.06	2.03
Yield of local variety (quintal/ha)	7	23.21	1.96
Price of Adola 1 variety (ETB/ha)	14	2900.00	103.78
Price of local variety (ETB/ha)	7	2300	0.00
Seed cost of Adola 1 variety (ETB/ha)	14	4000.00	.000
Cost of local seed variety (ETB/ha)	7	2528.57	75.59
Fertilizer cost (ETB/ha)	14	3887.50	90.80
Land preparation (ETB/ha)	14	3052.14	135.54
Sowing cost (ETB/ha)	14	1682.14	89.03
Weeding cost (ETB/ha)	14	1369.29	54.03
Harvesting cost (ETB/ha)	14	2502.86	94.66
Threshing cost (ETB/ha)	14	2560.71	81.28
TR of Adola 1 variety (ETB/ha)	14	101821.43	8773.40
TR of local (ETB /ha)	7	53392.86	4496.15
TVCs of Adola 1 variety (ETB/ha)	14	19054.64	225.67
TFC (cost of land) ETB/ha	14	9500	518.875
TVCs of local variety (ETB/ha)	7	17533.57	174.68
Net income of Adola 1 variety (ETB/ha)	14	73266.79	9229.895
Net income of local variety (ETB/ha)	7	26830.71	4409.977

Farmers' preference on demonstrated varieties

Adola 1 variety gave higher yield than local variety. Adola 1 variety production was preferred during Gana season though there is a possibility during Bona season based on availability of rainfall. The color of Adola 1 was preferred by farmers for both market and household consumption purposes. Adola 1 was early matured variety so that it was preferred by farmers. Adola 1 was easily threshed than local variety at Wadera district. However, it was slightly affected by birds at both districts. Despite affected by birds the early maturity of the variety was likened by experimental farmers since there was a shortage of rainfall in the study areas.

Table 3 Farmers' preference on demonstrated varieties (N=7)

	Rank	**Preferred wheat traits**	**Rank**	
	1^{st}	Higher Yield	2^{nd}	
	1^{st}	Early maturity	2^{nd}	
Adola 1 variety	1^{st}	Marketability	2^{nd}	Local variety
	1^{st}	Disease tolerant	2^{nd}	
	1^{st}	Easiness for threshing	2^{nd}	
	1^{st}	Bird attack	2^{nd}	
	1^{st}	Over all rank of variety	2^{nd}	

Conclusions and recommendation

Conclusions

Demonstration of Adola 1 variety was conducted at midland districts of Guji Zone. The result of demonstration showed that Adola 1 variety was higher yield than local variety. The result of Net income revealed that production of Adola 1 variety was profitable at midland areas of Guji zone. Experimental farmers were preferred Adola 1 over the local based on its disease tolerant, early maturity, good marketability and easiness for threshing. One problem

regarding Adola 1 variety production during demonstration was its attack by birds. This was due to its earliness to mature. Despite it was affected by birds farmers preferred to produce Adola 1 variety since there was shortage of rain fall in the midland areas of Guji zone. The production of Adola 1 was more preferred during gana season than bona season.

Recommendation

For further promotion, pre scaling up of Adola 1 variety should be conducted in the midland areas Guji zone. Farmers of midland area should use Adola 1 variety in their bread wheat production since it gave higher yield and returns.

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Pre extension demonstration of improved Desho grass in Selected Highland districts of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Food and feed is the most aspect in agricultural sector. Potential land is covered by crop production to feed the increasing human population. Hence, for livestock production feed is challenging to be solved. Therefore, balancing the available land for crop and livestock production is critical as the land is fixed resource. This could be achieved by demonstrating year round forage production on small area. This activity was conducted to evaluate biomass yield of Desho grasses and to enhance the knowledge and skills of farmers on production of Desho grass. Areka DZF No #590 and Kindo Kosha DZF No #591 desho grasses were planted on 5mx10m with recommended packages. Measurement, observation and interview were used to collect the data. The result of descriptive statistics showed that Kindo Kosha DZF No #591 variety had more plot cover (88.47%) than Areka DZF No #590 variety (85.76%). As desho grass is annual forage and regeneration trait was important for livestock feed. Kindo Kosha DZF No #591 variety also provide high in regeneration capacity (85%) than Areka DZF No #590 (83%). More fresh biomass was obtained from Kindo Kosha DZF No #591 (49.78t/ha) than Areka DZF No #590 (47.59t/ha). The result of paired sample test showed that there was a mean significance difference in knowledge and skills before and after on demonstration of desho grasses at 0.001 level. Knowledge and skills of farmers were increased by trainings and field days organized on desho grass demonstration. Demonstrated desho grass varieties were good at plot cover, plant height, regeneration and fresh biomass at highland of Guji zone. Therefore, they can solve feed shortage at study areas. Experimental farmers liked Areka DZF No #590 and Kindo Kosha DZF No #591 varieties for their livestock feeding. Therefore, it is better to pre scaled up these desho grasses at highland areas of Guji zone. To know more advantage of desho grass as livestock feed further research is needed on the effect of desho grass on milk and meat production at the study areas.

Key words: Desho grass, Demonstration, Guji, Areka, Kindo Kosha

Introduction

In Ethiopia, the livestock sub-sector has significant contributions to the national income (Wondimagegnhu *et al.*, 2019) and the livelihoods of households. However, livestock productivity is very low attributable to different factors of which poor nutrition is the major one. The livestock production is constrained by feed shortage in terms of both quantity and quality (Duguma *et al.*, 2017). On the other hand, the demand for livestock products by consumers in country projected at accelerate rate and it is difficult to satisfy the demand of consumer under such conditions unless urgent measure will be taken (Denbela *et al.*, 2020). Natural pasture based feed supply, inadequate and generally of poor quality in Ethiopia, especially in the dry season, has been predominantly responsible for the low productivity of livestock in crop livestock farming systems (Hidosa and Getaneh, 2021; Duguma and Janssens 2021 and Girma *et al.*, 2020). According to Mengistu (2002) many indigenous forage species in Ethiopia have low productivity or low digestibility which reduces their usefulness for livestock nutrition.

Improved feed production is required to support climate resilient agriculture, reduce greenhouse gas emission and increase livestock productivity in these agricultural systems (Jirata *et al.,* 2016). Among the recommended mitigation strategies of feed shortage in the country is the utilization of indigenous adaptable multi-purpose fodder species such as Desho grass (Abera *et al.,* 2021). To improve availability of livestock feed in terms of quantity and quality, it is better to cultivate Desho grass forage that have better biomass yield and nutritional quality. Desho grass has a crude protein content of 9.6% on DM basis at early stage and 1.6% at straw stage, respectively. The digestibility and voluntary intake decrease with increase in stage of maturity which indicates that the grass should be fed at early stage of maturity. Mature desho grass must be well supplemented with protein sources in order to sustain growth and/or milk production. Urea treatment may be a valuable option to improve its nutritive value with the addition of adequate energy supplementation (Teshale *et al.,* 2021).

The grass is also widely used in soil and water conservation activities to combat land degradation and to improve productivity of land (Yakob *et al.,* 2015). Farmers in many parts of Ethiopian highlands adopted Desho grass production because of its merits as animal feed and in soil and water conservation and management (Yakob *et al.,* 2015; Umer *et al.,* 2019). It has the potential to meet the challenges of feed scarcity as it gives high biomass yield per unit area and ensures year round forage supply due to its rapid growth and drought tolerance (Danano, 2007; Shiferaw *et al.,* 2011). However, improved production and utilization practices of Desho grass are also very important by small-scale farmers (Mengistu *et al.,* 2021).

Guji zone is well known by potential of livestock production but there was lack of improved forage species due to lack of demonstration and multiplication of forage varieties in the zone. The sustainable option to solve lack of forage varieties was adapting forage varieties followed by demonstration and scaling up of best forage varieties in the area (Basha *et al.,* 2021). Now a day potential land was covered by crop production which is expected to feed ever increasing human population. Only small and non-fertile lands left as a livestock feed. This led to shortage of feed for livestock seasonally. Therefore, balancing land for crop and livestock production is a mandatory. This will be attained in the form demonstrating improved forage grass like desho grass which can provide large volume of biomass from small area. Despite important as feed and soil conservation in many parts of the country at highlands of Guji zone desho grass is not produced by farmers. This is due to lack of improved desho grasses production on farmers' field. Demonstration of improved desho grass was important for promotion of desho grass at highlands of Guji zone.

Objectives

1. To evaluate biomass yield of Desho grass under farmers condition
2. To enhance the knowledge and skills of farmers on production of Desho grass
3. To identify farmers preference on production of Desho grasses

Research Methodology

Description of the study areas

Bore is 385 km away from Addis Ababa to the South. The district is bordered by Hula district of SNNPR in the North, Ana Sora district in the South, Bona district of SNNPR in the East and Dama district in the West. The major agro-ecology of the district was highland (90%) and midland (10%). Annual average of temperature of the district is 16.05 0C. The mean annual rainfall is 1300mm while its altitude ranges from 1400 up to 2910 meter above sea level allowing a favorable opportunity for crop and livestock production. Root crops such as potato, carrot and onion and vegetable crop like cabbage could be grown in the area. At Bore district, cattle, horses, sheep and bee keeping are the dominant livestock. Selling of milk is one of income generating activity for rural women. Bore is also well known by its 'white honey' which is produced from different plants found in the district. Some rural youth and male farmers of Bore district are migrants to extract minerals namely gold to maintain their income during off season (Basha and Dembit, 2017).

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 bordered by Bore to the north, Dama to the east, Arda Jila Mea Boko to the south and Girja to the east. 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).

Farmers' selection

Demonstration of improved desho grasses were done at Bore and Ana Sora districts. Five kebeles (three from Bore and two from Ana Sora district) were selected by district agricultural office. During 2020 production year 12 and in 2021/2022 year six experimental farmers were selected. Experimental farmers were selected based on their interest grow desho grasses and land ownership.

Materials and methods

For the demonstration, Areka DZF No #590 and Kindo Kosha DZF No #591 desho grasses were used. Two plant tillers were planted in hole in row of 50cm and 10cm between tillers. 100kg/ha of NPS was applied at planting and 50 kg/ha of UREA was applied after establishment of tillers. The grasses were planted on the area of 5mx10m. Prior to demonstration the selected experimental farmers were asked some questions to understand their prior knowledge and skills on desho grass production. After test, training on desho production was given for farmers. At vegetative stage field day was organized for further demand creation on desho grasses. At the last, the prepared question was re asked to experimental farmers in order to understand the impact of demonstration on knowledge and skills of farmers on desho grass production. Hand weeding and hoeing was done by experimental farmers (household menbers). Based on availability of moisture desho grasses were harvested three times in the year. Cutting and carry system was used to feed the livestock (sheep and cattle).

Methods of data collection and analysis

Measurement, observation and interview were used to collect the data. Plot cover, plant height regeneration and fresh biomass were collected with collaboration of experimental farmers and researchers. These data were taken three times and the mean was used for data analysis purpose. Fresh biomass was taken from $1m^2$ quadrant on random plot area and the result was converted hectare and ton. Randomly, five plant heights were collected and the mean of these randomly taken heights was used for analysis of the data. Knowledge and skills test (17 questions) was prepared on desho grasses production. Interview on questions regarding desho grass production was conducted before and after demonstration. Descriptive statistics and paired sample test was used to analysis the data. Independent t test also employed to test desho grass traits among the varieties.

Results and discussion

Performance of demonstrated varieties

From the demonstrated varieties Areka DZF No #590 variety had higher height (51cm) than Kindo Kosha DZF No #591 variety. One of important trait of desho grass is height which could increase the volume of feeds for livestock because desho grass can be chopped to different size. The larger in heights of grasses the more availability of feeds. Depending on covering of the space Kindo Kosha DZF No #591 variety (88.47%) had more plot cover than Areka DZF No #590 variety (85.76%). The result of this demonstration was in line with the study of Teshale *et al.,* 2021 Kindo Kosha DZF No #591 variety had more plot cover than Areka DZF No #590. Their finding also indicated that Areka DZF No #590 variety had more height than Kindo Kosha DZF No #591 like the current demonstration. One aspect of desho grass was covering the land and as much as high number of tillers on the plot. Kindo Kosha DZF No #591 variety also provide also high in regeneration capacity (85%) than Areka DZF No #590 (83%). As desho grass is annual forage and regeneration trait important was for livestock feed. The ability to regenerate after harvest can determine the amount of desho grass used for livestock. The more regenerate the more volume of feed throughout the year. More fresh biomass was obtained from Kindo Kosha DZF No #591 (49.78t/ha) than Areka DZF No #590 (47.59t/ha) (Table 1). The result of this demonstration was contrary to results of Teshale *et.,* 2021 (Areka DZF No #590 variety with 41.5 t/ha and Kindo Kosha DZF No #591 variety 36t/ha) and Tarekegn *et al.,* 2020 who indicated Areka DZF No #590 variety gave more fresh biomass than Kindo Kosha DZF No #591. Variation in fresh biomss could be due to variation in management and soil. However, the result this demonstration is in line with the results of Tesema (2022) Kindo Kosha DZF No #591 variety generated good fresh biomass than Areka DZF No #590 variety.

Despite numerical variation of Kindo Kosha DZF No #591 and Areka DZF No #590 in plot cover, plant height, regeneration and fresh biomass at the study area there is no statistical significance difference between the two varieties. The result of independent t test showed that there is no statistical significance difference between plot cover, plant height, regeneration capacity and fresh biomass of Areka DZF No #590 and Kindo Kosha DZF No #591 variety (Table 2). This indicated that farmers can use either Areka DZF No #591 or Kindo Kosha DZF No #591 variety for livestock feeding at the study areas.

Table 1 performance of demonstrated desho grasses

Variety demonstrated	Data collected	N	Mean	Std. Deviation
Areka DZF No #590	Plot cover in %	18	85.76	7.570
	Height in cm	18	51.28	7.934
	Regeneration in %	18	83.57	6.122
	Fresh biomass yield (t/ha)	18	47.59	7.093
Kindo Kosha DZF No #591	Plot cover in %	18	88.47	6.813
	Height in cm	18	50.81	7.014
	Regeneration in %	18	85.11	4.772
	Fresh biomass yield (t/ha)	18	49.78	10.811

Table 2 independent t test on desho grass traits

Desho grass traits		t-test for Equality of Means			
		T	Df	Sig. (2-tailed)	Mean Difference
Plot cover	Equal variances assumed	-1.129	34	.267	-2.709
	Equal variances not assumed	-1.129	33.629	.267	-2.709
Plant height	Equal variances assumed	.185	34	.854	.462
	Equal variances not assumed	.185	33.496	.854	.462
Regeneration capacity	Equal variances assumed	-.840	34	.407	-1.536
	Equal variances not assumed	-.840	32.086	.407	-1.536
Fresh biomass	Equal variances assumed	-.719	34	.477	-2.191
	Equal variances not assumed	-.719	29.348	.478	-2.191

Knowledge and skills of farmers on desho grass production

In agricultural extension system it is not merely technology transfer but also knowledge and skills of farmers on the production of recommended technology should be improved in order to sustain the use of technology in their farming system. This knowledge and skills is mainly improved by training, advising and showing the technology to the farmers. In this activity training was used as knowledge and skill improvement extension method. Two times training of farmers was conducted on desho grass production. Mini field day was also organized to create demand and important information (importance of desho grass and way of production) was delivered during the event. Training and mini field day enhanced farmers' knowledge and skills on desho grass production.

Table 3 Number of participants on training and mini field day on desho grass demonstration

Extension method used	Participants	Numbers of participants by sex		
		Male	Female	Total
Training	Farmers	83	37	120
	Development agents (DAs)	17	2	19
	Subject matter specialists (SMSs)	8	-	8
Mini field day	Farmers	94	19	113
	Development agents (DAs)	31	4	35
	Subject matter specialists (SMSs)	20	3	23
	Others	7	1	8

The result of paired sample test showed that there was a mean significance difference in knowledge and skills before and after on demonstration of desho grasses at 0.001 level (Table 4). This meant trainings given, field days, researchers' follow up and monitoring on demonstration increased farmers' knowledge and skills on desho grass production.

Table 4. Knowledge and skills test result

NS	Test exam	Mean	N	Std. Dev	T	Df	Sig. (2-tailed)
1	Knowledge and skills after demonstration	10.00	18	2.18	-	-	-
2	Knowledge and skills before demonstration	2.89	18	.850	-	-	-
3	Knowledge and skills after demonstration - knowledge and skills before demonstration	7.11	18	1.71	17.63	17	.001

Female farmers obtained fresher biomass yield than the male farmers in both varieties. This could be due to females farmers well manage their backyard field than male experimental farmers. In addition, female experimental farmers harvested fresh biomass yield of Areka than Kindo Kosha variety. However, knowledge and skills' of female farmers before and after demonstration was less than their counter parts (Table 5). This showed that male farmers could easily understand the knowledge and skills needed for desho grass production due to their more social interaction with Development Agents and researchers.

Table 5 Fresh biomass yield and knowledge and skills based on sex of experimental farmers

Sex of experimental farmer		Fresh biomass yield of Areka (t/ha)	Fresh biomass yield of Kindo Kosha (t/ha)	Knowledge and skill before demonstration	Knowledge and skill after demonstration
Female	N	3	3	3	3
	Mean	52.20	51.20	2.67	8.67
	Std. Dev	6.58	3.06	.577	1.53
Male	N	15	15	15	15
	Mean	46.67	49.50	2.93	10.27
	Std. Dev	7.03	11.84	.904	2.23
Total	N	18	18	18	18
	Mean	47.59	49.78	2.89	10.00
	Std. Dev	7.09	10.81	.85	2.18

Farmers' perception on desho grass demonstrated

Experimental farmers mentioned that both demonstrated desho grasses were nominated for further promotion due to their plot cover, good regeneration after harvest and fresh biomass yield. In addition, both varieties were palatable for livestock (mainly sheep and cattle) during wet and dry season. Areka DZF No #590 and Kindo Kosha DZF No #591 varieites of desho grasses were identified and preferred for livestock feed by experimental farmers. Farmers' mentioned that desho grass also used as soil erosion control. In the highlands there was high influence of erosion. Most land of highland areas of Guji affected by erosion. Demonstrated desho grass was effective to control erosion on the selected experimental farmers. Some

farmers mentioned that desho grass is becoming income generating feed as the grass is sold for NGO and local farmers. .

Summary and Conclusions

Land is a fixed production resource for farmers. The amount of land covered by crop and livestock production is not balanced as crop production takes the larger portion to feed the increasing human population. Though more land is covered by crop production there is food insecurity at many households. Food and feed is the most aspect in agricultural production. As a far as crop production is needed the role of livestock as ploughing and threshing in crop production is unnoticed. In addition, there is also high a demand of livestock products (mainly milk and meat) by rural and urban dwellers. Therefore, production of forages for livestock is important to get optimum livestock product. Due to lack of feed in quality and quantity through the year many animals were not provided good livestock product. Furthermore, many animals were not survived from drought and diseases due to lack of feed. Hence, demonstration of forages at farm level is important to solve livestock feeds.

Pre extension demonstration was conducted on two improved desho grasses at highlands of Guji zone. Desho grass was mainly used as a livestock feed and soil erosion control which affected highland areas since there was high rainfall. The result of demonstration showed that Areka DZF No #590 and Kindo Kosha DZF No #591 variety gave good fresh biomass throughout the year. Therefore, cutting and carry system is important to feed livestock at home (for fattening purpose or for sick animals). Areka DZF No #590 and Kindo Kosha DZF No #591 varieties were good at plot cover, plant height, regeneration and fresh biomass at highland of Guji zone. Therefore, they were expected to solve current feed shortage at highland areas. However, the production of Areka DZF No #590 and Kindo Kosha DZF No #591 has no statistical difference in plot cover, plant height, regeneration and fresh biomass. The result of knowledge and skill analysis showed that trainings and field day organized on demonstration had improved farmers knowledge and skills on desho grass production. Knowledge and skills of farmers on forage production can be increased by trainings and field days. Experimental farmers liked Areka DZF No #590 and Kindo Kosha DZF No #591 varieties for their livestock feeding.

Recommendations

Farmers can use either Areka DZF No #590 or Kindo Kosha DZF No #591 variety for their livestock feeding. Therefore, it is better to pre scaled one of demonstrated desho grasses at highland areas of Guji zone. To know more advantage of desho grass as livestock feed further research is needed on the effect of desho grass on milk and meat production at the study areas. Similar to crop production forage production needs effective trainings for farmers needed to sustain forage production at farm level.

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Pre scaling up of Tef variety at midland districts of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Tef is stable crop food in Ethiopia. However, many farmers were not food secured and only few model farmers used tef for their daily local food. This is due to the use of low yielder varieties. On the other hand, improved tef varieties were not disseminated for surplus production. Therefore, it is important to find the way of improved tef varieties were disseminated in potential areas of Guji zone. This activity was conducted to popularize improved Dagim tef variety, strengthen stakeholders' linkage and to improve farmers' income. Adola Rede, Odo Shakiso and Wadera were selected purposively. 83 farmers were selected for pre scaling up tef. In addition, four FTCs were used as multiplication site as a seed source for the next season. 400kg of Dagim variety was distributed. 4.5kg of Dagim variety was distributed for the selected farmer and sown on 0.25ha. Training and field day was organized. Yield, cost of production and farmers perception were collected by interview method. Data was analyzed by descriptive statistics, net income and narration. The yield performance of Dagim variety was 9.82 qt/ha which low compared to national and demonstration stage due to lack of rainfall. The result of net income showed that production of Dagim variety generated a return of 15735.72 ETB/ha. More net income (17551.63 ETB/ha) was obtained at Odo Shakiso district followed by Adola Rede district (16503.36 ETB/ha). There was a good yield and income at some farmers who sown Dagim variety at mid of September month. Dagim variety should be disseminated in the midland districts of Guji Zone.

Key Words: Pre scaling up, Tef, Dagim, Guji

Introduction

Tef (Eragrostis tef) is an ancient tropical cereal crop that has its center of origin and diversity in the northern Ethiopian highlands from there it is believed to have been domesticated (Demeke and Marcantonia, 2013). It is a staple food grain in Ethiopia mainly used to make injera as a traditional fermented Ethiopian pancake. In other countries like Australia, South Africa, and the United States it is predominantly used as a forage crop for animal feed (Kaleab, 2018; Barretto *et al.*, 2021).

The wide smallholder farmers in the country favor producing the crop because it is greatest adaptable to a wide range of environmental conditions can produce well in marginal areas and is extremely tolerant of drought and other constraints (Bekele *et al.*, 2020). The crop is less susceptible to diseases and insects and rich in nutrients (Mihretie *et al.*, 2021). Tef is the most important indigenous cereal crop in Ethiopia, which is the leading crop in terms of the area of production that is 2,928,206.26 million hectares, and the third in total production (55,099,615.14 quintals) next to wheat (57,801,305.96 quintals) and maize (105,570,935.92 quintals) (CSA, 2021). But, the average productivity of tef is lower compared to other cereals (Worku *et al.*, 2022; Gadisa and Addisu 2022). Tef production in Ethiopia is facing immense production constraints that affect the yield potential of the crop, including lodging, low inputs, inappropriate sowing method, post-harvest losses, and using low yielding local varieties (Fikadu *et al.*, 2019).

Tef is the main crop produced in the midland areas of Guji Zone. Usually the crop is sown after other crops (maize and haricot bean) are harvested. The crop is produced for both household consumption and cash crop. Tef could be produced in both seasons (*meher* and *belg*) hence the crop is used for double cropping purpose which increases farmers' production and income (Basha and Dembi, 2017). Despite double cropping of tef in the area many farmers were not food secured and only few model farmers used tef for their daily local food while other farmers were intended to sale their existing low product to the market rather than for household consumption. This is due to the use of low yielder varieties and lack of climate smart varieties (drought tolerant and early mature varieties) which can produce surplus production for farmers (Kebede *et al.,* 2018). However, improved tef varieties were not disseminated for surplus production. Therefore, it is important to find the way of improved tef varieties were disseminated in potential areas of Guji zone.

Tef is also getting popularity across the globe as it is a gluten-free and healthy food (Spaenij *et al.*, 2005; Zhu, 2018). Tef is a nutritionally rich crop and contains essential and important nutrients like carbohydrates, protein, fat, fiber, and minerals (Baye, 2014). It is also rich in some minerals like iron which is significantly higher than the amount that we can get from bread wheat (Fikadu *et al.,* 2019; Alaunyte *et al.,* 2012).

Ethiopian government is promoting the adoption of several agricultural technologies to improve the productivity of the agricultural sector (Wordofa *et al.,* 2021). In Ethiopian agricultural system most agricultural research technologies reach the end user in different ways (Kebede *et al.,* 2021). Currently extension system of the country is employing pre extension demonstration, pre scaling up/out and large scale demonstration as a tool for technologies/varieties promotion in rural/urban farming. Their difference is based on the scope of participants on the activity, land size and the intended objective. In pre extension demonstration, few participants will done research on small areas and based on the result of pre extension demonstration, further research will be conducted in the form of pre scaling up/out and the large scale demonstration will be followed for anticipated objective of released agricultural research technologies. In addition, the impact of pre-scaling up was greater than demonstration that ensures the yield and benefit of improved varieties for farmers. 19.06 qt/ha of Dagim was harvested at demonstration stage (Kebede *et al.,* 2021). Thus, this activity was initiated to pre scale up Dagim Tef variety in midlands of Guji zone.

Objectives of the Activity

1. To popularize Dagim Tef variety and strengthen stakeholders linkage.
2. To improve farmers' income.

Methodologies

Description study districts

Adola Rede district is 468km away from the Addis Ababa to the South. The district has altitude range of 1350-2340 meter above sea level, annual mean of 1000mm rainfall and annual average of 28°C 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 unimodal for highland parts. Sandy, clay and silt are the major soils of Adola Rede district. The major crops produced in the area include maize, tef, haricot bean, chat, coffee and the others (Girma *et al.,* 2020). Natural minerals are mainly found at Odo Shakiso district. Farmers of the district practiced mixed farming (crop and livestock). Tef, maize, haricot bean and coffee were the major crop production in the area. The district is also known by different fruits and vegetables. Most rural youth of Odo Shakiso district engaged on extraction of different minerals. Wadera district is one of agro pastoral areas of Guji zone. The district is well known by livestock rearing and livestock production is the major farming activity of the district. Tef, maize, haricot bean crops were mainly produced in the district (Kebede *et al.,* 2021).

Site selection/sample size

Three districts were selected from the midlands of Guji zone. Purposively, Adola Rede, Odo Shakiso and Wadera were selected based on their tef potential and suitable for monitoring. Seven (7) kebeles were selected from the selected three districts based on their tef production status. From each kebele, 11-16 farmers were selected. Totally, 83 farmers were selected for pre scaling up tef at the midlands of Guji zone. In addition, four FTCs were used as multiplication site where the yield obtained from the FTCs aimed to serve as a seed source for the next season.

Materials/methods used

Improved Dagim tef variety was used for pre scaling up purpose. The selected farmers obtained 4.5kg Dagim variety and sown it on 0.25ha. For further promotion of Dagim variety in the selected kebeles four FTCs were multiplied (26.5kg of Dagim on 1.5ha) to serve as a source of seed for the subsequent season. During 2020 (2013 E.C) and 2021/ 2022 (2014 E.C) production year 400kg of Dagim variety was distributed. During both years 20.75 hectare of farmers' land and 1.5ha of FTCs were covered by Dagim variety. NPS fertilizer was used at a rate of 121kg/ha. For promotion of Dagim variety training and mini field day was organized at each year. Hand weeding and herbicide (2-4-D) was used to control weed.

Data collection and Analysis

Yield data was collected from selected farmers. Yield, cost of production and farmers perception were collected by interview method. Data was analyzed by descriptive statistics, net income and narration.

Results and discussion

Number of farmers participated on trainings and field day

For proper technology transfer effective extension method is mandatory. For this activity training and mini field day were used to capacitate farmers' knowledge and skill. Training and mini field day was conducted both years. Accordingly, farmers, development agents and subject matter specialists were participated on the events. Training was used to enhance farmers' knowledge and skills on Dagim production and field day was used to motivate farmers to grow Dagim tef variety by observing the performance of variety on the field.

Table 1. Number of participants on training and field day

Extension methods	Farmers			Development Agents			Subject Matter specialist (SMSs)			Total participant
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Training	107	21	128	19	4	23	19	3	22	173
Mini Field day	89	21	110	15	2	17	10	1	11	138

Stakeholders' linkage

Promotion of all agricultural technologies cannot be provided by a single organization. It needs multi stakeholders who had common goal for improvement of agricultural production (Basha *et al.,* 2021). Therefore, for this study the linkage between Bore Agricultural Research Center, District Agricultural offices, Development Agents, Agricultural Cooperatives and farmers were strengthened via seed distribution, provision of agricultural inputs (herbicides and fertilizers) and information flow for tef production. The stakeholder had participated during training and field day. Despite some seed were provided as starting for pre scaling up there is still high demand of tef and fertilizer from farmers' perspective. Therefore, the next scaling up should focus on sufficient distribution of Dagim and fertilizer based on farmers interest.

Yield gained from pre scaling up of Dagim variety

Adola Rede and Odo Shakiso districts were considered during 2020 year. Good yield was obtained during 2020 year. Wadera was included during 2021/2022 production year. Among the three districts higher yield was obtained from Odo Shakiso district (12.39 qt in 2020 year while lower yield was obtained from Wadera district (5.88 qt/ha) during 2021/2022 year. Lack of rainfall at both seasons had affected the yield of Dagim variety. The combined result of yield performance of Dagim variety was 9.82 qt/ha at midland districts of Guji zone (Table 2). This yield was result half the national tef productivity (18.82 qt/ha) in Ethiopia (CSA, 2021) and also lower than during its demonstration (19.06 qt/ha) at midland districts of Guji zone (Kebede *et al.,* 2021). This showed that at the same area there was different rain fall which affect the yield performance of the crop.

Table 2: Yield gained from pre scaling up of Dagim variety

Districts where pre scaling up was conducted		Yield obtained (qt/ha) 2021/22 year	Yield obtained (qt/ha) 2020 year	Combined
Adola Rede district	N	22	14	36
	Mean	11.17	9.29	10.44
	Std. Deviation	1.405	1.069	1.574
Odo Shakiso district	N	22	13	35
	Mean	12.39	8.62	10.99
	Std. Deviation	1.821	3.254	3.036
Wadera district	N	-	16	16
	Mean	-	5.88	5.88
	Std. Deviation	-	.719	.719
Total	N	44	43	87
	Mean	11.78	7.81	9.82
	Std. Deviation	1.722	2.432	2.890

N= number of farmer

Profitability gained from pre scaling up of Dagim variety

Net income was used to estimate profitability of pre scaling up of Dagim variety. Total Revenue was calculated as yield obtained multiplied by farm gate price. Total variable costs included were costs of seed, fertilizer, land preparation, weeding, harvesting and threshing. Fixed cost was cost of land. Straw of tef was important as livestock feed at the study areas. Therefore, it was included as benefit obtained from Dagim tef production. The revenue of straw was also calculated similar to tef yield revenue, amount of straw obtained in quintal multiplied by price sold at production time. Therefore, total net income from this pre scaling up was the sum of net income from Dagim variety plus revenue obtained from straw. The result of net income showed that production of Dagim variety generated a return of 15735.72 ETB/ha at midland districts of Guji zone (Table 3). More net income (17551.63 ETB/ha) was obtained at Odo Shakiso district followed by Adola Rede district (16503.36 ETB/ha) and lower net income (10036.25 ETB/ha) was obtained at Wadera district (Table 4). This result of net income was lower than during its demonstration (38042.50 ETB/ha) at the same districts (Kebede *et al.*, 2021). This was due to the low yield as a result of shortage of rainfall at pre-scaling up stage.

Table 3. Net income obtained from pre scaling up of Dagim variety

Factors	N	Mean	Std. Deviation
Yield obtained (qt/ha)	87	9.82	2.890
Farm gate price	87	3536.78	392.995
Cost of fertilizer……a	87	2043.08	134.039
Cost of land preparation……..…...b	87	2201.03	1434.285
Cost of weeding…….…....c	87	288.10	79.087
Cost of harvesting…….….d	87	1261.03	372.562
Cost of threshing……....e	87	1813.88	976.631
Cost of seed……...f	87	1250.00	.000
Other costs……g	87	109.77	128.303
Total variable costs (a+b+…+g) (ETB/ha)	87	8966.95	2603.913
Fixed cost of land (ETB/ha)	87	10632.18	2151.878
Total Revenue of tef (yield * farm gate price)	87	33907.64	8191.092
Net income of tef= Total Revenue-TVC-FC…..h	87	14308.61	6730.289
Straw obtained (qt/ha)……i	87	52.11	24.284
Price of straw (ETB/qt)……...j	87	29.23	9.745
Revenue obtained from straw sale (i*j)……..k	87	1427.11	679.623
Total net income = h + k……l	87	15735.72	6904.599

Table 4. Net income gained from the districts (ETB/ha)

districts where pre scaling was conducted		total net income (Net income of tef + revenue of straw)
Adola Rede	N	36
	Mean	16503.36
	Std. Deviation	4099.473
Odo Shakiso	N	35
	Mean	17551.63
	Std. Deviation	8955.965
Wadera	N	16
	Mean	10036.25
	Std. Deviation	2923.855
Total	N	87
	Mean	15735.72
	Std. Deviation	6904.599

Farmers' perception regarding Dagim variety

Despite lack of rain fall during Dagim production still farmers were interested to grow Dagim variety due to its early maturity and preference both market and household consumption. The color is white so that it had a good market demand.

Exit strategy

The exit strategy of this activity was multiplying Dagim variety 1.5 ha on the selected four Farmers Training Centers. 26.5kg of Dagim variety was distributed during production years. The seed obtained from the FTCs was planned and discussed with Agricultural offices as to revolve for subsequent production seasons.

Conclusion

Pre scaling up of Dagim was conducted at midlands of Guji Zone. Though the production was affected by lack of rainfall still there is no option for farmers to produce tef other than Dagim variety. There was a good yield and income at some farmers who sown Dagim variety at mid of September month.

Recommendation

Farmers should early harvest maize as soon as it matured and sow tef at early September month where there could be enough rainfall. Dagim variety should be disseminated in the midland districts of Guji Zone. Since tef can be produced twice a year provision of tef variety and fertilizer for farmers should available based the seasons.

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Demonstration of Soil Test based NPS fertilizer rate based on calibrated for Teff in Girar Jarso District of North Shewa Zone, Oromia

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Abstract

The pre-extension demonstration of soil test based NPS fertilizer rate based on calibrated for Teff technology with its full packages practices was done to demonstrate and evaluate the newly adapted teff variety and thereby create awareness for farmers and agricultural extension agents. One improved teff variety (Dagim) was demonstrated Girar Jarso district in two kebeles (Wartu and Dire doyu) two peasant associations were selected purposely from the district based on teff production potential. The experiment was demonstrated on a simple plot with a size of 10 x 10 m. teff grain yield data, and farmer perceptions and preferences were collected and analyzed by simple descriptive statistics. The varieties showed remarkable variation in their yield potential across the testing areas. The average yield performance of the Dagim with soil test based (13.81 qt/ha) obtained from the farmer's field was relatively higher than Dagim without soil test based (10.12 qt/ha) variety and used local variety as a standard check. Similarly, the average yield performance recorded for Dagim with soil test-based technology was higher as compared to Dagim without soil test-based technology. Based on the procedure of variety evaluation and selection criteria, farmers set their criteria to evaluate and select the best variety following the real situation existing. Thus, against each of the criteria and weight attached, Dagim with soil test-based technology was selected for high yield, tolerance to disease and lodging, and early mature as compared to local variety. Therefore; it is important to scale up this variety/technology on a larger scale to improve yield. Thus, Dagim with soil test based NPS fertilizer rate based on calibrated technology Dagim with soil test based NPS fertilizer rate based on calibrated technology recommended for further scale-up.

Key words: Demonstration, Soil-test, Yield

Introduction

Teff (Eragrostis tef) is a major staple food crop in Ethiopia. Teff is grown at middle elevations between 1,800 and 2,200 meters above sea level and in regions that have adequate rainfall. Compared to other cereals, teff is considered a lower risk crop as it can withstand adverse weather conditions (Fufa et al. 2011). While research on improved teff varieties has been done since the mid-1950s, investments have been limited and only a small number of improved varieties have been released, i.e., about 20 in total (Fufa et al. 2011). Its grain is mainly used for making enjera, a spongy flatbread, the main national dish in Ethiopia (as well as Eritrea). Teff is also valued for its fine straw, which is used for animal feed as well as mixed with mud for building purposes.

Teff is the most important crop in Ethiopia, as measured by a number of indicators. In 2011/12, it was estimated that teff made up 20 percent of all the cultivated area in Ethiopia, covering about 2.7 million hectares and grown by 6.3 million farmers. The second most important crop was maize at 15 percent of all cultivated area. However, given the relatively low yields of teff, the total national production of teff (3.5 million ton) was lower than maize (6.1 million ton) and sorghum (3.9 million ton) (CSA 2012).

When we look at the value of production of teff using a simple average of producer prices collected by the Central Statistical Agency (CSA) in a large number of producer markets in the country and compare it to other crops, we find that teff production in 2012 was valued at 1.6 billion USD, again the most important crop in the country. If we use the commercial surplus data for the period 2011/12, teff value was estimated to be 464 million USD or one quarter lower than coffee (599 million USD), Ethiopia's most important export product. The value of commercial surplus of teff is equal to the commercial surplus of the three other main cereals combined in the country (sorghum, maize, and wheat). By any standards, teff is an important crop, for farm income as well as food security.

However, Declining soil fertility, poor management practices and shortage of rainfall are among the major causes of low productivity of crops in Ethiopia. Hence, identification of proper fertilizer mix is beneficial the macroeconomic level by improving the efficiency of fertilizer procurement and resource allocation.

Despite these agronomical and nutritional benefits of tef, both the total production and productivity of tef is relatively low. The main reasons for inferior yield of tef are suboptimal genetic gain, low access to seeds of improved varieties, poor agronomic practices and lodging (Kebebew et al., 2017; Mizan et al., 2016). Although 42 improved tef varieties have been released by the National Research System in Ethiopia (MoANR, 2017), their adoption by farmers is low (Kebebew et al., 2017).

Understanding the principles of soil fertility is vital to efficient nutrient management, crop production, as well as environmental protection. Nutrient management is indispensable for crop production and productivity increments on different soil types. So, soil nutrient calibration study is pertinent to increase efficiency use of inorganic fertilizer like DAP and Urea (Kefyalew *et al*, 2018). Profitable crop production requires adequate levels of phosphorus (P) and other nutrients. For this careful planning is required because of volatile grain and fertilizer prices. Soil test-based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. Therefore, fertilizer application schedules should be based on the magnitude of crop response to applied nutrients at different soil fertility levels (Santhi *et al*., 2002).

Oromia region is the most important tef producing area in the country; and its share in total national production is estimated to be 48% as high (Ibrahim *et al.*, 2018). In the production year of 2019/2020, the total area covered by teff was 1,487,970.57 hectares with a production of 28,090,978.41 quintals and yield of 18.88 qt/ha from 2,742,049 holders.

Tef is the main crop produced in area of North Shewa zone. The total production of tef in North Shewa zone for the year 2019/20 was 2,578,684.86 quintals produced. The average productivity was registered as 18.95 qt/ha (CSA, 2020). Previously, Fitche Soil Agricultural Research Center was conducted on soil test-based crop response phosphorus calibration study and verification of soil test-based phosphorus recommendation on tef in Girar Jarso district

from 2017-20 having different P and N levels and FiARC adapted dagim variety promising result was obtained.

Therefore; the result of soil test-based phosphorus critical value (18ppm) and phosphorus requirement factor (3.03ppm) for teff production in Girar Jarso district. The economic analysis also indicated that soil test-based phosphorus-fertilizer recommendation is economically feasible for Tef production in the district. Fertilizer application based on soil test was increased efficient use of fertilizer for improving agricultural production. This activity was demonstrated to evaluate yield performance and profitability of soil test based NPS fertilizer rate based on p-calibrated for tef under farmers' condition and create awareness on Soil test based NPS fertilizer rate based on p-calibrated for tef in Girar Jarso District.

Material and Methods

Description of the Study Area

The study was conducted in Girar Jarso district North Shewa Zone Oromia, Ethiopia. The district is located at 112 km from the capital Addis Ababa. Geographically location of the district is lies between $09^0$38'52.8"N to $10^0$00'10.8"N latitude and $38^0$34'22.8"E to $38^0$50'20.4"E longitude. The elevation ranged from 1300 and 3419 meters above sea level. The mean annual rain fall is 1200mm According to Fitche Station Meteorological data (Haile Mariam, 2014). The maximum and minimum mean temperature of the area is 35^0C and 11.5^0c respectively.

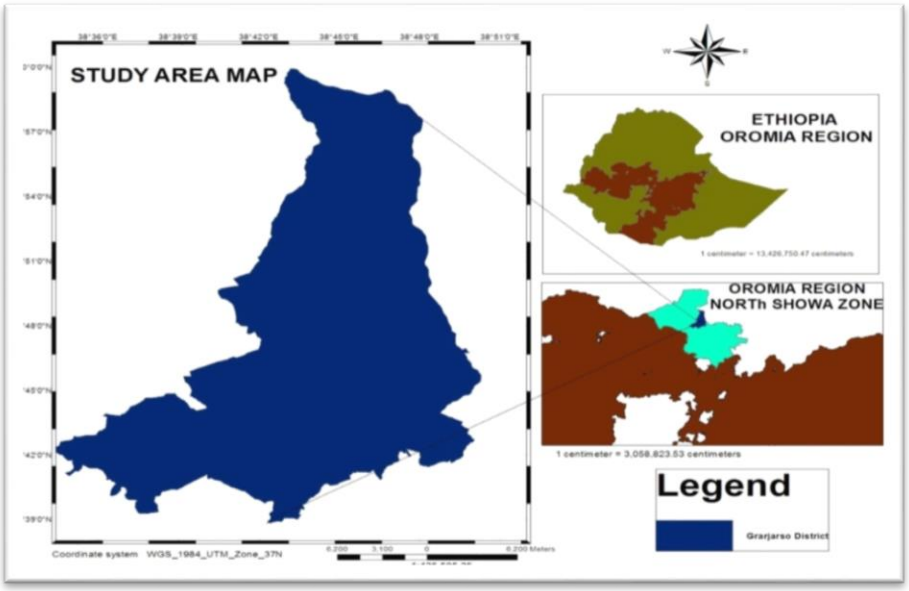

Figure 1: Location map of Girar Jarso district.

Site and farmers selection

Farmers were selected purposively based on soil sample result and their interest 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 PAs in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 3FRGs (FRG/ PA) from one PA 15 farmers and a total of 45 farmers were grouped in 3 FRG. In the FRG 5 farmers target farmers (3 male trial farmers and 2 female target farmers) and the remaining farmers worked with targeted farmers. PAs was selected purposively based on the potentiality of tef, 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.

Research Design

One improved variety with different fertilizer application (soil test-based fertilizer recommendation) Dagim variety and one local check, were replicated across fifty trial farmers. One improved and one local check was planted on 9 farmers' land. 10m*10m plot size of land from individual trial farmer for each pre-extension demonstration of soil test based NPS fertilizer rate based on calibrated for Dagim varieties. Each variety sowing at the spacing of 20cm between rows on 10m*10m. Fertilizer rate NPS 92kg/ ha and UREA 92kg/ha, Seed rate 15 kg/ha

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were implemented on farmers' fields to create awareness about the soil-test based NPS fertilizer rate based on calibrated for Dagim varieties. The evaluation and demonstration of the 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 and Focus Group Discussion. Types of collected quantitative data were number of farmers participated in FRG, yield performance, number of stakeholders participated in training and field days while qualitative data were farmers' perception toward the new technology, awareness created and farmers' technology selection criteria

Data analysis

Quantitative data was summarized using simple descriptive statistics (Mean, Frequency and Percentage) while the qualitative data collected using group discussion and key informant interviews, field observation and oral histories was analyzed using narrative explanation or PRA (Participatory Rural Appraisal) tools and argument. Finally, data from different sources were triangulated to get reliable information.

Economic Analysis

Partial budget analysis was done to identify economic feasibility among the Demonstration of soil test based NPS fertilizer rate based on calibrated for teff. The average open market price (Birr kg^{-1}) of teff, at field level and fertilizers was used for analysis. For a Demonstration of Soil Test based NPS fertilizer rate based on calibrated for to be considered a worthwhile option to farmer, the minimum acceptable rate of return MRR. This enables to make recommendations from marginal analysis. Marginal rate of return (MRR) was calculated by using the formula given blow;

$$\text{MRR} = \frac{\text{Net Income STB(dagim)} - \text{Net Income from blanket(dagim)}}{\text{Total Variable Cost of input}}$$

Results and Discussion

Training of target group (Farmers, DAs and Experts)

Multidisciplinary research team; crop, extension and socio-economic research team, soil fertility research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge. Development agents, experts and farmers were participated on the training given on soil test based NPS fertilizer rate based on calibrated for Tef and Dagim variety. Field day was also organized for more awareness creation.

Table 1: Type of profession and number of participants on the training at Girar district

		Girar/Pas		
No.	Participants	Male	Female	Total
1	Farmers	20	5	25
2	Das	6	-	6
3	District experts	3	1	4
	Total	29	6	35

Source: Own computation 2021/22

Among the training participant stakeholders, 71.43% were farmers. This showed that most of the training participants were farmers. From those farmers, 25% are female farmers' participant.

Mini-field day organized

Table 2: Type of profession and number of participants on the mini field day at Girar District

		Girar/Pas		
No.	Participants	Male	Female	Total
1	Farmers	32	7	39
2	Das	9	1	10
3	District experts	4	-	4
4	Others	5	2	7
	Total	50	10	60

Source: Own computation 2021/22

During mini- field days and farm visit, different questions, opinions and suggestion were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved teff variety (Dagim) variety with Soil Test based NPS fertilizer rate based on calibrated technology production because of better yield and earned income by selling seeds for different stakeholders (neighbors' farmers) as compare to the local seeds. 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 dagim variety with Soil Test based NPS fertilizer rate based on calibrated technology across the study site. The yield performance of the improved varieties (Dagim and local) was 16.1qt/ha and 6qt/ha at wartu and statistically significant yield difference at 26.5% probability level was observed between Dagim and local one.

Table 3 yield performances of the demonstrated dagim variety with STB NPS fertilizer rate based on calibrated

District	**Varieties**	**Mean(qt/ha)**
Girar Jarso	Dagim with STB	13.81qt/ha
	Dagim blanket	10.12qt/ha
	Local	5.9qtl/ha

Data source: Own data

Table 4**.** Yield performance of improved Dagim variety across districts on Farmer's land.

PA	**Varieties**	**Mean (Qt/ha)**
Wartu	Dagim with STB	16.18
	Dagim blanket	12.65
	Local	6
Koticho	Dagim with STB	11.24
	Dagim blanket	8.5q
	Local	5.5
Dire Doyyu	Dagim with STB	14
	Dagim blanket	9.2
	Local	6.2

Summary of yield performance of the variety

The result indicated that demonstration of improved dagim varieties with soil test based NPS fertilizer rate based on calibrated technology and local obtained the higher yield advantage (16.18qt/ha) compared to local check (5.5qt/ha) respectively. The percentage increases of the improved varieties over the local check were 26.5% under farmer condition. This showed that improved tef varieties with Soil Test based NPS fertilizer rate based on calibrated technology had advantages over the local check.

Table 5: Summary of yield performance in study areas

Varieties	Average yield/ha	Yield difference	Yield advantage over the local check (%)
Dagim STBR	13.80	3.69	26.5
Dagim blanket	10.12	4.22	14.1
Local check	5.9		

Source: Own computation 2021/22

Farmers' perception/Opinion

Farmers in the study area also selected the best performing improved tef variety/Dagim with soil test based NPS fertilizer rate based on calibrated technology 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 farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were yield, diseases tolerance/rust, color, number of tiller and maturity period. Based on the above criteria's; farmers evaluated the varieties and ranked first Dagim with soil test based NPS fertilizer rate based on calibrated technology followed by Dagim with blanket over the local. Therefore, the most farmers selected Dagim with soil test based NPS fertilizer rate based on calibrated technology to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the variety.

Partial budget analysis

To estimate the economical significant of soil test based NPS fertilizer rate based on calibrated technology, partial budget analysis was employed to calculate the Marginal rate of return (MRR) to investigate the economic feasibility of technology and variety. Based on actual unit prices during the year 2020/21 harvesting season farm gate price of 43 ETB (Ethiopian Birr) per kg of teff, 16.35 and 15.01 Birr per kg of DAP and Urea, respectively were used to calculate variable cost. The economic analysis showed that the highest net income (61106.35 ETB per ha) and marginal Rate of Return (393.64%) was obtained from soil test-based fertilizer recommendation (Table 3). Thus, the MRR showed that it would yield 3.94 birr for every birr invested. Therefore, soil test-based fertilizer recommendation records the highest MRR that is in acceptance range. So, farmers and other end users in the study area advised to use this soil test crop response-based recommended fertilizer which is cost effective, economically feasible and environmentally safe.

Table 6. Partial budget analysis for demonstration STB fertilizer recommendation of tef in Girar Jarso District

Treatment	Variable Input (Kg ha^{-1})		Unit price (ETB)		TVC	Output (Kg ha^{-1})	Unit price (ETB)	Gross Income (ETB ha^{-1})	Net Income (ETB ha^{-1})	MRR (%)
	DAP	Urea	DAP	Urea						
Local	100	100	16.3	15.01	3135.52	764	43	32852	32852.00	
Dagim Blanket	100	100	16.35	15.01	3135.52	1031	43	44333	41197.48	266.16
Dagim with STB	398.62	44.02	16.35	15.01	7177.65	1588	43	68284	61106.35	393.64

Where: ETB = Ethiopian Birr, TVC = Total Variable Cost, MRR = Marginal Rate of Return

Conclusion and Recommendation

One improved teff variety including soil test based NPS fertilizer rate with local check were demonstrated in one district of north Shewa zone for one year. Yield, disease/rust and lodging tolerance, early mature were identified and used as selection criteria across all the locations to select the best performing variety with technology. The overall mean yield of the Dagim with soil test based NPS fertilizer rate variety was 13.81 qt/ha which is relatively higher than the Dagim variety which gave 10.12 qt/ha.

Generally, this study indicated that Dagim with soil test based NPS fertilizer rate based on calibrated technology was higher yielding and the most preferred technology by farmers at Girar district. Local variety was the low yielding variety and also the least preferred varieties by farmers in the study district. Dagim with soil test based NPS fertilizer rate based on calibrated technology has 7.9qt/ha yield advantages over the local one in the study area. Therefore, based on these findings, could be recommended to teff growers in the north Shewa Districts for further promotion. Farmers also liked Dagim with soil test based NPS fertilizer rate based on calibrated technology for enhanced attractive color. Therefore, the Dagim with soil test based NPS fertilizer rate based on calibrated technology could be used by teff producers for scaling up.

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Pre-extension demonstration of Improved Oat (Avena sativa) Technologies in Degam and Girar Jarso districts of North Shewa Zone, Oromia

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Abstract
The pre-extension demonstration of improved Oat (Avena sativa) Technologies with its full agronomic practices was done to demonstrate and evaluated the newly adapted oat varieties and thereby create awareness for farmers and agricultural extension agents. Two improved oat varieties (bonabas and 8251) were demonstrated on purposely selected Degam and Girar Jarso districts. Four peasant associations were selected purposely from each district based on forage production potential. The experiments were demonstrated on a simple plot with a size of 10 x 10 m. Forage fresh biomass data and farmer perceptions and preferences were collected and analyzed by simple descriptive statistics. The varieties showed remarkable variation in their fresh biomass potential across the testing areas. The average fresh biomass performance of the Bonabas (80.26ton/ha) variety obtained from the farmer's field was relatively higher than 8251 (63.63ton/ha) variety and local as a standard check. Based on the procedure of variety evaluation and selection criteria, farmers set their criteria to evaluate and select the best variety following the real situation existing. Thus, against each of the criteria and weight attached Bonabas variety were selected for its high fresh biomass. Therefore; it is important to scale up this variety on a larger scale to improve the availability of quality feed and boost the production and productivity of livestock in the area.

Key words: *Demonstration, Bonabas variety, Farmers preference*

Introduction

Livestock in Ethiopia derives most of their feed from natural pasture and crop residues. CSA (2017) report on livestock feed usage and experience by smallholders indicates grazing is the major type of feed resource (54.59%) followed by crop residues (31.6%), hay (6.81%), by-products (1.53%), and improved feed (0.31%). Grazing (natural pasture) and crop residue which contributes to the higher proportions of livestock feed resources are characterized by high fiber, low protein, minerals, and vitamins (Adugna et al., 2000).

Such low-quality feeds are associated with a low voluntary intake, thus resulting in insufficient nutrient supply, low productivity, and even weight loss (Hendrickson et al., 2004). Thus, for a more efficient and productive livestock industry, cultivation and utilization of nutritious, high-yielding, and low-cost feed technologies that are easy and available within the limit of the resources of poor farmers have paramount importance.

One such potential forage species for integration into the existing livestock feeding system is the annual fodder oat. Fodder oat is the most widely used annual forage crop worldwide, serving as an important source of nutrition for ruminant livestock (Andrzejewska et al., 2018). It is a well-adapted fodder crop mainly in an altitude range from 1700-3000 m.a.s.l. with 500-800 mm mean annual rainfall (Mengistu, 2008). Oat is well adapted to a wide range

of soils and relatively tolerant to moisture stress, waterlogging, and frost. It can be a good source of animal feed in the dry season if harvested at the right stage of growth, cured, and stored as hay. It is also a quick-growing, palatable, succulent, and nutritious fodder crop (Alemayehu, 2007)

The extent of horizontal expansion and utilization trend, socio-economic factors governing production and utilization of Oats, available improvement opportunities and the overall prospect of Oats in the region have not been clearly understood. It is also essential to create awareness on the presence of alternative Oats varieties in order to enable farmers to make their best choice based on the intended purpose of growing Oats. Among the forage grasses, oat is the best adapted and productive forage with minimum input usage. oat varieties have high dry matter yields. It can be used for making hay and for grazing.

adaptation of fodder oat verities was carried at Fitche agricultural research center, and thus two varieties Bonabas and 8251 were recommended. The adapted oat varieties (Bonabas and 8251) are good biomass compared to both previously locally adapted varieties. However, to demonstrate and evaluate the varieties in the study area, demonstration of this varieties with its production package has not been done yet at the on-farm level. Since demonstrating new technology on farmers' fields are the main tools to familiarize the farming communities with the new feed technology and thereby select the best variety with farmer participation. Therefore, this study was conducted to evaluate productivity and profitability, create awareness improved oat varieties in Degam and Girar Jarso districts of North Shewa zone, Oromia.

Materials and Methods

Description of the study Area

The demonstration was conducted in Degema district of North Shewa Zone, Oromia, central high lands of Ethiopia. The district is located at 124 km of the capital Addis Ababa in the Northwest direction. The district is located between 9°34'0" to 10°03'0" North and 38°29'0" to 38°44'0" East and at an average elevation of 2878 m.a.s.l. The mean annual rainfall of the area is about 1150 mm that ranges from 900 to 1400 mm. The maximum and minimum annual temperature is 15^0C and 22^0C, respectively.

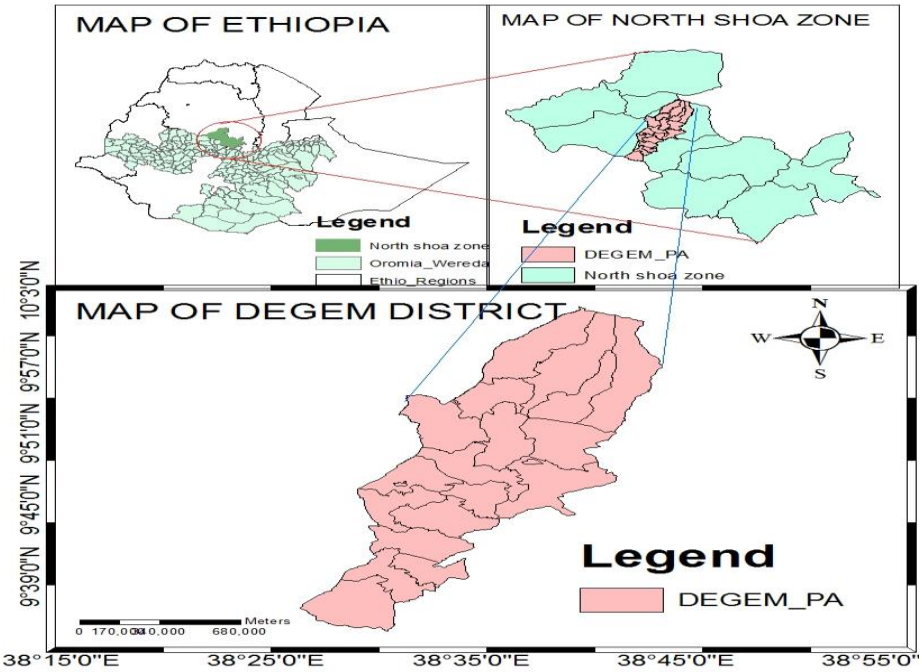
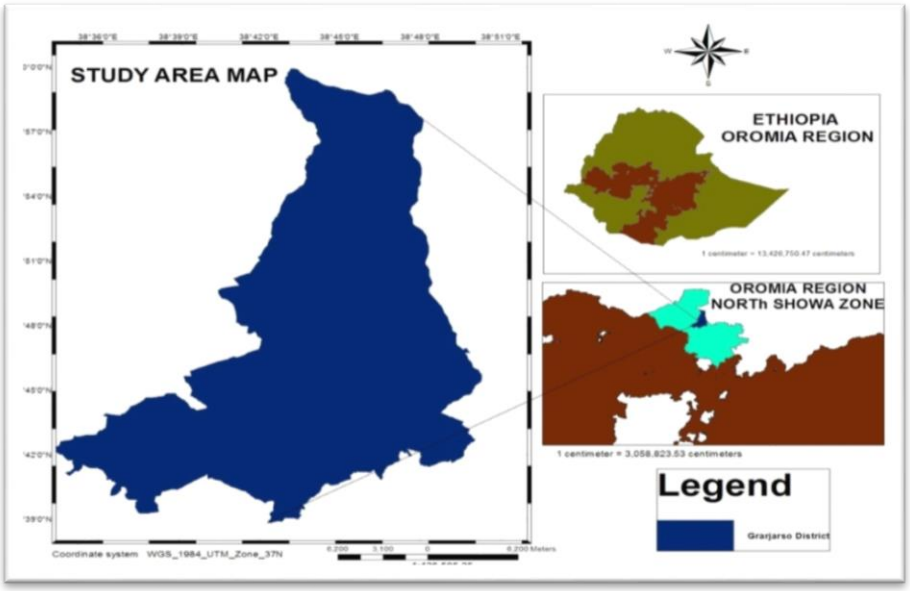


Figure 1: Location map of Degem district

The study was conducted in Girar Jarso district North Shewa Zone Oromia, Ethiopia. The district is located at 112 km from the capital Addis Ababa. Geographically location of the district is lies between $09^0$38'52.8"N to $10^0$00'10.8"N latitude and $38^0$34'22.8"E to $38^0$50'20.4"E longitude. The elevation ranged from 1300 and 3419 meters above sea level. The mean annual rain fall is 1200mm According to Fitche Station Meteorological data (Haile Mariam, 2014). The maximum and minimum mean temperature of the area is 35^0C and 11.5^0c respectively.



Site and Farmers Selection

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 PAs in consideration of gender issues (women, men and youth). In the form of establishing FRG in the study areas total of 4 FRGs (FRG/ PAs) from each PA a total of 60 farmers were grouped in 4FRG. In the FRG 3 farmers will trial (2 male trials and 1 female trials) farmers and 12 farmers worked with trials farmers.

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

District	Pas	No. of trial farmers	Area covered
Degam	H/kare	3	10mx 10m for each Plots
	Efarso	3	
Girar Jarso	Wartu	3	
	D/doyu	3	
Total		**12**	

Source: Own Data,2012

Implementation Design

Two improved treatments (Bonabas and 8251) oat varieties were replication-replicated across three trial farmers per PAs. Two improved were sown on 12 trial farmer's land. 10m*10m plot size of land from individual trial farmer for each demonstration/oat varieties. Each variety planted at the spacing of 20cm between rows and 10cm between plants (10cm* 10cm) as recommended technology source gives higher yield. Fertilizer rate of 100 kg NPS all applied sowing and 150 kg Urea in split and the other half at after a month of emergency 30-45 days after planting is recommended and seed rate 100kg/ha.

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were implemented on farmers' fields to create awareness about the Oat varieties. 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/forage. 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, number of stakeholders participated on the training and field days. While qualitative data were farmers' perception toward the new technology.

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 tools and argument. Finally, data from different sources was triangulated to get reliable information.

Results and Discussion

Training of target group (Farmers, DAs and Experts)

Multidisciplinary research team; animal feed and range land management, extension and socio-economic research team and other stakeholders (Agriculture office) actively participated by sharing their experience and knowledge for the sake of publicity of the work done Development agents, experts and farmers were participated on the training given on demonstration of oat animal feed production and management. Field day was also organized for more awareness creation.

Table 2: Type of profession and number of participants during the training at two districts

		Degam		G/Jarso		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	30	3	30	5	68
2	DAs	2	0	4	0	6
3	District experts	3	1	3	0	7
4	Another expert	5	0	3	0	8
	Total	40	4	40	5	89

Source: Own computation 2020/21

Among the training participant stakeholders, 76.4% were farmers. This showed that most of the training participants were farmers. From those farmers, 9% are female farmers' participant.

During the training different questions, opinions and suggestion were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved oat technology production because of better biomass and it is preferred by their cattle. 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 oat technology especially bonabas variety.

Table 3: Yield performance of improved oat technologies across districts on Farmer's land

Varieties	**Mean(qt/ha)**	**Maximum**	**Minimum**
Local check	34.74ton/ha	38.79ton/ha	30.68ton/ha
8251	63.63ton/ha	83.17ton/ha	44.08ton/ha
Bonabas	80.26ton/ha	87.08ton/ha	73.43ton/ha

Summary of yield performance of the varieties

The result indicated that demonstration of improved oat technology and local obtained the higher yield advantage (45.52ton/ha) compared to local check. The percentage increases of the improved varieties/bonabas over the local check were 39.58% under farmer condition. This showed that bonabas varieties had advantages over the local check.

Table 4: Summary of yield performance in study areas

Varieties	Average yield/ha	Yield difference	Yield advantage (%)
Local check	34.74	28.89	29.37
8251	63.63	16.63	11.56
Bonabas	80.26	-	39.58

Source: Own computation 2021/22

Farmers' Opinion/perception

Farmers in the study area also selected the best performing improved oat 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 biomass, crop stand and maturity. Based on the above criteria's; farmers evaluated the varieties and ranked bonabas followed by 8251.

Generally, farmers selected the varieties (bonabas and 8251) based on their biomass, maturity and adaptability to the environment. Therefore, the most farmers selected both improved bonabas varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties

Therefore, the most farmers selected bonabas varieties to reuse on their farm for the future. Hence, based on these findings, could be recommended livestock rearing in the north Shewa Districts needs bonabas oat variety for further promotion

Conclusion and Recommendation

Two improved fodder oat varieties including check were demonstrated in two districts of north Shewa zone. Biomass yield, plat height/stand, leafiness and uniformity were identified and used as selection criteria across all the locations to select the best performing varieties. The overall mean fresh biomass of the Bonabas variety was 80.26ton/ha which is relatively higher than the 8251 variety which gave 63.63ton/ha.

Generally, participant farmers participated in participatory evaluation and selection of the varieties reasonably evaluated, ranked, and selected Bonabas as the first best preferred and suitable variety with the real existing situation on the ground, and thus this variety will be proposed for further scaling up.

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Promotion of beekeeping technology using youth group in Amaya Woreda of Southwest shewa Zone

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Abstract

The study aimed to improve youth's knowhow on application of the beekeeping technologies, to improve youth's income through beekeeping technology and to determine beekeeping contribution to youth's livelihood in Amaya District of southwest Shewa Zone. In this regards, activity implementation was conducted at the selected apiary site of FRGs by which members were experienced in working together through pooling their resources for common benefits. Data were obtained using open-ended questionnaire, focus group discussions and personal observation. Villages for the study were purposively selected to reflect where beekeeping and jobless youth is predominantly found within the district. A total of 20 youth beekeepers participated in the project under one FRG. Descriptive statistics used as analytical tools. The results indicate that, beekeeping participant youth had generated ETbir 123,192 income from sales of honey and the contribution of beekeeping to total household income was only 30.34%. This study recommends that, facilitation by government and other development stakeholders is required to link rural based beekeepers to formal national markets in order to create incentives for beekeepers to seek for improved beekeeping technologies that will boost up their production levels. The study recommends increased use of moveable frame hives and thus increased productivity through strengthened beekeeping extension services by development program.

Key words*: improved beekeeping, youth, jobless, FREG, Amaya*

Introduction

One of the means by which farm level productivity can be increased is through the introduction and dissemination of improved agricultural technologies to farmers. This is possible if and only if, information on the adoption and risk-taking behavior of farmers is known in advance (Admassie and Ayale, 2010). In order to promote diversification in agriculture and reduce poverty in Ethiopia, beekeeping offers a great potential for income generation and poverty alleviation (Kassa T. and Regasa, 2020; Sisay, 2015). Unlike other agricultural projects such as crop and livestock, beekeeping is a relatively low investment enterprise and can be undertaken by most people irrespective of age, sex, disabled (Mujuni *et al*., 2012). However, beekeeping has not received sufficient attention in the past as it does presently in developing country (Mujuni *et al*., 2012), cited in Matanmi *et al*. (2008). Despite the potentiality of beekeeping in Ethiopia, little effort is made to develop beekeeping sector in the country.

Adopting improved technologies and improved management practices would greatly improve the yields and quality of honey (Wilson, 2006). The country already earns an average of 420 million ETB (1) (35 million USD) annually from the sale of honey (Gidey & Kibrom, 2010). This figure is expected to increase in the future (Paulos, 2011). Indeed, in 2011, the European Court of Justice ruled that honey containing pollen from genetically modified plants could

not be sold in the European Union which gives Ethiopia an advantage over other major honey-exporting countries since most Ethiopian honey is free of genetically modified plants as well as pesticides and other agrochemicals (Hartmann, 2004).

In most cases, Ethiopian beekeepers are observed to use traditional hives, which are very difficult to manage honeybees and to produce honey and honey products in the required quality and quantity. However, it has been observed as more than 15 kg/hive crude honey can be produced if chefeka hive and 20kg/hive from movable frame bee hives used. Varies participatory approach studies showed that an improved technology that is based on farmers' participation is easily transferable and applicable (Nuru and Edessa, 2005).

Amaya district is potential in beekeeping but due 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 moveable frame hives with full components are promoted, they can greatly improve the income of beekeepers and contribute to the national economy. From this point of view, therefore, recommended beekeeping technology introduced to increase production and productivity of beekeeping in the study area.

General objective

The overall objective of the study was to evaluate beekeeping contribution to youth's socioeconomic in Amaya district.

Specific objectives

- To identify the income contribution of beekeeping to youth's total income
- To increase skills of youth in beekeeping technology application
- To increase youth's income from beekeeping technology in the study area

Methodology

Description of the study area

The study was conducted in Amaya District of the southwest Shewa Zone of Oromia National Regional State, Ethiopia. The Ameya District is one of the 12 Districts of the southwest Shewa Zone (Figure 1). The capital of the district is Gindo, which is 30 km away from the Zonal Capital, Waliso, and 144 km Southwest of Addis Ababa. The district is located between 8 29'59, 99''N and 37 44'59, 99" E latitude and longitude, respectively. The altitude of the study area ranges between 1500–3240 m above sea level. The mean annual temperature and rainfall of the study area is 19.6^0C and 1127 mm, respectively. The 2007 national census reported a total population for this District at 122,056, of whom 61,578 were men and 60,478 were women (CSA, 2008).

Site and youth beekeeper selection

For this study, Amaya district was chosen purposively on the assumption of its potentiality in beekeeping production, large number of jobless youth and close follow up. At the beginning, memorandum of understanding was signed with southwest Shewa Zone and Amaya district livestock resource development agency to introduce the objectives of the activity and expected out puts as well as share roles and responsibilities among stakeholders. Selection of

the site and youth beekeepers was carried out in close consultation with the Amaya district livestock resource development agency.
With limited resources, 20 youth beekeepers were captured in the project under one FRG (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.

Data Types, Sources of Data and Method of Data Collection

Both quantitative and qualitative data were collected from primary source and secondary sources. Primary data were collected on a range of variables that are important this study.
This includes, but is not limited to: data on income from beekeeping, honey yield, training, perception of youth's, number of youths involved, number of bee colonies owned, to mention a few. The primary data were generated using different data collection methods including check list, open ended interview and personal observation. In addition, secondary information was collected from Amaya livestock resources development agency, published and other documents.

Methods of Data Analysis

This study generated both qualitative and quantitative data. Qualitative data was analysed using qualitative tools and quantitative data were analysed using quantitative tools. The dominant types of qualitative data analysis tools used in this study are, content analysis of policy documents and thematic analysis of responses from key informant interviews and FGD. Whereas, quantitative data were analyzed using descriptive statistics such as proportion/percentages and frequency mean, and presented in Tables and chart.

Results and Discussion

This part presented improved beekeeping technology, production and productivity of beekeeping and awareness of beekeeper on the technology.

Beekeeping activities

The results in this study show that number of movable frame hive varies across year. The number of moveable beehives was 20 through 2012 to 2014 E.C. (Table 1).

Table 1. Number of bee colony owned by youth group in the study area across year

variable	Year E.C		
	2012	2013	2014
Number of bee hive	20	20	20

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 21.75 kg per movable frame bee hive due to taking up of improved beekeeping management practices in the areas. Higher Mean honey yield from box hives (23.5 kg) was recorded at the third year of bee colonies establishment (Figure1). The reason

why honey yield was higher in the third year than the first and second year of colonies set up could be developed ample bee forage around apiary site, acquired beekeeping knowledge and skills by FRG members, strong seasonal bee management practices, close monitoring and follow up of honeybee colonies.

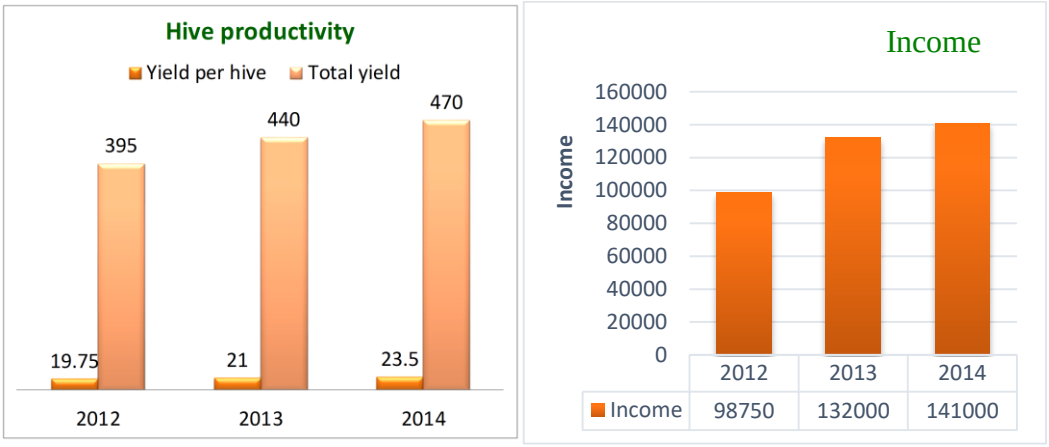

Figure1. Honey yield productivity and income across years

*One kg honey was ETbir 250 for 2012 and ETB300 for 2013 and 2014.

The overall average kilogram of honey harvested was 435. Considering the average number of beehives as reported in this study, it can be estimated that on average a beehive in the study area produces.

Regarding the benefit, beekeeping FRGs was benefited from honey sold. On average ETBirr 123, 916.67 obtained by target groups due to introduced technology in the area. It implies that taking up of beekeeping technology has a tendency to increase the annual income of household during interim period. The findings show that, beekeeping participant youth had income generated from sales of honey. It means that, a beekeeper earns only ETbir 516 per month from beekeeping. This suggests the income generated from the venture is lower than one would expect because every people everywhere expected to gain $1.25 a day per person by 2030 according to very essence of sustainable development goal (ICSU, 2015). For this if individual youth own 20 bee colonies, it is possible to end poverty as s/he can earn ETBirr 123, 916.67 individually unlike in group. Injecting youth with optimum income can overcome the complex problems of migration from rural to urban, hunger, hopelessness, helplessness and dependency.

Income contribution of beekeeping technology to rural youth

The contribution of beekeeping to income of youth in the study area was determined focused on the amount of income a youth earn from beekeeping. Therefore, the proportion of income earned by a youth from beekeeping to the total youth income was computed to determine the contribution of beekeeping to the total youth income. The total income for beekeepers was computed from the data on income which a youth earn from sales of honey plus income earned from other sources of income in the study area (Figure 2). Findings in this study show that, beekeeping contributes 30.34% of the total household income in the study area. Beekeeping contribution would be greater if 20 recommended number of hives were managed by each youth. This finding is about similar to the findings by Ngaga et al. (2005) which studied the contribution of beekeeping to household income in the southern highlands

and southern parts of Tanzania and revealed that beekeeping contributes 27.4% of a beekeeper's total cash income per year. These imply that, the contribution of beekeeping enterprises to jobless youth income improvement in the study area is promising. This might be beekeeping does not need fertile land and daily attention unlike crop farming. Besides, there is no permanent daily wage to attract available labor force in the study area. Lalisa (2021) also reported that honey production improves lives of poor groups and can be serve as adaptation strategy to combat recurrent climate change.

Youth said that we had had income which was indispensable revenue we had never attained before the intervention. Besides, our observation verified that jobless youth able to enhance their income through continuous appraisal of their participation in beekeeping.

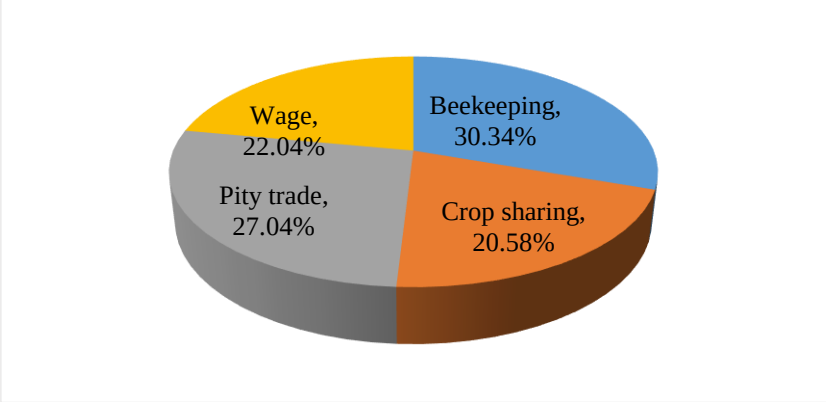

Figure 2: Proportion of income from beekeeping to youth's total income

Beekeeping training and group dynamics of youth group

Preliminary needs assessment of rural youths' interest was conducted. Besides, the most prevalent beekeeping practices constraints faced by rural youth like lack of knowledge of bee colony transferring from traditional onto improved bee hives, active and dearth period management practices, post-harvest honey handling techniques, lack of bee protective cloths and tools as well as market problems were identified. Then, training techniques that back up knowledge and skill development was employed for 20 (Female =3) youths (Figure 2 A). In order to make theoretical parts more understandable to the youths, pictorial facts were displayed using power point, poster, flip charts, video shows and success experiences on improved beekeeping. Further below beekeeping training topics were delivered through establishing facilities and training materials for the group members for five days (Table 3) by apiculture senior researchers.

Table 2. Number of Training Participants by Gender

S/N	Title	Duration	Beekeepers			Bee expert			DAs		
			M	F	Total	M	F	Total	M	F	Total
1	Basic beekeeping	5	20	5	20	3	1	4	3	1	4
2	Refreshment	3	17	3	20	2	0	2	1	1	2

In order to make FRG members grasp ideal beekeeping technology, 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 3). 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.

Group formation and strengthening was intended to clearly define group norms, encourage youth fellowship development, experience the power of synergy, and establish roles and responsibilities assigned to members for common benefits. Hence, training in business plan development, entrepreneurship, group governance and record keeping was organized. 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.

Furthermore, group was frequently contacted in order to validate that group formation would be strong enough and effective against assumption indicated in the project. In order to further strengthening group to continually operate their business, refreshment training targeted on honey and bees wax marketing and business skill was provided for each group members.

Exit strategy

In order to minimize the problems of insufficient extension advisory services youth were equipped with appropriate beekeeping knowledge and skills to be self-reliant. Finally, the whole beekeeping activities routine activities together with how to reach wider areas and more people were handed over to respective Amaya agriculture and natural resources office.

Conclusion and Recommendation

This paper has described the vitally important benefits that beekeeping can have on the lives of rural youths. Recognizing the contribution of beekeeping to the livelihoods of jobless youth, beekeeping can be used as the tool in creating job opportunities to transform vulnerable people into secured life, and the communities are aware of the value of bees in forest conservation and the need to safeguard them.

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. Based on the findings of this study, it can be concluded that, the income level generation from beekeeping is relatively promising and it can provide full employment if 20 box hives are owned by individual youth. The realized contribution of beekeeping to livelihood (30.34%) based on the proportion of income generated from beekeeping to other household sources of income is good that led to significant contribution result. Therefore, based on the implication of the findings of this study it can further be concluded that, , still beekeeping in the study area has a potential of contributing to livelihood improvement through income generation to the beekeepers and the government, creating employment to the community and improving biodiversity if all the shortcomings are well addressed. It is the duty and responsibility of the government and any other development stakeholder to support youth to utilize this potential to improve livelihood. The study recommends increased use of moveable frame hives and thus increased productivity through strengthened beekeeping extension services by development program.

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Pre extension Demonstration and Evaluation of Centrifugeable Honeycombs Using Starter Strips in Woliso Woreda, Oromia Region

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Background and Justification

Beekeeping in Ethiopia plays an important role in income generation for farmers. On average, one beekeeper can get ETB 1057.5 from one transitional chefeka hive per year (Wongelu, 2017). They use this income to purchase livestock, agricultural inputs, food crops and other household items (Workineh, 2007, Kerealem et al., 2009). It is likely to be at its most profitable if improved beekeeping technologies with its all packages used. Improved box hives have been introduced and promoted in the country. Still now number of users is still low due to the reason that this hive requires accessories (wax printer and extractor) that are not affordable at small scale level (Workineh, 2007). Therefore important to develop, adopt and promote alternate technology to solve problems of beekeepers. Accordingly, on station study conducted on centrifugeable honeycombs using starter strips and the result indicates, there was no significant difference on honey yield for colonies under starter strips (18.8± 1.85 and) comb foundation (19.5± 1.86(Kibebew and Dereje, 2006). To solve beekeepers problem on areas of source, on time access and increasing price quality beeswax (ETB 375/kg), to reduce problem of access to wax printer which is not affordable at individual beekeepers level (ETB 8,000) and shortage of access at Woreda livestock office level during active season, respond to request of stakeholders in Zonal ADPLAC meeting and produce extractable honey combs which has relatively the same yield as that of using printed wax by demonstrating centrifigueable honey combs from starter strips.

Objectives

- To demonstrate and evaluate profitability of the technology under farmers' management
- To create awareness on the importance of the technology
- To improve farmers' knowledge and skill on use of the technology

Materials and Methods

Study design

To evaluate the technology package, five colonies in box hive with foundation sheet in both brood and honey champers and five colonies in box hive with starter strips in brood chambers and no foundation on supers used as a treatment per site.

Site and farmers selection

The activity demonstrated and evaluated in one site at Woliso woreda. The selection of demonstration site and farmers was purposive. One demonstration site and 15 beekeepers selected as a member of FREG and one FREG established. Experienced beekeepers on box hive selected as one of selection criteria. Demonstration and evaluation of the technology conducted with these FREG members. Apiary of model beekeeper used as center for learning

and technology demonstration. Selection of the site and beekeepers carried out in close consultation with the respective Woreda livestock offices.

Technology evaluation and demonstration methods

As to the method, MoU with Livestock office signed with Woreda livestock office to have common understanding on the objectives of the activities, share responsibilities and joint monitoring and evaluation of the technology package. Practical training given for beekeepers, development Agents (DAs) and bee experts. Establishment of experimental colonies, regular follow up and demonstration and evaluation of the technology conducted by HBRC technical staff in partnership with FREG members, (DAs) and Woreda level experts. To evaluate the technology a total of 10 honeybee colonies 5 with and 5 without foundation sheet established and data collected during the study period.

Method of data collection

Primary data collected and documented using data collection sheet, personal observation of sites and group discussion. Secondary data also collected from respective Woreda livestock office, literatures, research reports and internet search.

Method of data analysis

Collected data analyzed using simple descriptive statics such as mean, percentage and frequency and tables used to present data. Independent t – test and partial budget analysis used to compare and analyze performance of the technology package under beekeepers condition.

Result and Discussion

Capacity Building

Capacity of selected FREG members, DAs and experts to apply improved beekeeping technology package built through two rounds theoretical and practical training conducted at their beekeeping site, Village Administration. In the first round of the training, practical training is given for three consecutive days on site selection, hive standing making, foundation sheet making, colony transferring and follow up of established colony. The second round training also given on improved beekeeping technologies and management practices, seasonal management of honey bee colonies, protection of bee colonies from pest and predators and value addition to beekeeping products and marketing aspects. Besides basics of beekeeping practices, training on beekeeping as business given to the FREG members. On the training, 30 beekeepers, one DA and 2 experts trained two rounds for three consecutive days at each round. See table one below.

Table 1: Number of Beekeepers, Development Agents, and Experts participated on training

No	Category	Number of trainee		
		Male	Female	Total
1	Beekeeper	15	15	30
2.	Development Agent	1	0	1
3.	Expert	2	0	2

Technology Demonstration and Evaluation

Colony establishment and follow up

For the demonstration and evaluation purpose, 10 honey bee colonies transferred to box hive and regular honeybee follow up activities such as inspection, adding hive volume, harvesting, reducing hive volume and feeding of the honey bee colonies during dry season undertaken seasonally with these FREG members.

Honey yield

In this study, honey yield harvested from demonstration hives during the demonstration period 2020-2021 G.C used for evaluation of the technology. The main honey season of the area is from September- December. Accordingly, honey yield harvested annually in December from experimental colonies with and without foundation sheet on honey chambers for two consecutive years. On average, 17.05 kilogram per hive per year from box hives with foundation sheet on honey chambers and 12.8 kilogram per hive per year from box hives without foundation sheet on honey chambers table two shown below.

Table 2: Annual honey yield from demonstration hives

Treatment	N	annual honey yield		Average annual honey yield
		2020	2021	
With foundation sheet (Control)	5	17.5	16.6	17.05
Without foundation sheet	5	13.2	12.4	12.8

As shown on table one above, the mean honey yield with foundation sheet on honey chamber was higher than honey yield without foundation sheet on honey chamber. The reason why honey yield with foundation sheet in honey chamber is higher could be time and food resource required to build up honey comb is less in honey chamber with foundation sheet and this helped honeybees exert effort on honey production. The result of this research is in contradict to findings of Kibebew and Dereje wich states there was no significant difference on honey yield for colonies under starter strips and comb foundation (Kibebew and Dereje, 2006).

Extraction of the honey combs

Frames of sealed honey above 70% collected from demonstration hives to test whether the honey combs can be extractable in three frame honey extractor. Sealed honey having foundation sheet is more extractable in honey extractor. But, sealed honey without foundation sheet tend to break frequently during extraction and difficult to reuse fame for the next honey season frame.

Financial Analysis

To estimate the profitability of honey production without foundation sheet in honey chamber, a simple financial analysis has been done. In order to compare the profitability with and without foundation sheet in honey chambers, beeswax cost and honey yield recorded and compared assuming other costs are similar for both treatments. The analysis was done to arrive at per hive net return from both treatments.

As shown on the table below, purchase of beeswax and service charge for printing were the cost items that needed to produce honey using foundation sheet in honey chambers and categorized under column one, category of cost. The average price paid to purchase beeswax is 375ETB per kg and service charge for printing the wax is 20 ETB per kg at current market (2021).

On the other hand, honey yield was the benefit for the both types of bee hives and categorized under column two, return. To get the total revenue from each type of hive, honey yield obtained in the course of the year was multiplied by selling price. In the study area, the average honey yield per annum for box hive using foundation sheet and box hive without foundation sheet was 17.5kg and 13.2kg, respectively. The average price of one kilogram extracted honey during the evaluation period is 290 ETB per kg (2021).

	Column 1		Column 2		
Added cost (Birr)	With foundation sheet	Without foundation sheet	Additional return (Birr)	With foundation sheet	Without foundation sheet
Beeswax cost	375.00	0.00	Honey yield	5,075.00	3,828.00
Printing service charge	20.00	0.00	Total added return	5075.00	3,828.00
Total costs of production	395.00	0.00	Total return from sell of honey	5075.00	3,828.00

Source: own data computation, 2021

Net income from box hive using foundation sheet (5075- 395=4680ETB)
Net income from box hive without foundation sheet (3,828- 0=3,828ETB)
Net loss of box hive without foundation sheet is (3,828-4680=-852 ETB).

As shown on the incremental benefit or loss calculation, the beekeeper loss 852 ETB if it did not use beeswax on honey chambers. But, the reality on the ground is most beekeepers were not using and producing honey using box hive assuming honey production using box hive is not possible without using printed beeswax in this hive.

Conclusion and Recommendations

As to conclusion, the beekeeper can produce pure honey without using foundation in honey chambers. Though honey yield is less in hives without foundation sheet, the farmer can overcome beeswax (quality and price) and casting mold (on time access and high cost to purchase at beekeeper level) problems. The overall finding of this study mainly underlined the importance of extension support and technical back to the beekeepers in promoting honey production on box hive without foundation sheet in honey chambers.

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Pre- scaling up of improved Field pea technology to potential district of Western Oromia

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Abstract

Pre-scaling of improved field pea varieties was carried out at Jimma Arjo district of East Wollega Zone of Western Oromia. The main objective of this study was to make wider awareness on improved field pea using recently released Lammiif variety. The improved field pea variety; Lammiif, was planted on 0.25 ha of land with the spacing of 40 cm between rows and recommended seed rate of 180 kg/ha and fertilizer rate of 100 kg NPS. Accordingly, the project was carried out on 31 farmers' field. Thus, 17.1 quintals of improved field pea variety (Lammiif) was freely distributed for selected farmers while fertilizers and management aspects; such as, labor and others were covered by the farmers themselves for cost sharing as per initial agreement signed during site and farmers selection. Field day was also arranged to create awareness and share experiences among farmers on improved field pea production and management. Feed backs obtained from farmers showed that Lammiif variety is high yielder, disease tolerant, adaptable and have high number of seeds per pods. Therefore; the variety should further be promoted by respective extension organizations in collaboration with other key stake holders' in the area.

Key words: Pre-scaling up, field pea, Lammiif

Introduction

Background and Justification

According to FAO (1998) center of origin/diversity of field pea are East Africa and West Asia with secondary center in South Asia and South and East Mediterranean sub-regions. The species *P. sativum* is dominant in Ethiopia even though wild and primitive forms are also known to exist in the high elevation of the country (Mussa *et al*., 2006). Field pea produced in various regions and widely grown in north, south, west and central parts of the country including, pocket areas in highlands and mid highlands with altitude ranging from 1800-3000 m.a.s.l .

Generally, it is a crop of manifold merits in the economic lives of the farming communities of high lands of Ethiopia. It is a rich source of protein (25%), carbohydrates (12%), vitamins A and C, calcium and phosphorus, apart from having a small quantity of iron. Peas being very rich in proteins are valuable for vegetable purposes. Besides; according to Gemechu *et. al*. (2016), in areas where mono cropping is a dominant practice the crop has double advantage in terms of fixing atmospheric nitrogen and it serves as a "break crop" to diseases and pests when rotated with cereals. Even though the above facts clearly show the important role the crop plays in the country's agriculture, its average seed yield has remained very low in the highlands of Western Ethiopia (MoRAD, 2010). The major reasons are: susceptibility of the landraces to array of diseases, inherently low yield potential of the landraces and poor management practices.

Field pea with other food legumes covers about 13.24 % of the total 12.49 million hectares of crop areas in Ethiopia and is the 4th most important stable food legume among the highland pulses in rural Ethiopia (CSA, 2016). According to CSA (2016), in Ethiopia field pea covers about 221, 415.67 ha of the total arable land with a total production of 3, 233, 901.34 Quintals. This constitutes about 13.40 % of the total area covered by pulses and 11.68 % of

the total annual production of pulses in the country. In addition in Oromia region, the total production was 1,409,959.49 quintal for the same year. Therefore, the contribution of the Oromia region for the country production was 44 %. The total area cultivated by field pea small holder farmers for the meher season 2015/2016 in East Wollega and West Shewa zones were 2,563.80 ha and 7,257.28 ha; respectively.

The estimated average productivity of field pea in East Wollega and West Shewa zones were 9.57 quintals per hectare and 19.38 quintals per hectare; respectively, which is low compared to Oromia Region average of 16.90 quintals per hectare in 2015/16 (CSA 2016). The most parts of Western Oromia are one of the potential areas for field pea production. In these areas, farmers produced Field pea crop mainly for the home consumption and market purpose. However, farmers found in these locations were little access to improved field pea technologies, as result of this fact, the productivity per hectare obtained from the local cultivars was low.

To tackle such challenges Bako Agricultural Research Center (BARC) has been conducting intensive research work on the crop and has recently released *Lammiif* field pea variety that has better yield, disease, insect-pest tolerant than the previous varieties. The new variety has a , potential yield of 23-30 qt/ha on farmers' field (MoARD, 2011),. Yet, little has been done to scale up and transfer this improved field pea variety with its agronomic practices to wider farming community apart from small plot demonstrations. Hence, considering the reality mentioned above this activity was initiated aiming to popularizing (transferring) the technologies to farmers' there by outspreading (scaling up/out) of those selected technologies to the end users based on farmers' selection criteria. These in turn increases household income and contribute more to productivity improvement which in turn would contribute to household food security..

Objectives

- To promote tested and verified improved technology/ies of field pea for small holders' farmers in the district;
- To disseminate the selected variety and build seed diffusion channel ;
- To strengthen linkages with target beneficiaries and stakeholders so as to enhance their confidence on results of research;
- To build knowledge and skill of the farmers on field pea production and management practice.

Materials and Method

Operation sites and participant actors

Cost sharing approach was the main strategy to promote and disseminate the technology in the coming years. Accordingly, the project was carried out in field pea producing district of Jimma Arjo of East Wollega Zone of Western Oromia. From the district, 1 PA was selected. The already tested and verified field pea variety; *Lammiif*, through FRG during demonstration stage was planted on minimum of 0.25 ha per farmer of land along with applying all recommended management practices and on a total of 31 farmers' field. For scaling up of field pea varieties 17.1 quintals of improved field pea variety (Lammiif) was freely distributed for selected farmers while fertilizers and all that required for management;

such as, labor and others were covered by the farmers themselves as per our agreement during selection; cost sharing. All the necessary recommended agronomic practices; spacing between rows and plants were 40 cm by 5 cm; respectively and fertilizer rate of 100 kg/ha NPS at planting were applied. All recommended cultural and agronomic practices were implemented.

Provision of training and Input distribution and Planting

After sites and farmers' were selected both theoretical and practical training were given to farmers, Development agents and district experts. Training provided on the following areas; such as, field pea production management, breeding aspect, post harvesting (seed quality). The aim of training was to create awareness of farmers', Development agent and district experts on field pea technology. Finally; after the plots were properly ploughed and made ready for planting ahead of the planting date, all necessary inputs (seed) were delivered to the farmers. Planting was made on the farmers' field by BARC researchers, TAs as well as Farmers Extension Groups.

Data collection and Analysis

For this activity all the necessary qualitative and quantitative data were collected; these includes yield data, total number of farmers, DAs, experts participated on training , field visits, farmers' perception on the attribute of the technology. Simple descriptive statistics tools such as mean, graph, table, frequencies and percentages were used to summarize the data/result.

Technology gap and Technology index

Technology gap is the difference between potential yield and demonstration yield of improved field pea variety *(Lammiif)* per unit area. At the same time technology index is the difference between technology gap and potential yield and then multiplied by hundred. Technology gap indicates that 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. Technology gap, extension gap and technology index were calculated as per the formula given by Samui *et. al*. (2000).Further; according to Dhaka *et.al.*, 2010 its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. To this end, the technology gap and index of demonstrated varieties (Lammiif) were calculated using the underlying formulas and presented in below table.

Technology gap = Potential yield qt/ha – Demonstration yield (1)

$$\textbf{Technology index} = \frac{\textbf{Potential yield - Demonstration yield}}{\textbf{Potential yield}} * 100 \quad (2)$$

Extension gap q ha =Demonstration yield q ha - Farmers yield q ha (3)

Communication methods (dissemination strategies)

Field day and field visit, training and print media such as leaflets, pamphlets and production manuals were used for further creating awareness and for enhancing users' knowledge and skill in rice production.

Monitoring and Evaluation

Researchers, extension agents and farmers' jointly participated on monitoring and evaluation at least once in fortnight (two weeks) to supervise the overall management, progress performance of the variety and others to fill gap observed starting from site selection through harvesting. At the end based on its performance the variety was jointly evaluated with FEGs, researchers, extension agents and other relevant stakeholders'.

Result and Discussion

Training

Below (table 1) summarize gender disaggregated number of stakeholders' participated on training

Table1. Gender disaggregated number of stakeholders' participated on Training

Training Topic	Participants									
Field pea production and management	Farmers			DAs			Experts			Grand Total
	M	F	Total	M	F	Total	M	F	Total	
	27	6	33	4	-	4	4	-	4	41

Field day

Field days were jointly organized and arranged with district level agriculture and natural resource offices so as create opportunities for all relevant stakeholders', to create awareness on the importance and availability of the technology, to learn from the technologies promotion activities and also to evaluate the performance of varieties, to enhance farmers' knowledge on rice production and management and to give/collect feedback from all relevant stakeholders' for further way forward. For the last four years totally 43 farmers 4 development agents and 4 district experts were invited and attended on the field day event. Below (table 2) summarize gender disaggregated number of participants participated on the field day event organized.

Table 2: Gender disaggregated number of stakeholders' participated on field Visit

Stakeholder Participated on Field visit event						
Farmers		DAs		Experts		Total
M	F	M	F	M	F	
35	8	4		4	-	51

Amount Seed distributed and Number of Participant Farmers over years

Totally about 17.10 quintals of basic seed of improved field pea variety; *Lammiif*, were distributed to 31 farmers' for scaling up purpose over the last three years in Jimma Arjo district "Hindhee" PA. Below (figure 1) summarize amount seed distributed and number of participant farmers participated over the last three years as follows.

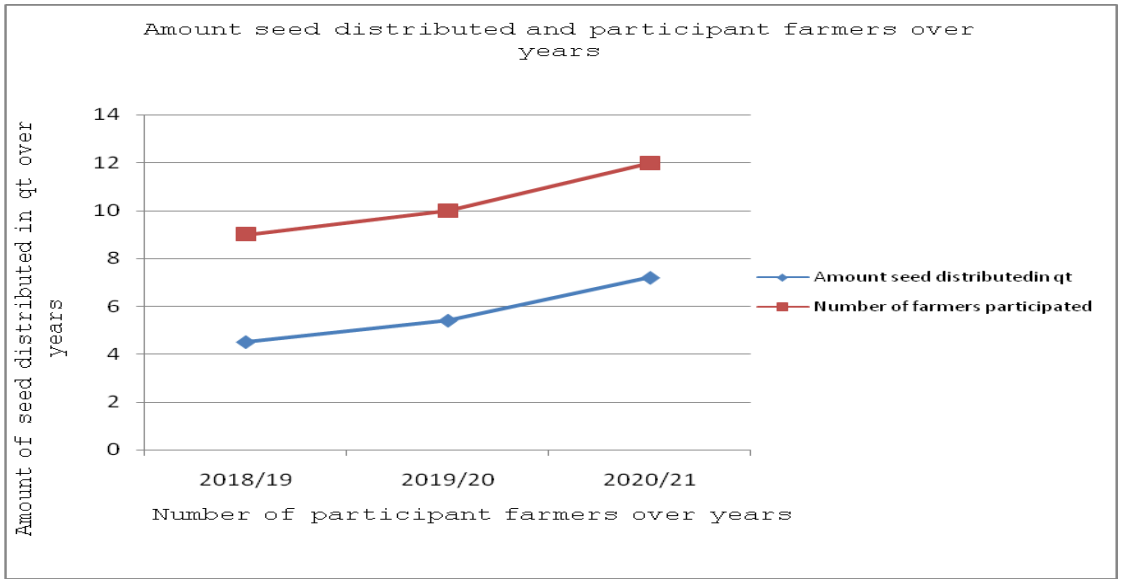

Figure 1 amount seed distributed and number of participant farmers participated over the last four years

Source: Own data, 2020-2022

On farm yield performance field pea variety

The mean yield obtained over years from field pea; *Lammiif* variety was collected from sample farmers and summarized in (figure 2) below.

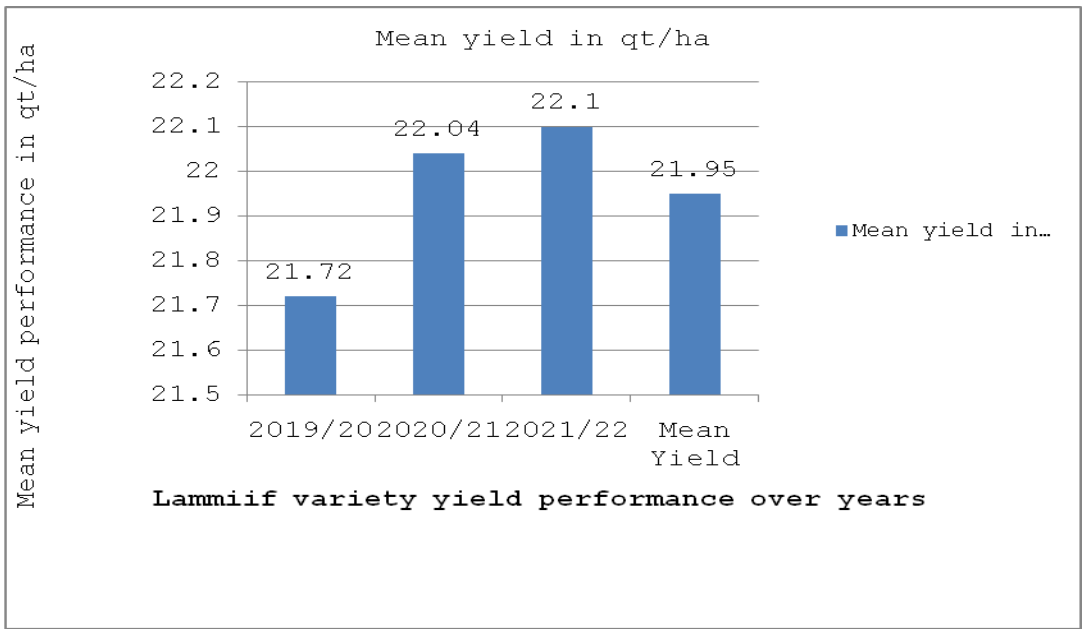

Figure2. field pea mean yield performance in qt/ha over years

The above table revealed that the highest mean yield was recorded during 2021/22 production season and relatively the lowest mean yield of field pea was recorded higher 2019/20 production season. Over all; however, participant farmers' and other stakeholders' participated on the pre-scaling up activity and other events such as field day and field visits evaluated and revealed that except its long maturing time Lammiif variety as a high yielder, very good in color (marketability), disease tolerant, lodging tolerant, very good stand/plant

height, high number of pods per plant and high number seeds per pod. Consequently; taking these facts into consideration we recommend that scaling up of this technology on large area of land and more number of farmers will be mandated.

Yield Potential and Yield Gap Analysis

Field pea Grain Yield

Mean grain yield of improved field pea variety demonstrated in Jimma Arjo over years were 21.72 qt/ha in 2019/20, 22.04 qt/ha in 2020/21 and 22.1 qt/ha in 2021/22; respectively, recorded. The total mean yield was 21.95 qt/ha which was 82.92 % higher than the farmer practices (varieties) (12qt/ha). This difference is due to the utilization of best-fit variety *(Lammiif)* and the application of the recommended agronomic practices and field management. From these results it is evident that the performance of *Lammiif* variety was found better than the farmer's practice. This result clearly elucidated that farmers' practices of grain yield performance were by far lower as compared to grain yield obtained by large scale demonstration (Table 3). Hence, large scale demonstration of improved field pea varieties should be more emphasized in the targeted environment of potential field pea growing regions in the country.

Table 3. Grain yield performance of *Lammiif* field pea variety tested at Jimma Arjo in 2019/20-2021/22 crop season.

Name of variety	Area (ha)	Potential yield (qt/ha)	Demonstration yield (qt/ha)	Farmers practice (qt/ha)	% Yield increases over farmers practices
Lammiif	9.5	26.5	22.11	12	82.92
Total	**9.5**				

*Percentage of yield increase over farmers practice = {(demonstration yield − farmers practice)/farmers practice} × 100.

Technology Gap and Technology Index

Grain yield gap was analyzed based on the actual implementation of improved field pea technologies and the trend of farmers practices to grow field pea in the district. Based on this the yield gap of field pea has been explicated in terms of technology and extension gaps. Technology Gap (TG) analysis indicates the extent to which technologies have not been adopted. This feedback information is essential to identify the weakness of technology transfer program, to remove bottlenecks and accelerate adoption of improved technologies (Neha P. 2018). The mean value of technology gap (TG) analysis and overall gaps against the recommended technology practices were computed. Hence, the overall technology gap was calculated using the formula given under the methodology part and it was found to be 4.39 qt/ha. The yield difference may be observed due to the environmental differences.

Similarly, extension gap (EG) was calculated and found to be 10.11% and the result indicated that it needs emphasis to strengthen the extension approach using various methods like offering training to farmers, skill and experience sharing, awareness enhancement via information dissemination channels and other pertinent methods. It is also believed that advanced improved field pea technology production package with acceptable grain quality will subsequently change the extension gap. Hence, dissemination of newly released improved field pea technologies including production packages will have a significant

contribution to replace farmers' field pea varieties and then hasten adoption rate. At the same time technology index (TI) was computed using formula and recorded 16.57%. This is an indication that realized yields at farmers' fields and at the demonstration sites still have huge potentials for yield increment. If this gap is minimized, the field pea production and productivity will be enhanced (Table3, Table 4).

Table 4. Field pea grain yield gap analysis of Lammiif variety.

Name of variety	Technology gap (qt/ha)	Extension gap (q/ha)	Technology index (%)
Lammiif	4.39	10.11	16.57

Impact/Change of Intervention

Institutional Linkage

It is not possible to attain sustainable and incremental economic development without strong institutional linkages among relevant stakeholders engaged in transforming the agricultural sector and improving the livelihood of the resource poor farmers'. The major reason among others was that most of the intervention made by different institutions was unilateral and lacked coordination and synergy. But these days approach of developing partnership and institutional linkage in agricultural technology/commodity promotion proved successful and therefore is viewed as a win-win working model by stakeholders' involved across the value chain from technology generation via production to marketing of value added products. Furthermore; the successful accomplishment of this innovative work together with the active involvement of all relevant and responsible stakeholders has brought about significant and positive attitudinal change towards partnership and collaboration thus built mutual trust and self-confidence among themselves in expanding their cooperation in other similar joint initiatives.

Outcome of the activity (achievements)

- Farmers have got improved field pea variety of their own preference;
- Mutual trust between farmers, researchers, DAs and other stakeholders was fostered
- 31 farmers were reached through direct intervention;
- Many were reached via other routes(sale, exchange, gift);

Success factors

- Availability of the proven technology ;
- Multi-disciplinary research team;
- Identification of the key stakeholders;
- A strong linkage among stakeholders;
- Scaling up strategy with shared vision and;
- Supportive research management

Farmers' Perception on the Technology

During feedback assessment farmers were revealed the advantages and disadvantages of the technology as well as their views/perception towards the technology. Accordingly; the farmers strongly liked and listed the merits of the technology over the commercial varieties in terms of yield, color, disease tolerant, market price, number of pods per plant, number of

seeds per pod and taste. Besides; the farmers' also appreciated the group approach (FREG) in due of its quickness in sharing knowledge, responsibility sharing, ownership, team spirit and easiness in solving problems and easy operation.

Exit Mechanism

The mandate and scope of Bako Agricultural Research center is technology generation, adaptation and demand creation through demonstration and pre-scaling activities on limited farmers' fields. To this end, actually promoting scaling out/up the already demonstrated, verified, proved and selected technologies is the mandate of respective district agricultural and natural resource office. Therefore; the wider scope dissemination or scaling up/out of the technology should be handled/over taken and implemented by agricultural and natural resource offices as well as other relevant and mandated stakeholders' involved in this area. The technology is not a 'plant' and 'harvest' type it is rather skill training; thus, what is passed is not physical resource. To in effect, this BARC and the respective agriculture and natural resource office discussed, agreed and signed an exit strategy on how the technology to be promoted sustainably and on wider scale. Eventually; training manual, leaf lets and production manuals were also prepared in "Afaan Oromoo" were handed over to the respective sites for better promotion of the technology.

Conclusion and Recommendation

Prior to this pre-scaling up activity pre-extension demonstration of improved field pea technologies was carried out in Jimma Arjo district of East Wollega Zone of Western Oromia. One newly released field pea variety; Lammiif, was planted along with standard check; Gedo-1, on 10m*10m adjacent plots of land and on a total of 8 hosting farmers in the district. At maturity stage participatory variety evaluation and selection was arranged and held so as to evaluate, rank and select best suiting variety/ies in accordance with their real situation. Accordingly; *Lammiif* variety was selected first in all of the traits. To this end; the demonstrated improved variety was much better in yield performances than the standard released check used and varieties on the hands of the farmers'.

This pre-scaling up activity was commenced with awareness creation and provision of training to different relevant stakeholders' so as to build their capacity with regard to promotion of field pea technology. Furthermore, the successful accomplishment of this pre-scaling up activity through active involvement of different relevant stakeholders' has brought about significant and positive attitudinal change towards partnership and collaboration and thus; built mutual trust and confidence among themselves in promoting their cooperation in other similar joint activities.

Generally; the improved field pea variety '*Lammiif"'* gave higher yield and better benefit than local varieties in the study district where this pre-scaling activity has been carried out. Thus; by using this improved variety with its full package, farmers can earn more benefit than conventional and local varieties. As the variety is preferred by farmers' and other stakeholders' promotion and dissemination of the technology should continue sustainably on wider scope. Eventually; this could be achieved through district agricultural and natural resource offices and other relevant and collaborative stakeholders.

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Pre- scaling up of improved Yam technology to potential district of Western Oromia

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Abstract

*Pre-scaling of improved yam varieties was carried out at Wayu Tuqa district of East Wollega Zone of Western Oromia. The main objective of this study was to make wider awareness on improved yam using recently released Bulcha variety. The improved yam variety; Bulcha, was planted on 10m*10m plots of land with the spacing of 75cm *25cm between rows and plants and with recommended fertilizer rate of 100 kg NPS and 100kg of UREA. Accordingly, the project was carried out at Wayu Tuqa district of East Wollega zone on 31 farmers' field. For scaling up of field pea varieties 17, 050 tuber cuttings of improved yam variety (Bulcha) were freely distributed for selected farmers while fertilizers and all that required for management; such as, labor and others were covered by the farmers themselves as per our agreement during selection; cost sharing. Field day was also arranged to create awareness and share experiences among farmers on improved yam production and management. Feed backs obtained from farmers revealed that this yam variety is with high yielder, disease tolerant, adaptable and very good taste. Therefore; the variety should further be promoted by respective extension organizations in collaboration with other key stake holders in the area.*

Key words: Pre-scaling up, yam, Bulcha

Introduction

Background and Justification

Yams (*Dioscorea* spp.) are the Dioscoreaceae vine plants grown and staple food in tropical and sub-tropical regions that produce underground or aerial tubers (IITA, 2010). Yams are edible energy-rich tuber crops developed from modified and thickened underground stems storage organs which they are bulky, perishable, and vegetatively propagated by the tuber (Tamiru, 2006 and Bradshaw, 2010). Among different type of root and tuber crops, yams (*Dioscorea* spp.) are the common usable staple food, livestock feed, or as raw materials for the production of different industrial products (Ben, 2010). Yams are monocot seems to have an African origin (Agbaje *et.al.*, 2003). The genus *Dioscorea*is the largest of the ten genera of Dioscoreaceae and it contains about 600 varieties species and 95 percent of these crops are grown in Africa (Izekor and Olumese, 2010). Yams have a relatively narrower range of production, being mainly confined to the tropical region throughout the world from sea level to 1,400 meters. The main production of yam is in the savannah region of West Africa, where more than 90% of the crop is grown.

Unlike the other root and tuber crops the white and yellow yam (*Dioscorea rotundata* and *Dioscorea cayenensis [esculenta]*, respectively) are thought to be indigenous to West Africa, whereas the water yam (*Dioscorea alata*) is thought to have originated in Southeast Asia (Joseph *et.al.* 2016). Despite the intense labor requirements and production costs, consumer demand for yam is very high in West Africa; making yam cultivation quite profitable for farmers (IITA, 2010).The world average annual yield of yams was 10.2 tonnes per hectare in 2010. The most productive yam farms in the world were in Colombia, where nationwide average annual yield was 28.3 tonnes per hectare (FAO, 2011). With some farms reporting

yields significantly above 30 tonnes per hectare for yellow yam and others reporting less than 1 tonne per hectare (Opara, 2003).

Yam tubers are comprised of approximately 75.6-83.3 % carbohydrate, 3-7.4 % protein 0.5 - 1.5% fiber, 0.7-2.0% ash, and 0.05-0.02% fat. A large proportion (65- 75%) of the yam tuber is made up of water (Degras, 1993). In addition; they are a starchy staple food, rich in carbohydrates and are also valuable sources of some vitamins, particularly vitamin C. Yam tubers contain about 13-24.7 mg/100g ascorbic acid and most of it is retained during cooking (Coursey, 1969; Wanasundera and Ravindran, 1994). They are also very good source of minerals and are high in dietary fiber, vitamin B6, potassium and manganese and low in saturated fat, sodium and cholesterol (Wanasundera and Ravindran, 1994; Walsh, 2003).

According to Zeven and Wet (1982) Ethiopia is the center of origin for one of *Dioscorea* species (*D. abyssinica Hochst.ex Kunth*). Many different accessions of this species are extensively cultivated by subsistence farmers in the Southern, South-western and Western parts of Ethiopia across a range of agro-ecologies (Miege and Sebsebe, 1997). More importantly people in these parts of Ethiopia use yams as the most preferred food item for distinguishable guests and during the main traditional celebration of Meskel Holiday (Muluneh *et al*., 2005). Yam (*Dioscorea* spp.) is widely grown in many parts of Ethiopia particularly in southern and southwest parts of the country and plays a vital role in local subsistence in the region. It serve as a 'life saving' plant group for the marginal farming and forest dwelling communities, during periods of food scarcity (Agbaje *et.al.*, 2003). True yams are ubiquitous lowland tropical food plants (Ikeorgu, 2000); and are a staple foodstuff and also important as a secondary (famine) food. Besides; yam is an attractive crop in poor farms with limited resources and is also available all year round making it preferable to other unreliable seasonal crops. These characteristics make yam a preferred food and a culturally important food security crop in some sub-Saharan African countries (Izekor and Olumese, 2010).

Despite the tremendous importance of yam production for food security and hunger reducing programs and, pharmaceutical factory particularly in the developing countries the production is not as such of its demand, and it has shown fluctuation since 2007 (FAO, 2012). Lack of access to improved varieties, high cost of labor for stalking weeding and planting, lack of mechanization for planting and harvesting the tuber, pests and diseases are accounted to be the constraints of yam production (Atiri *et al*., 2003). Further; the production potential of yam species cultivated throughout the tropics and subtropics of the world is limited in one or more of the following reasons: lack of access to inputs, high cost of inputs, poor producer prices, lack of capital, incidences of pests and diseases, poor transportation facilities and inadequate extension services (Degras, 1993; Zaknayiba and Tanko, 2013; Reuben and Barau, 2012).

To tackle such challenges, BARC has been conducting intensive research work on the crop and has recently released yam variety that has better yield, disease, insect-pest tolerant than the previous varieties. To this end, actually BARC has recently released variety; Bulcha with potential yield of 460 qt/ha on farmers' field (MoARD, 2009), to reverse the scenario and alleviate the problem of low productivity as well as co-related challenges sustainably. Hence, prior to this pre-scaling up activity pre-extension demonstration of improved yam technologies was carried out in Wayu Tuqa district of East Wollega Zone of Western Oromia. The recently released yam variety; Bulcha, was planted along with Commercial check on 10m*10m adjacent plots of land and on a total of 8 hosting farmers in the district. At maturity stage participatory variety evaluation and selection was arranged so as to

evaluate, rank and select best suiting variety/ies in accordance with participating farmers real situation. Accordingly; Bulcha variety was selected first in all of the traits. To this end; the demonstrated improved variety was much better in yield performances than the check used and varieties on the hands of the farmers. Tp this end bulcha variety was recommended for further scaling up works. Yet, little has been done so far to transfer this improved yam varieties with its agronomic practices. Hence, considering the reality mentioned above BARC extension team initiated this activity aiming at popularizing (transferring) the technology at farmers' field there by outspreading (scaling up/out) of the selected technology to the end users based on farmers' selection criteria. These in turn increase household income and contribute more to food security so as to alleviate food shortage.

Objectives

- To promote tested and verified improved technology/ies of yam for small holders' farmers in the district;
- To disseminate the selected variety and build seed diffusion channel ;
- To strengthen linkages with target beneficiaries and stakeholders so as to enhance their confidence on results of research;
- To build knowledge and skill of the farmers on yam production and management practice.

Materials and Method

Operation sites and participant actors

Cost sharing approach was the main strategy used to promote and disseminate the technology. Accordingly, the activity was carried out in major Yam producing district of Wayu Tuqa East Wollega zone. From the district, 1 PA was selected. The already tested and verified yam variety; Bulcha, was freely distributed for selected farmers while fertilizers and all that required for management; such as, labor and others were covered by the farmers themselves as per our initial agreement made during farmers selection ,grouping and cost sharing sensitization.

Agronomic management

All the necessary recommended agronomic practices; spacing between rows and plants were 75 cm by 25 cm; respectively and fertilizer rate of 100 kg/ha NPS at planting and 100 kg/ha Urea (splitting into to two half at planting and the remaining after 40-45days of planting) were applied. All recommended manure and agronomic practices were implemented.

Provision of training and Input distribution and Planting

After sites and farmers' were selected both theoretical and practical training were given to farmers, Development agents and district experts. Training provided on the following areas; such as, yam production management, breeding aspect, post harvesting (seed quality). The aim of training was to create awareness of farmers', Development agent and district experts on rice technology. Finally; after the plots were properly ploughed and made ready for planting ahead of the planting date, all necessary inputs (seed) were delivered to the farmers. Planting was made on the farmers' field by BARC researchers, TAs as well as FEG farmers.

Data collection and Analysis

For this activity all the necessary qualitative and quantitative data were collected; these includes yield data, total number of farmers, DAs, experts participated on training , field visits, farmers' perception on the attribute of the technology. Simple descriptive statistics tools such as mean, graph, table, frequencies and percentages were used to summarize the data/result.

Technology gap and Technology index

Technology gap used in this activity is the difference between potential yield and demonstration yield of improved Yam variety (Bulcha) per unit area. At the same time technology index the percentage in the difference between technology gap and potential yield. Technology gap indicates that 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. Technology gap, extension gap and technology index were calculated as per the formula given by Samui *et. al.* (2000) .Further; according to Dhaka *et.al*., 2010 its important tool and contributes in the process of narrowing down the gap between the potential and demonstration yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties. To this end, the technology gap and index of demonstrated varieties (Bulcha) were calculated using the underlying formulas and presented in below table.

Technology gap = Potential yield qt/ha – Demonstration yield (1)

$$\textbf{Technology index} = \frac{\textbf{Potential yield - Demonstration yield}}{\textbf{Potential yield}} * 100 \quad (2)$$

Communication methods (dissemination strategies)

Field day and field visit, training and print media such as leaflets, pamphlets and production manuals were used for further creating awareness and for enhancing users' knowledge and skill in yam production.

Monitoring and Evaluation

Researchers, extension agents and farmers' jointly participated on monitoring and evaluation at least once in fortnight (two weeks) to supervise the overall management, progress performance of the variety and others to fill gap observed starting from site selection through harvesting. At the end based on its performance the variety was jointly evaluated with FEGs, researchers, extension agents and other relevant stakeholders'.

Result and Discussion

Training

Below (table 1) summarize gender disaggregated number of stakeholders' participated on training

Table1. Gender disaggregated number of stakeholders' participated on Training

Training Topic	Participants									
Yam production and management	Farmers			DAs			Experts			Total
	M	F	Total	M	F	Total	M	F	Total	
	15	5	20	4	-	4	4	-	4	24

Field day

Field days were jointly organized and arranged with district level agriculture and natural resource offices so as create opportunities for all relevant stakeholders', to create awareness on the importance and availability of the technology, to learn from the technologies promotion activities and also to evaluate the performance of varieties, to enhance farmers' knowledge on yam production and management and to give/collect feedback from all relevant stakeholders' for further way forward. For the last four years totally 69 farmers 16 development agents and 12 district experts were invited and attended on the field day event. Below (table 2) summarize gender disaggregated number of participants participated on the field day event organized.

Table 2: Gender disaggregated number of stakeholders' participated on field Visit

Stakeholder Participated on Field visit event						
Farmers		DAs		Experts		Total
M	F	M	F	M	F	
51	11	4	-	3	-	69

Amount of tuber cuttings distributed and number of participant farmers over years

Totally about 17, 050 tuber cuttings of improved yam variety; Bulcha, were distributed to 31 farmers' for scaling up purpose over the last three years in Wayu Tuqa district Bonaya Mollo PA. Below (figure 1) summarize amount tuber cuttings distributed and number of participant farmers participated over the last three years as follows.

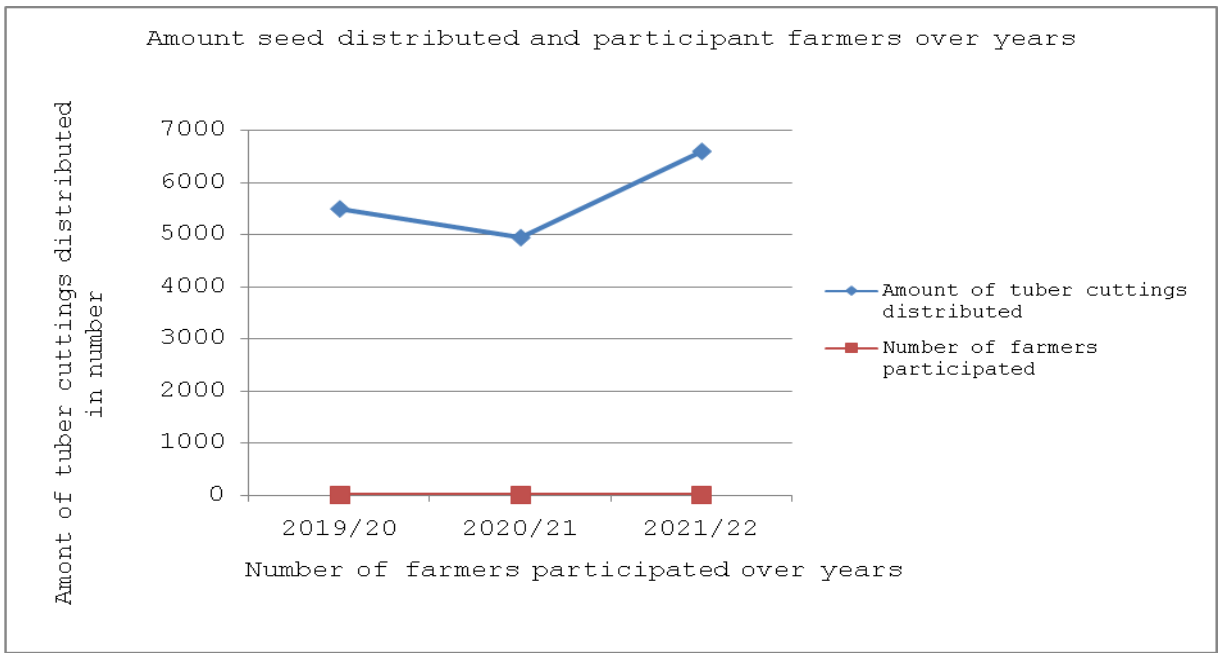

Figure 1 amount tuber cuttings of Bulcha variety distributed and number of participant farmers participated over the last four years
Source: Own data, 2020-2022

On farm yield performance yam variety

The mean yield obtained over years from yam; Bulcha variety was collected from sample farmers and summarized in (figure 2) below.

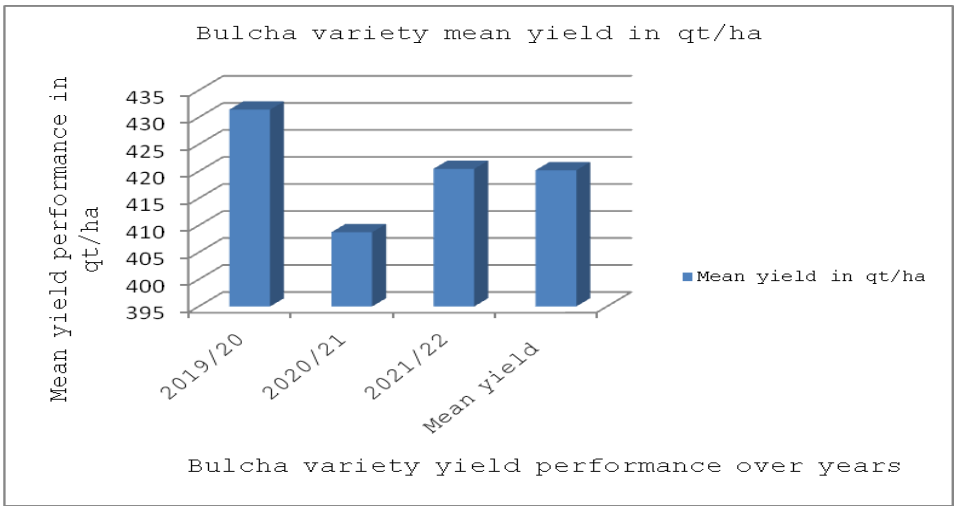

Figure2Mean yield performance of Bulcha yam variety in qt/ha over study years

The above table revealed that the highest mean yield was recorded during 2019/20 production season and relatively the lowest mean yield of yam was recorded in 2020/21 production season. Over all; participant farmers' and other stakeholders' participated on the pre-scaling up activity and other events such as field day and field visits evaluated and revealed that except its long maturing time Bulcha variety as a high yielder, very good in color (marketability), disease tolerant, number of tuber per plant and taste. Consequently; taking these facts into consideration we recommend that scaling up of this technology on large area of land and more number of farmers will be mandated.

Yield Potential and Yield Gap Analysis

Yam Grain Yield

Mean grain yield of improved yam (Bulcha)variety demonstrated in Wayu Tuqa over years were recorded as 431.43 qt/ha in 2019/20, 408.74 qt/ha in 2020/21 and 420.47 qt/ha in 2021/22; respectively. The total mean yield was found to be 420. 21 qt/ha which was 84 % higher than the farmer practices (varieties) (250qt/ha). This difference is due to the utilization of best-fit variety (Bulcha) and the application of the recommended agronomic practices and field management. From these results it is evident that the performance of Bulcha variety was found better than the farmer's practice. This result clearly elucidated that farmers' practices of tuber yield performance were by far lower as compared to tuber yield obtained by previous demonstration (Table 3). Hence, large scale demonstration of improved yam variety should be more emphasized in the targeted environment of potential yam growing regions in the country.

Table 3. Tuber yield performance of Bulcha yam variety tested at Wayu Tuqa in 2019/20-2021/22 crop season.

Name of variety	Area (ha)	Potential yield (qt/ha)	Demonstration yield (qt/ha)	Farmers practice (qt/ha)	% Yield increases over farmers practices
Bulcha	0.31	460	420.21	250	68
Total	**0.31**				

*Percentage of yield increase over farmers practice = {(demonstration yield − farmers practice)/farmers practice} × 100.

Technology Gap and Technology Index

Grain yield gap was analyzed based on the actual implementation of improved yam technologies and the trend of farmers practices to grow yam in the district. Based on this the yield gap of yam has been explicated in terms of technology and extension gaps. Technology Gap (TG) analysis indicates the extent to which technologies have not been adopted. This feedback information is essential to identify the weakness of technology transfer program, to remove bottlenecks and accelerate adoption of improved technologies (Neha, P, 2018). The mean value of technology gap (TG) analysis and overall gaps against the recommended technology practices were computed. Hence, the overall technology gap was calculated using the formula and it was found 39.79 qt/ha. The yield difference may be observed due to the environmental differences.

Similarly, extension gap (EG) was calculated using the formula and found to be 170.21 qt/ha and the result indicated that it needs emphasis to strengthen the extension approach using various methods like offering training to farmers, skill and experience sharing, awareness enhancement via information dissemination channels and other pertinent methods. It is also believed that advanced improved yam technology production package with acceptable grain quality will subsequently change the extension gap. Hence, dissemination of newly released improved yam technologies including production packages will have a significant contribution to replace farmers' yam varieties and then hasten adoption rate. At the same time technology index (TI) was computed using formula and recorded to be 8.65 %. This is an indication that realized yields at farmers' farm and even at the demonstration sites still have huge potentials for increase. If this gap is minimized, the yam production and productivity will be enhanced (Table3, Table 4).

Table 4. Yam tuber yield gap analysis of Bulcha variety.

Name of variety	Technology gap (qt/ha)	Extension gap (q/ha)	Technology index (%)
Bulcha	39.79	170.21	8.65

Impact/Change of Intervention

Institutional Linkage

It is not possible to attain sustainable and incremental economic development without strong institutional linkages among relevant stakeholders engaged in transforming the agricultural sector and improve the livelihood of the resource poor farmers'. The major reason among others was that most of the intervention made by different institutions was unilateral and lacked coordination and synergy. But these days approach of developing partnership and institutional linkage in agricultural technology/commodity promotion proved successful and therefore is viewed as a win-win working model by stakeholders' involved across the value chain from technology generation via production to marketing of value added products. Furthermore; the successful accomplishment of this innovative work together with the active involvement of all relevant and responsible stakeholders has brought about significant and positive attitudinal change towards partnership and collaboration thus built mutual trust and self-confidence among themselves in expanding their cooperation in other similar joint initiatives.

Outcome of the activity (achievements)

- Farmers have got improved yam variety of their own preference;
- Improved their food security;
- Mutual trust between farmers, researchers, DAs and other stakeholders was fostered
- 31 farmers were reached through direct intervention;
- Many were reached via other routes(sale, exchange, gift);

Success factors

- Availability of the proven technology ;
- Multi-disciplinary research team;
- Identification of the key stakeholders;
- A strong linkage among stakeholders;
- Scaling up strategy with shared vision and;
- Supportive research management

Farmers' Perception on the Technology

During feedback assessment farmers were revealed the advantages and disadvantages of the technology as well as their views/perception towards the technology. Accordingly; the farmers strongly liked and listed the merits of the technology over the commercial varieties in terms of yield, color, disease tolerant, market price, number of tubers per plant and taste. Besides; the farmers' also appreciated the group approach (FREG) in due of its quickness in sharing knowledge, responsibility sharing, ownership, team spirit and easiness in solving problems and easy operation.

Exit Mechanism

The mandate and scope of Bako Agricultural Research center is technology generation, adaptation and demand creation through demonstration and pre-scaling activities on limited farmers' fields. To this end, actually promoting scaling out/up the already demonstrated, verified, proved and selected technologies is the mandate of respective district agricultural and natural resource office. Therefore; the wider scope dissemination or scaling up/out of the technology should be handled/over taken and implemented by agricultural and natural resource offices as well as other relevant and mandated stakeholders' involved in this area. The technology is not a 'plant' and 'harvest' type it is rather skill training; thus, what is passed is not physical resource. To in effect this BARC and the respective agriculture and natural resource office discussed, agreed and signed an exit strategy on how the technology to be promoted sustainably and on wider scale. Eventually; training manual, leaf lets and production manuals were also prepared and written in "Afaan Oromoo" were handed over to the respective sites for better promotion of the technology.

Conclusion and Recommendation

This pre-scaling up activity was started with awareness creation and provision of training to different relevant stakeholders' so as to build their capacity with regard to promotion of the technology. Further, the successful accomplishment of this pre-scaling up activity through active involvement of different relevant stakeholders' has brought about significant and positive attitudinal change towards partnership and collaboration and thus; built mutual trust and confidence among themselves in promoting their cooperation in other similar joint activities.

Generally; improved technologies gave higher yield and better benefit than local varieties in the district where this pre-scaling activity has been carried out. Thus; using improved varieties with its full package farmers can earn more benefit than conventional and local varieties. As the variety is preferred by farmers' and other stakeholders' which is an opportunity for the farmer's promotion and dissemination the technology should continue sustainably on wider scope. Eventually; this could be achieved through district agricultural and natural resource office and other relevant and collaborative stakeholders.

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Pre-Extension Demonstration of Bako Modified Engine Driven Groundnut Decorticator Machine in South Western Oromia

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Abstract
The study was conducted in Jimma Zones of Oromia Regional State, Ethiopia. The objective of the study was to demonstrate and evaluate the engine operated groundnut decorticator machine performance under the farmers' condition at the study area. Four sites were selected as hosting farmer for the demonstration of the technology at different sites namely Kishe, Gasera, Burka Gudina and Kalo selected from three districts (Shebe, Limu and Mana) purposively. Total of 81 farmers (30 Female, 51 Male) and, 11 agricultural workers (SMS and DAs), 15 others (Kebele Administrators and Researchers) have attended the mini field days. The evaluation result showed that the groundnut decorticator machine has average decorticating efficiency 96.12% and capacity of 3.39 kg/min with good performance. Similarly, the participant farmers' perception responses showed that 60.53 *% and* 57.89% *replied the engine operated groundnut decorticator machine had high performance and the rest* 39.47 *% and 42.1% responded it to the medium capacity and efficiency respectively. Concerning the machine's grain breakage minimizing, 89.47% and 10.53% respondents replied that it showed high and medium performance. Hence, most farmers have perceived the machine performance positively and so, scaling up the machine is required.*
Keywords: *Decorticator, Groundnut, Engine Operated, Capacity, Efficiency, Breakage.*

Introduction

Groundnut (Arachis Hypogaea) is a low land edible oil crop which cultivated near 100 countries, which 90% are developing countries and it uses as staple food and valuable cash crops for millions of households (Ahmed et al., 2020). It is South America origin and introduced in to Eritrea and Ethiopia in 1920s (Tesfay, 2021).
The lowland areas of Ethiopia have considerable potential for increased oil crop production including groundnut. According to the CSA report on area and production of crops, more than 521,326 private peasant holding households have been grown groundnut in 80,841.57 hectares of land in the 2017/18 cropping season leading to a total production of over 1.45 million quintal with average national yield of 17.93 quintal in the country (Tesfay, 2021)in the country. According to the same report, Oromia region constitutes the largest proportion of groundnut production areas accounting for 63% (328, 283 ha) followed Benishanul Gumz is the second largest contributor in terms of groundnut production areas (20,033.19 ha)

Groundnut production is one of the most crucial agricultural crop in the world (Tesfay, 2021). Adaptability to dry condition, it requires low inputs and makes it suitable crop for tropical and subtropical. Groundnut is a legume crop, which improves soil fertility by fixing atmospheric nitrogen and save fertilizer cost in subsequent crops (Tesfay, 2021). This is an option for smallholder farmers who are unable to purchase inorganic fertilizer due to concurrent increment of fertilizer price(Tesfay, 2021). In many countries, groundnut used as oil seed, food and animal feeds all over the world which contains digestible protein (25 to 34%), cooking oil (44 to 56%), and vitamins like thiamin, riboflavin and niacin. Its cake and haulms (straw stem) are used for livestock feed (Tesfay, 2021).

Groundnut production is constrained and declined in Ethiopia. Its' main causes are 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 (Sori, 2021).

In southwestern Oromia, the groundnut is an important oilseed crop in terms of serving as a source of food and generating income. As to report of Jimma Zone Agricultural Development Office (JZADO, 2018), Shabe and Limu districts of Jimma Zone are major ground nut growing areas covering 6454 hectares with 133, 940 quintal of ground nut production. Farmers heavily depend on it for consumption either through processing or roasting to fulfill their basic needs and selling it especially poor farmers generate their income from activities related with groundnut production.

Despite large production and productivity of groundnut crops, groundnut production in the study area is constrained by pre and post-harvest management practices of the product. Among the post-harvest management practice, the farmers in the study area decorticate the crop traditionally which is tedious work and time-consuming work. The usual practice is separating the grain from pods by beating the pod against a rough thick iron rod. Almost, all the groundnut producer farmers use manual decorticating being in groups of family (dabo), which is laborious and time taking activity as farmers of the area as no any improved groundnut decorticating technology.

To solve this problem, Jimma Agricultural Engineering Research center had demonstrated and evaluated engine operated groundnut decorticator machine on purposively selected districts of Jimmaa and Buno Bedele zones.

Objective of the study

- To create farmer awareness engine driven groundnut decorticator machine
- To evaluate the performance groundnut decorticator machine under farmers
- To get feedback from users on the groundnut decorticator machine for further improvement

Materials and Methods

Material

The sample Bako model engine operated groundnut decorticator machine was produced in JAERC production workshop.

Methodology

Three districts were selected from Jimma zone randomly in which four Kebeles were considered purposively based on the crop production potential. From each selected Kebele, a group of 10-15 hosting farmers was selected together with respective Keble DA's for the technology demonstration. Field day was also arranged at the selected sites. Measurements, interview, and group discussion methods were used for data collection on the technical performance.

Data collected

- Quantitative data collected on the machine performance based in terms of time and labor consumed in Man-hr per kg/hr.
- Qualitative data were collected on farmer's opinion and comments

Method of data analysis:

The quantitative data were analyzed by using descriptive while qualitative data on perception were analyzed by using three stages Likert scale ranking method.

Result and Discussion

Training Farmers, SMS and DAs on the engine operated ground nut decorticator machine
Practical and theoretical trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) that exist at the selected Kebele level on the operation and maintenance of engine operated groundnut decorticator machine to create awareness before actual demonstration carry out at large. Accordingly a total of 76 farmers, 8 DAs and 5 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS

No	**Location**			**Training Participants**				
				Farmers		**Others**		**Total**
	Zone	Woreda	Kebele	Male	Female	DAs	SMSs	
1	Jimma	Shabe	Kishe	14	9	2	1	**26**
			Gasera	10	5	2	2	**19**
		Lumu kosa	Burka Gudina	14	7	2	1	**24**
2	Buno Bedele	Bedele	Kalo siri	16	11	2	1	**30**
	Total			**44**	**32**	**8**	**5**	**99**

Table2. Performance of the groundnut decorticator under farmer management

Woreda	**Kebele**	**Replication**	**Efficient (%)**	**Capacity (kg/min)**	**Breakage (%)**
Shabe	Kishe	1	95.40	3.49	0.02
		2	96.31	3.38	0.01
		3	97.22	3.57	0.02
		Average	**96.31**	**3.48**	0.016
Shabe	Gasera	1	96.31	3.35	0.01
		2	97.11	3.43	0.01
		3	95.24	3.51	0.02
		Average	**96.22**	**3.43**	**0.013**
Limu Kosa	Burka Gudina	1	96.32	3.41	0.02
		2	95.32	3.24	0.01
		3	97.62	3.31	0.01
		Average	**96.42**	**3.32**	**0.013**
Bedele	Kalo siri	**1**	96.42	3.35	0.03
		2	95.51	3.36	0.04
		3	94.63	3.31	0.03
		Average	**95.52**	**3.34**	**0.033**
	Total	**Average**	**96.12**	**3.39**	**0.018**

The performance evaluation of the technology was made based on the attributes recognized as important showed that average decorticating efficiency 96.12% and capacity of 3.39 kg/min with good performance.

Thus, the above table indicates that the groundnut decorticator has good efficiency that preferred by the participant farmers.

Demonstration of the improved groundnut decorticator machine

Table.2 Field day conducted

No	**Locations**		**Participants of field days**									
			Farmers				DAs &SMS		Others		Total	
	District	Kebele	Adult		Youth							
			M	F	M	F	M	F	M	F	M	F
1	Shabe	Kishee	8	5	4	2	2	1	3	1	17	9
		Gasera	6	4	5	3	1	1	2	2	14	10
2	Limu K.	Burka Gudna	7	3	5	3	2	1	2	1	18	8
3	Bedele	Qalo Siri	10	6	6	4	2	1	4	0	22	11
	Total		**31**	**18**	**20**	**12**	**7**	**4**	**11**	**4**	**69**	**38**

Table 3. Perception of farmers

No.	**Attributes used for acceptance degree**	**Response level**	**Participants' reaction (No=38)**	
			Fr	%
1	Decorticating capacity (kg/hr)	Low Medium High	- 15 23	- 39.47 60.53
2	Cleaning efficiency %	Low Medium High	- 16 22	- 42.1 57.89
3	Crop loss/damage (%)	Low Medium High	34 4 -	89.47 10.53 -

The evaluation result showed that the machine has saved farmers' labor and time having average decorticating efficiency of 96.12% with good performance capacity of 3.32 kg/min. Likewise; participant farmers' perception responses showed that 60.53% replied the improved groundnut decorticator machine had high decorticating capacity and the rest 39.47% ranked it to medium performance. Yet no respondent responded for its poor level of decorticating capacity. Hence, most farmers perceived the engine operated groundnut decorticator machine positively based on its performance. As to the crop loss/damage/, 89.47 respondents replied that it showed low level while 50.53% medium.

Conclusion and Recommendation

Conclusion

- The groundnut decorticator machine has average decorticating efficiency 96.12% and capacity of 3.39 kg/min with good performance.
- The difference in size of the groundnut due to crop variety requires arrangement of fitting sieve size to maintain the machine performance.
- Most of the participant farmers' response showed that they perceived the engine operated groundnut decorticator machine positively for its high capacity and efficiency.

Recommendation

- The Agricultural office and the technical manufacturers should closely work for more technology supply creating linkage among farmers and manufacturers for sustainable delivery.
- The improved machine need scaling up for farther popularization.

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Participatory Demonstration of Jimma model household biomass stove in south western Oromia

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Abstract

The study was conducted in Jimma Zones of Oromia Regional State, Ethiopia. The objective of the study was to demonstrate and evaluate the Jimma model household biomass stove performance under the farmers' condition. Three districts namely Shebe, Goma and Mana were identified of which Kishe, Gasera, Ompo Gurude and Kenteri Kebeles selected purposively and the technology demonstration carried out at hosting farmers' sites. Total of 48 farmers (13 Female, 35 Male), 8 agricultural workers (SMS and DAs), 18 others (Kebele Administrators and Researchers) have attended the field days. The evaluation results indicate that average burning rate of rice husk and coffee husk was 31 g/min &32 g/min while thermal efficiency was 26% & 27% during hot start test and fire power was 6763 Watt and 8657 Watt during hot start test respectively. In the same way, participant farmers' perception responses showed that 87.1% replied the Jimma model household biomass stove has high efficiency and the rest 12.9% responded it to the medium performance. Yet no respondent responded for its low level efficiency. Most farmers have perceived the household biomass stove positively on its performance. Regarding the machine affordability, 80.6% respondents replied that it showed highly affordable and easily repaired and maintained in case damaged that was liked by almost all the attendants. So, the stove need be scaled up.

Keywords*: Biomass, Stove, Coffee husk, Rice husk, Efficiency, Affordability, Maintenance.*

Introduction

In Ethiopia, enormous amounts of coffee husk and pulp are generated from coffee processing industries annually. But, these materials have been poorly utilized and managed or left to decompose or burned in open fields (Yisehak, 2009). However, utilization of coffee husk and pulp is an option to reduce the problems (Yared et al., 2010).

Coffee husk has been consumed usually by households in place of firewood with inefficient open fire stoves. However, direct utilization of this type of biomass as a source of energy is not suitable because it has low density, high smoke low energy intensity (Abakr & Abasaed, 2006).

The rice production in Ethiopia is about 30 million hectares that 5.6 million hectares suitable that produced in South western highlands of Oromia region (MoA, 2010). Jimma Zone merely covered about 105,140 hectares of total area by coffee including small-scale farmers' holdings, state and private owned plantations (JZARDO, 2008).

The biomass burning provides basic energy requirements for cooking and heating of rural households, cooking for institutional and for process in a variety of traditional industries. The biomass energy use in such cases is characterized by low energy efficiency & emission of air pollutants. South western Oromia region is enriched with agricultural biomass resources especially agricultural residue such as coffee husk, rice hull, saw dust and others from small scale industries and from the rural area farmer's agricultural production. Those agricultural wastes are increasing from time to time without efficient uses and causing environmental,

health problem and air pollution while the rural community life in the study area depends on fire wood collected from forests causing deforestation, environmental degradation, wood scarcity and etc.

To reduce these problems, the JAERC has developed and evaluated the household biomass stove using water boiling test (WBT) with two pot (dist) which have standard sizes 5.5 liter by two biomass types rice husk and coffee husk. It also carried out in terms of burning rate, thermal efficiency and fire power. The results indicate that average burning rate of rice husk and coffee husk was 31 g/min &32 g/min while thermal efficiency was 26% & 27% during hot start test and fire power was 6763 Watt and 8657 Watt during hot start test respectively.

Therefore, demonstration of household biomass stove that can save time, labor and reduce environmental pollutions was made for cooking application in Jimma Zone.

Objectives of the study

- To create awareness on household biomass stove for cooking at small farmers level in the study area
- To evaluate the machine using coffee husk and rice husk under farmers condition
- To get feed backs on household biomass stove from user farmers and other stake holders

Materials and Methods

Materials

The sample Jima Model Biomass Stove was produced in the JAERC production workshop.

Two Vessels of different size (5.5 liter and 3.5 liter were used for potato cooking.

Rice and coffee husks are used as energy sources

Methodology

Three districts were selected from Jimma zone randomly and from which four Kebeles were picked out purposively based on biomass potential. From each selected Kebele, a group of 10-15 hosting farmers were selected purposively with respective Keble DA's for the technology demonstration. Field day was also arranged at selected sites. Measurements, interview, and group discussion methods were used for data were collection on the technical performance

Data collected

- Quantitative data collected on the machine performance based in terms of time and labor consumed in Man-hr per kg/hr.
- Qualitative data were collected on farmer's opinion and comments

Method of data analysis:

The quantitative data were analyzed by using descriptive while qualitative data on perception were analyzed by using three stages Likert scale ranking method.

Research Methodology

Materials

Raw materials necessary for manufacturing the prototype of household biomass stoves were purchased and the prototype was produced in Jimma Agricultural Engineering Research Center workshop. Sample coffee husk and rice husk were also used as raw materials for demonstration purpose. Raw materials, which had been used for this study, are summarized in below table.

Table.1. Raw materials used for this study

Steel sheets	Pcs	4	500	2000
Iron steel sheet	Pcs	2	1000	2000
Double ring round bar	Pcs	2	500	1000
Plain round bar	Pcs	4	400	1600
Hand glove	Pcs	4	50	200
Biomass (coffee and rice husk)	Sack(100kg)	10	500	5000
Biomass sacks	Pcs	6	15	90

Site selection, farmer identification and FRG establishment techniques

The activity was done in purposively selected districts of Jimmaa zone. To undertake demonstration of Biomass stove purposive sampling method was used. Accordingly, three districts namely Shabe, Gommaa and Maannaa were selected purposively from Jimmaa zone based on the availability of coffee and rice husk. After that, four Kebeles (Gasara and Kishe from Shabe district, Kenteri kebele from Maannaa district and Omo Gurude from Gommaa district) were selected based on existence of coffee and rice husk. From each kebele one FRG, having 20 members with the arrangement of all classes of farmers including gender with proportion of almost 85% to 15% women and men respectively were organized with their respective DAs, and women's affairs bureau based on their interest and willingness to be as FRG member, status of coffee and rice residues. Lastly one host farmer was selected from each organized FRG for demonstration purpose based on suitability and proximity to all other members to take part during demonstration activities. Accordingly, household biomass stove was demonstrated and evaluated on the host farmer field by considering the involvement of all FRG members and Agricultural Experts (DAs &SMSs) through provision of different extension services (training and mini-field days).

Technology demonstration and capacity building techniques

During demonstration of Household biomass stove, different Agricultural Extension Participatory Approaches such as, group meetings, and field demonstrations were used with the purpose of, ensuring farmers engagements with facilitators in all demonstration processes and, increasing their levels of understanding toward operation and maintenance of the stove. Different extension services such as training and mini-field days were organized with the purpose of, creating awareness and enhancing knowledge and skills of the farmers toward technology by using several extension-teaching methods such as, individual methods, group discussion methods, result and method demonstration methods.

Methods of data collection and types of data collected

Appropriate data collection methods such as farmer's group discussion, interview and observation were used to collect both quantitative and qualitative data. Quantitative data used for this study are technical performance of the stove such as thermal efficiency of stove, burning rate, fire power and time lose due to using the stove, number of farmers and other stakeholders participated during demonstration and training, whereas, qualitative data collected were farmers opinion toward technology.

Methods of data analysis

The quantitative data was analyzed using suitable descriptive statistics tools such as average and simple percentage whereas; qualitative data was measured by Likert scale and analyzed by categorization and interpretation methods.

Result and Discussion

Performance of Biomass stove under the farmers' management

On farm evaluation of biomass stove was made in teamwork with researchers from JAERC, SMS, DAs and farmers by using rice and coffee husk in 3.5L pot(Dist) of water separately. It was evaluated based on different parameters such as, burning rate (g/min), thermal efficiency (%), firepower (Watts) & time to boil water (Min).
Thus, the evaluated result of the stove shows that, biomass stove was more preferred by the participants.

Table.2: WBT results using rice husk biomass for a 5.5 L Pot (dist.)

Parameters test	Unit	High Power Test (Cold Start)	High Power Test (Hot Start)	Low Power (simmering)
		Average	Average	Average
Burning rate	g/min	29	31	8
Thermal efficiency	%	25.61	26	24.01
Fuel consumption	g/lit	102	104	123
Firepower	Watts	6305.352	6763	1810
Time to boiling water	Min	13.2	12.2	45
Turn-down ratio	_	_	_	3

Table.3: WBT results using coffee husk biomass for a 5.5 L Pot (dist)

Parameters test	Unit	High Power Test (Cold Start)	High Power Test (Hot Start)	Low Power (simmering)
		Average	Average	Average
Burning rate	g/min	28	32	11
Thermal efficiency	%	26.66	27	25.14
Specific fuel consumption	g/lit	98	98	123
Firepower	Watts	7546.674	8657	2916
Time to boil water	Min	12.6	10.8	45
Turn-down ratio	_	_	_	3

Training of farmers, subject matter specialists and development agents

Training was organized with accommodating about 72 participants of which 47 participants were female and 25 participants were male from selected districts. It was provided through participatory approach to ensure maximum engagement through discussion and interactions among participants as well as with the facilitators. It was entailed both theoretical and practical learning that allowed participants to gain both theoretical and practical understanding of the Biomass Stove operation and maintenance. The training was mainly focused on how to operate, maintain technology, and relative advantage of technology over local practice. Multidisciplinary team consists of researchers from renewable energy research team, Extension research team and different technicians were organized to deliver the training on capacity building and facilitating extension efforts on technology.

Table4. Training given to farmers, DAs & SMS

No	**Kebele**	**Farmers**		**DAs**		**SMSs**		**Total**
		Male	Female	Male	Female	Male	Female	
1	Gasara	4	10	2	0	1	0	**17**
2	Kiishee	3	8	2	2	1	1	**17**
3	Kenteri	6	16	1	1	0	1	**25**
4	Oomo Gurude	2	8	1	0	2	0	**13**
	Total	15	42	6	3	4	2	**72**

Mini-field day

Mini field day was organized in collaboration with farmers, agricultural experts and other stakeholders with the purpose of creating awareness about the importance and availability of the stove and collecting relevant feedback about performance of the stove from the participants.

Accordingly, 104 participants were taking part, from this figure 73 were small-scale farmers among them, 36 were male and 37 were female households, 13 participants were agricultural experts (DAs and SMSs) and 18 were other stakeholders from districts development experts.

Table.5 Summary of participant on mini-field day

Participants	**Sex**				**Total**
	Adult Men	**Young men**	**Adult women**	**Young women**	
Farmers	23	13	26	11	73
DAs	2	3	0	2	7
SMS	3	1	2	0	6
Other	9	5	3	1	18
Total	37	22	31	14	**104**

Feedback collected from the farmers

Feedback during and after demonstration to analyze farmers' opinion about the stove on some attributes like efficiency, availability, suitability, portability, and maintainability were collected from Sixty three (63) respondents including farmers and other stakeholders and the collected opinions were measured and ranked by using Likert scale ranking method.

Table.6: Summary of farmers' feedback

Attributes	**Scale of measurement**	**Number of participant responded in percent(N=63)**
Efficiency	High	51(80.95%)
	Medium	12(19.05%)
	Low	0(0)
Suitability to use	More suitable	49(77.78%)
	Suitable	14(22.22%)
	Less suitable	0(0)
Availability	Easy	48(76.2%)
	Moderate	12(19.0%)
	Difficult	3(4.8%)
Maintainability	Appropriate	55(87.3%)
	Moderate	8(12.7%)
	Inappropriate	0(0)
Portability	Easy	56(88.98%)
	Moderate	7(11.2%)
	Difficult	0(0)

From total interviewed farmers, majority (80.95%) of respondents responded that the stove had high efficiency, followed by medium efficiency 19.05% of respondents. No respondents responded for its' low efficiency.

Nearly three- fourth (77.78%) of respondents responded that, biomass stove was more suitable to use, followed by suitable to use. There is no respondents responded for its' low suitability.

Regarding its affordability, about 76.2% of respondents responded that, Biomass stove was easily affordable to medium and small-scale farmers, followed by moderate 19.0% and difficult 4.8% of respondents. From total interviewed, about 87.3% of respondents opined that, biomass stove was appropriate to maintain by local technicians and farmers when it is

wanted, followed by moderate 12.7% of respondents. However, no respondents responded for it is inappropriate to maintain.

Regarding its portability, majority of respondents responded that biomass stove was easily moved from place to place when it is wanted.

Consequently, most of interviewed respondents were positively perceived to Biomass stove.

Conclusion and Recommendation

Conclusion

The stove was tested at host farmer field and the result indicated that the average burning rate, average thermal efficiency and time to boil water by using coffee husk biomass of 5.5 L pot at High Power Test (Hot Start) were 32g/min, 27% and 10.8 minutes respectively. Whereas, the average burning rate, average thermal efficiency and time to boil water by using the rice husk biomass and 5.5 L pot, were 31 g/min, 26% and 8 minutes respectively. Both practical and theoretical training were given to 72 participants of selected sites. Mini field day also organized at all demonstration sites. Accordingly, 73 farmers, 13 agricultural experts and 18 other stakeholders were participated. After training and mini-field day, feedbacks were collected from 63 respondents. Farmers' perception showed that, from total interviewed farmers, 80.95%, 77.78%, 76.2%, 87.3% and 88.98% of respondent responded that, the stove is high efficiency, more suitable, easily affordable, appropriate to maintain and high portability respectively. Whereas, 19.05%, 22.22%, 19.0%, 12.7% and 11.2% of respondent responded that, the stove is useful, suitable, affordable, maintainable, and portable respectively. Hence, most farmers perceived the household biomass stove performance positively.

Recommendation

- The technology supply need be arranged to user farmers preferably where the potential biomass production exist satisfactorily.

- Scaling up of the technology is needed for more awareness creation.

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Participatory demonstration of Bako Modified Engine Operated Dry Coffee Dehulling machine though FRG in south Western Oromia

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Abstract

The study was conducted in Jimma Zones of Oromia Regional State, Ethiopia. The objective of the study was to demonstrate and evaluate the Bako Modified Engine Operated Coffee Dehuller machine performance under the farmers' condition at the study area. Five sites were selected as hosting centers for the popularization of the technology at different sites namely Wanja Kersa , Suse, Kedamasa, Kenteri and Seko selected from four districts (Gera, Goma Mana and Dedo) purposively. Total of 69 farmers (19 Female, 50 Male) and, 10 agricultural workers (SMS and DAs), 16 others (Kebele Administrators and Researchers) have attended the mini field days. The performance evaluation of the technology was made based on the attributes recognized as important showed that average capacity of 120.19g/sec, dehulling efficiency (78.65%) and breakage of 8,12 % having good dehulling performance as preferred by the participant farmers that need be scaled up for wider popularization.
Keywords*: Dehuller, Coffee, Engine Operated, Capacity, Efficiency.*

Introduction

Agriculture is the most important economic sector of the country. According to the data from the Central Statistical Agency (CSA, 2015) it contributes 42 % of the GDP, 85% of the foreign earnings and employs around 85 % of the total population of the country.

Coffee is one of the world's most vital agricultural commodities and the primary source of income for125 million people globally (Werrell & Femia, 2017). According to the International Coffee Organization (ICO), it is also one of the most traded agricultural commodities in the world and a source of income for millions of smallholder farmers, mostly in middle- and low-income countries (ICO, 2021). Ethiopia is the largest producer of coffee in Africa and the fifth in the world, next to Brazil, Vietnam, Colombia, and Indonesia, contributing to about 4.2% of the global coffee production (International Coffee Organization, 2021b),(Rica & Salvador, 2021)

The country has a diverse ecology and production system for growing coffee in all regional states with varying ranges of suitability and area coverage. Nevertheless, the major coffee growing areas are concentrated in the southwestern, southern, western, and eastern parts of the country (Reay, 2019). According to (Tassew et al., 2022), the estimated area of land covered by coffee in Ethiopia is about 0.8million ha of land whereas, estimated annual production of coffee is about 0.5million tons with average productivity of 0.63 tons ha-1.

Coffee is one of the most tradable agricultural commodities in the world and plays a very important role in the national economies (Wolde, 2017, Cochet, 2014). It is the major source of foreign currency and employments for Ethiopia and it contributes about 4-5% of GDP, 10% of total agriculture production, 25–30% of total export earnings and 80% of total employment ((Esteri, 2016), Worku, 2019). Over 25% of the population of the country are directly or indirectly engaged in the production, processing, trading of coffee and deriving a significant part of their livelihoods from coffee (Gardens et al., 2019; Ayele et al., 2021).

Coffee land coverage and dependency of smallholder farmers on coffee is high especially in southwest Ethiopia. Jimmaa zone is one of the potential coffee growing zones in Oromia region, which has a total area of 1.1millions hectares of land (Gashaw & Shumeta, 2018). According to (Diro et al., 2019) the share of coffee income from total income in coffee producing districts of Jimma zone is 77% and share of land allocated to coffee crop in these areas is more than 69%. This shows that coffee is not only the source of cash and income; but also the means of livelihood for the smallholder farmers of the area. Despite the abundant opportunities in the zone for increasing coffee production and productivity, such as a suitable growing environment, and variety of local coffee types, coffee quality is declining from time to time.

These quality problems are mainly associated with improper post-harvest processing and handling practices such as drying on bare ground, improper wet dry processing, storage and transportation, (Fininsa, 2019). Among, the problem of post-harvest processing and handling, dry coffee pulping being practiced in the study area is traditional methods. The local farmers de-hull their coffee by using pestle, which leads to low quality of coffee, time consuming and laborious activity.

Taking these problems in to account, demonstration and on farm evaluation of engine operated dry coffee DE hulling machine was undertaken by the Jimma Agricultural Engineering Research Centre (JAERC). The machine had demonstrated and evaluated at different purposively selected districts. It has average capacity of 87kg/hr., with efficiency of 76.7% and minimizes wastage of crop and time to de-hulling it.

Object of the study

- To create awareness on engine operated coffee dehuller at small farmers level in the
- To evaluate coffee dehuller machine under farmers condition
- To get feed backs on the improved dehuller from farmers and other stake holders

Materials and Methods

Materials

Different raw materials used for manufacturing the prototype of engine operated coffee dehuller were produced and the prototype was manufactured in Jimma Agricultural Engineering Research Center production workshop. Dry coffee was used to demonstrate and evaluate the machine.

Source; from own data

No.	Item description (list of raw materials)	Unit	Quantity
1	Mild steel	Pcs	4
2	Angle iron	Pcs	20
3	Bearing with housing	Pcs	4
4	Metal sheet	Pcs	15
5	Belt	Pcs	2
6	Cast steel	Pcs	2
7	Shaft	Pcs	2
8	Bolt and nut	Pcs	400
9	Paint	Kg	15
10	Antirust	gal	1
11	Bolts and nuts (10 dia)	Pcs	15
12	Engine	PCS	1

Sites Selection, Farmers identification, and FRG organization techniques

Demonstration of engine operated coffee dehuller technology was conducted Jimmaa and Bunnoo Bedellee zones of Oromia region. Purposive sampling method was employed to select each representative districts and respective kebeles. Accordingly, Five districts namely Dedo, Manna, Gomma, Gera districts from Jimma & Bedele district from Buno Bedele zone were selected purposively based on status of coffee production. Seven kebeles namely, Omo Funtule, Omo Gurude, Waro Kolobo, Waro Sombo, Kenteri, Jisa & Ilaala kebeles were selected purposively based on existence of coffee & accessibility for demonstration.

Selection of FRGs members was based on farmers consent or interest to be held as member, accessibility for supervision of activities, good history of harmony with groups and transparency to share innovations to other farmers. To this end, one FRG having 20 members with the arrangement of all classes of farmers including gender with proportion of almost 70% to 30% men and women respectively was established at each selected kebeles to improve better communication and learning system among Farmers, researchers and other extension agents. Lastly, one host farmer was selected based on his willingness, his potential for coffee production, and suitability and proximity to all FRG members to attend on all demonstration activities from each established FRG. To this end, all FRG members and other follower farmers were encouraged to participate during demonstration conducted at each site.

Technology demonstration techniques

During demonstration and evaluation of engine operated dry coffee dehuller machine, Agricultural Extension Participatory Approach (PA) that consisted of group meeting (FRG) and field demonstrations were used as the main methods to enhance involvement of the farmers in all demonstration process and, ensure maximum engagement through discussions and interactions among participants as well as with the facilitators.

Capacity building techniques

During provision of extension services such as training and mini-field days, Farmers to Farmers Communication Approach was used with the aims of improving better communication and learning system among Farmers, researchers and other extension agents. Thus, training and mini-field day were organized at all demonstration sites through extension teaching methods such as, individual methods, group discussion method, result and method demonstration with the purpose of, creating awareness and enhancing knowledge & skills of the farmers toward engine operated dry coffee dehuller machine.

Type of data collected and data collection methods.

Data collection is the process of collecting and measuring information on specific attributes of technology. So that, for this study necessary data was collected for the purpose of gaining a better understanding of participants conviction and finding areas of improvement. To collect both qualitative and quantitative data several methods of data collection were employed. Those methods are face-to-face interviews, observation and focus group discussion (FGD). Types of data collected are, machines performance like capacity (kg/hr.), efficiency (%) and breakage loss(kg), number of farmers participated on extension events (demonstration, training and mini-field days), farmers opinion toward demonstrated technology.

Method of data analysis

The collected quantitative data was expressed in numbers and analyzed by descriptive statistics like, frequency, percentage whereas, the qualitative data was expressed in words and analyzed by interpretation, and categorizations through three stages of Likert scale ranking method.

Result and Discussion

Training Farmers, SMS and DAs on the engine operated coffee dehuller machine

Practical and theoretical trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) at the selected sites on the operation and maintenance of the machine to create awareness during demonstration. Accordingly a total of 68 farmers, 7 DAs and 6 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS on engine operated coffee dehuller machine

No	Location		Training Participants				
			Farmers		workers		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Gera	Wanja Kersa	12	5	1	1	19
2	Goma	Omo Funxule	8	4	2	1	15
3	Goma	Kedamasa	9	6	1	1	17
4	Mana	Kenteri	7	2	1	1	11
5	Dedo	Seko	10	5	2	2	19
6	Total		46	22	7	6	81

Table2. On-farm Evaluation of engine operated dry coffee dehuller machine

Site	Sample (g)	Time (sec)	unpulped (g)	Broken(g)	Capacity(g/sec)	Efficiency (%)	Percent of breakage (%)
Goma, OF1	6000	44	883.33	500.00	136.36	77.92	8.33
Goma, OF2	6000	40	816.67	611.11	150.00	79.58	10.19
Goma, OF3	6000	50	1000.00	555.56	120.00	75.00	9.26
Average	**6000.00**	**44.67**	**900.00**	**555.56**	**134.318**	**77.50**	**9.26**
Gera, WK1	6000	45	916.67	577.78	133.33	77.08	9.63
Gera WK2	6000	57	733.33	600.00	105.263	81.67	10.00
Gera WK3	6000	52	816.67	600.00	115.384	79.58	10.00
Average	**6000.00**	**51.33**	**822.22**	**592.59**	**116.89**	**79.44**	**9.88**
Dedo Seko1	6000	54	833.33	488.89	111.11	79.17	8.15
Dedo Seko2	6000	49	1083.33	388.89	120.44	72.92	6.48
Dedo Seko3	6000	49	1000.00	333.33	120.44	75.00	5.56
Average	**6000.00**	**50.67**	**972.22**	**403.70**	**118.41**	**75.69**	**6.73**
Mana, Kenteri1	6000	50	666.67	388.89	120.00	83.33	6.48
Mana, Kenteri2	6000	55	583.33	411.11	109.09	85.42	6.85
Mana, Kenteri3	6000	54	916.67	388.89	111,11	77.08	6.48
Average	**6000.00**	**53.00**	**722.22**	**396.30**	**113.20**	**81.94**	**6.60**
Grand Average	**6000.00**	**49.92**	**854.17**	**487.04**	**120.19**	**78.65**	**8.12**

Note: OF (Omo Funtule), WK (wanja Kersa) sites

The performance evaluation of the technology was made based on the attributes recognized as important showed that average capacity of **120.19** g/sec, dehulling efficiency (78.65%) and breakage of 8,12 % showing good performance.
Thus, the above table indicates that the engine operated dry coffee dehuller machine has good dehulling efficiency as preferred by the participant farmers.

Demonstration of the improved engine operated coffee dehuller machine

Mini-field days conducted

Table3. 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	Gera	Wanja Kersa	6	3	2	1	1	1	2	2	11	7
2	Goma	Omo Funxule	5	2	1	2	1	-	3	2	10	6
3	Goma	Kedamasa	7	2	4	2	2	-	2	1	15	5
4	Mana	Kenteri	8	1	3	-	2	1	2	-	15	2
5	Dedo	Seko	10	4	7	2	1	1	2	0	20	7
	Total		36	12	14	7	7	3	11	5	71	27

In view of that, 69 farmers (19 Female, 50 Male), 10 agricultural workers (SMS and DAs), 16 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the technology attributes
Table4. Farmer's perception toward engine operated dry coffee dehuller

Attributes used for acceptance degree	scale measurement	participants' reaction on coffee dehuller (No=29)	
		Frequency	Percentage %
Dehuller capacity (kg/hr)	Poor	-	-
	Medium	8	29.58
	Good	21	72.41
Dehuller Efficiency %	Poor	-	-
	Medium	2	6.9
	Good	27	93.1
Breakage/loss (%)	Poor	-	-
	Medium	1	3.5
	Good	28	96.5

The participant farmers' perception responses showed that 72.41% replied the engine operated dry coffee dehuller machine had good dehulling capacity and the rest 29.58% responded it to the medium performance. Similarly, 93.1responses replied for good dehulling efficiency. Yet no respondent responded for its poor level of capacity and efficiency. Hence, most participant farmers perceived its performance positively.

Conclusion and Recommendation

Conclusion

- The engine operated dry coffee dehuller machine had average capacity of 120.19 g/sec, dehulling efficiency (78.65%) and breakage of 8.12 % with good performance.
- The perception responses showed that the participant farmers viewed the dry coffee dehuller machine positively for its good dehulling capacity and efficiency while no respondent responded for its poor level of dehulling capacity.

Recommendation

- The research centre has to arrange the follow up training for local microenterprises and the end user for sustainable utilization of the technology.
- As the improved engine operated dry coffee dehuller machine was appropriate for small and medium level coffee producer farmers and private investors, it has to be scaled up.

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Pre-Extension Demonstration and Evaluation of Finger Millet technologies in West Hararghe Zone, Oromia National Regional State

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Abstract

*The demonstration was conducted in Daro Lebu and Habro districts of West Hararghe zone with the objectives to evaluate improved finger millet variety under farmers' condition, to create awareness for different stakeholders and to analyze the profitability of the technology. The totals of two kebeles were selected based production potential of the crop and eight trial farmers were selected from both districts based on their willingness to the technology. Both agronomic and economic data were collected, and data record sheet and observation were used as a tool and method of data collection. Descriptive statistics and score ranking method were used to analyze quantitative and qualitative data respectively. Bako-09 finger millet variety was evaluated with Tesema (standard check) variety on 10m*10m plot area. The result of the demonstration showed that, the highest and the lowest mean yield; 28.61 Qt/ha and 23.04 Qt/ha were recorded from Bako-09 variety and standard check respectively, and Bako-09 variety has also shown 24.1% yield advantage. The result of t-test also showed that there is significant difference at less than 1% probability level. Farmers have also selected Bako-09 variety with its early flowering, early maturity, number tiller, lodging resistance, drought tolerance, seed color and biomass. The result of cost-benefit analysis/ha for the technologies revealed that net profit of* 65,722 *ETB for Bako-09 variety and 50,232ETB for the standard check could be gained. Based on the findings, Bako-09 variety is recommended to be scaled in the study area and similar agro-ecologies.*

Keywords: *Demonstration, technologies, finger millet, evaluation*

Introduction

Finger millet (*Eleusine coracana (L.) Gaertn)* is an important cereal crop in the semi-arid and tropical regions of the world. The name finger millet is derived from the appearance of spikes or fingers, which are arranged and appear like human fingers. Compared with other major cereals such as rice, wheat and barley, it is relatively drought-tolerant due to its C4 photosynthesis system and adaption to grow under harsh and marginal agro-ecologies. Finger millet is grown mainly for its grain, which is utilized to make traditional food and drinks, while the stalks are used for livestock feed, construction and fuel. Finger millet has various human health benefits such as reducing diabetes (Anitha et al., 2021), obesity and anemia (Gupta et al., 2017) osteoporosis (Maharajan et al., 2021; Tsehay et al., 2006), malaria and diarrhea (Assefa et al., 2013; Vetriventhan et al., 2015). The health values of finger millet are linked to its high calcium, iron and dietary fiber content and being gluten-free. These health benefits will render finger millet as a crop of niche market opportunity in the future. Finger millet is cultivated in more than 25 countries in Africa and Asia (FAOSTAT, 2019).

In Ethiopia, the grain is processed to make unleavened bread (locally referred to as enjera) and for malting to prepare local drinks such as a distilled spirit 'Areki' or local beers such as

'tella' and non-alcoholic drinks such as 'karibu' and 'shamita', while the straw is vital as a livestock feed and for thatching of houses (Assefa et al., 2009).

Ethiopia is the second largest producer of finger millet in the world after India (Indiastat, 2019; Lule et al., 2012). Ethiopia's total production of Finger millet is 12,030,164.02 quintals from 480,343.25ha of land with average productivity of 25.04 quintal per hectare and it's the 6th most important cereal crop grown in the country after Tef, Maize, Wheat, Sorghum and Barely, and it is majorly produced in Amhara, Oromia, Tigray, Benishangul Gumuz and S.N.N.P regions of the country; in Oromia also 2,515,632.41 quintals of yield is gained from 97,266.93 ha. Similarly in West Hararghe zone, from 1334.92 hectare total land covered under the crop, 19,810.83 quintal production was obtained with average productivity of 14.84 quintal per hectare (CSA, 2021).

Despite the importance of finger millet for food security and livelihoods, its productivity is relatively low (2.504 t/ha) in Ethiopia compared with the potential yield of the crop (6 t/ha) achieved under experimental conditions (Lule et al., 2012). The low productivity of the crop in the country is attributable to a range of biotic and abiotic stresses and socio-economic constraints prevalent in the smallholder production systems in Ethiopia. Finger millet blast caused by Magnaporthe grisea (Barr) (teleomorph) is the most damaging disease, causing yield losses in the range of 7.32–54.07%, depending on climatic conditions and cultivar susceptibility (Sasmal et al., 2016). Notable insect pests of the crop include grasshoppers (Caelifera) and shoot fly (Atherigona soccata (Rondani)), pink stem borer (Sesamia inferens (Walker)), finger millet root aphid (Tetraneura nigriabdominalis (Sasaki)) and aphids (aphidoidea) (Sasmal et al., 2018; Mulualem et al., 2013). Yield losses have been reported due to several insect pests such as termites (isopteran) (with a loss of 23%) (Asargew et al., 2014), aphids (35.1%) and pink stem borer (56%) (Mulualem et al., 2013). Recurrent drought stress associated with climate change is the leading constraint affecting finger millet production and other main crops in Ethiopia. The impact of drought stress on finger millet production depends on cultivar susceptibility, the onset date, the intensity and duration of the drought stress and the associated prevailing environmental conditions. Although finger millet is relatively drought-tolerant, 100% yield losses can be incurred due to intense and early onset of drought stress (Wang et al., 2016).

Hence, using tolerant varieties to drought and disease as well as early maturing type with the available moisture in the moisture stress areas could be essential to increase its production and productivity of smallholder farmers. To realize this, Mechara Agricultural research Centre has been conducting adaptation study on different finger millet varieties and recommended Bako-09 variety due to its high yield potential (68 Qt/ha) and other important traits as well as with the yield advantage of 23% over (standard check). So, the study was initiated to demonstrate the new variety on farmers' field with the objectives to evaluate improved finger millet variety under farmers' condition, to create awareness for different stakeholders on technology and to analyze the profitability of the technology.

Materials and Methods

Description of the study area

The demonstration was conducted in Daro Lebu and Habro districts of west Hararghe zone in 2021/22 cropping season.

Daro Lebu district is one of the 16 districts of West Hararghe zone in Oromia regional state. It is located 434 km east of Addis Ababa capital city of Ethiopia and 110 Km from zonal capital Chiro. The district is situated between 7º52'10''and 8º42'30'' N and 4º023'57'' and 41º9'14''E. It is surrounded by four districts namely Habro in North, Gololcha in West, Boke in East and Hawi Gudina in South. Mechara is capital town of the district. The district covers an area of 210280 hectares and divided in to 37 kebeles and three rural towns of which 23 Kebeles in low land and 17 Kebeles are in mid-land areas. The 2007 national census reported a total population for this woreda of 198,095, of whom 101,596 were men and 96,499 were women; 16,862 or 8.51% of its population were urban dwellers. The majority of the inhabitants said they were Muslim, with 94.21% of the population reporting they observed this belief, while 5.18% of the population practiced Ethiopian Orthodox Christianity. The soil of the area is dominantly reddish brown Nitosols. Rainfall pattern in the area is bi-modal; *kiremt* rainy season (June, July, August and September) and *belg* rainy season (February, March, April and May) with average annual rainfall amount of 1120 mm an altitude ranging from 976 to 2077m a.s.l. Mean annual temperature is 21°C with mean annual minimum temperature of 13°C and maximum 27°C (Mechara agricultural research center, meteorological station 2009-2021 year (Wasihun Gizaw, 2021).

Habro district is found in West Harerghe Zone of Oromia Regional State, eastern part of Ethiopia. The district is located about 410 Km east of Addis Ababa, the capital city of Ethiopia and 78 Km from Chiro town, the capital of West Hararghe Zone. Geographically, Habro district is located at 8.57° N to 8.91° N latitude and 40.34° E to 40.69° E longitude. Gelamso town is the administrative capital of the district and is bordered on the south by Darolebu, on the west and north by Guba Koricha, on the northeast by Kuni, and on the southeast by Boke. The 2007 national census reported a total population for this woreda of 190,455, of whom 98,593 were men and 91,862 were women; 25,233 or 13.25% of its population were urban dwellers. The majority of the inhabitants said they were Muslim, with 84.92% of the population reporting they observed this belief, while 14.52% of the population practised Ethiopian Orthodox Christianity. The elevation of the district ranges from 1400 to 2400 m.a.s.l with mean annual rainfall of 966.7mm and the mean annual temperature was 19.97°C. The majority of the woreda's soil type is occupied with ols, Haplic Luvisols and Eutric Vertisols (Dereje, 2013).

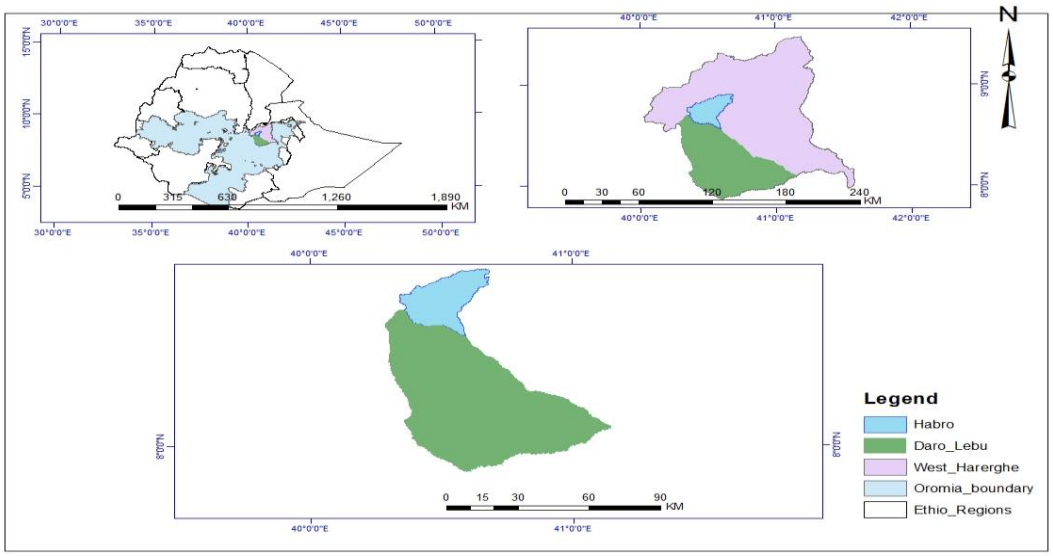

Fig. 1: Map of the study area

Site and Farmer Selection

The demonstration was conducted in Daro Lebu and Habro districts of west Hararghe zone in 2020/21 cropping season. Two kebeles; Kotora from Daro Lebu and Gadisa from Habro districts were selected purposely based on Finger millet production potential of the area. Accordingly, four farmers from each kebele and total of eight experimental farmers were selected depending on: their willingness to the technology, allocate the necessary land and manage the trials.

Research Design and experimental materials

The demonstration was conducted on 10m*10m simple plots for each variety. Bako-09 finger millet variety was evaluated with Tesema (standard check) variety. While conducting the activity, 12 kg/ha seed rate, 100 kg/ha NPSB, 50 kg/ha Urea, 40cm row spacing with drilling sowing method and other agronomic practices were employed.

Types of Data and Method of Data Collection

Both agronomic data such as date of sowing and yield per unit area, qualitative data (farmers' preference) and, economic data (input and labor cost) were collected. Data record sheet, observation and FGD on mini field day were used as a tool and methods of data collection.

Method of data analysis

Quantitative data were analysed using descriptive statistics and qualitative data like farmers preference is analysed through score ranking method and narration. T-test was used to compare the means of the two varieties and cost-benefit analysis is used to show benefit gained from the technology.

Results and Discussions

Capacity Building

Training was organized and given for eighteen different stakeholders including contact farmers (8), SMSs (6) and extension workers (4) regarding finger millet production technology.

Performance of the variety on farmers' field

Table 1: Yield summary of finger millet varieties

Variety	Yield (Qt/ha); (N=8)					
	Min	Max	Mean	Std. dev.	t-test	Yield adv. (%)
Bako-09	20.13	39.04	**28.61**	5.55	0.14***	24.1
Tesema	11.95	30.95	23.04	7.36		

As it is depicted in the table above, the maximum yield in quintal per hectare 39.04 was recorded from Bako-09 followed by Tesema (standard check) 30.95. Similarly, the minimum yield in quintal per hectare recorded from Bako-09 and standard check was 20.13 and 11.95 respectively. On the other hand, the highest mean, 28.61 quintal per hectare was recorded for Bako-09 variety with standard deviation of 5.55 and the lowest mean 23.04 quintal per hectare with the standard deviation of 7.36 for the standard check. The result of t-test showed that there is a significant mean difference between the yields of the two varieties at less 1% probability level which suggests using this improved variety could increase the probability fetching best result, and Bako-09 variety has also shown 24.1% yield advantage over the standard check.

Yield performance of Bako-09 variety at different stages (Qt/ha)

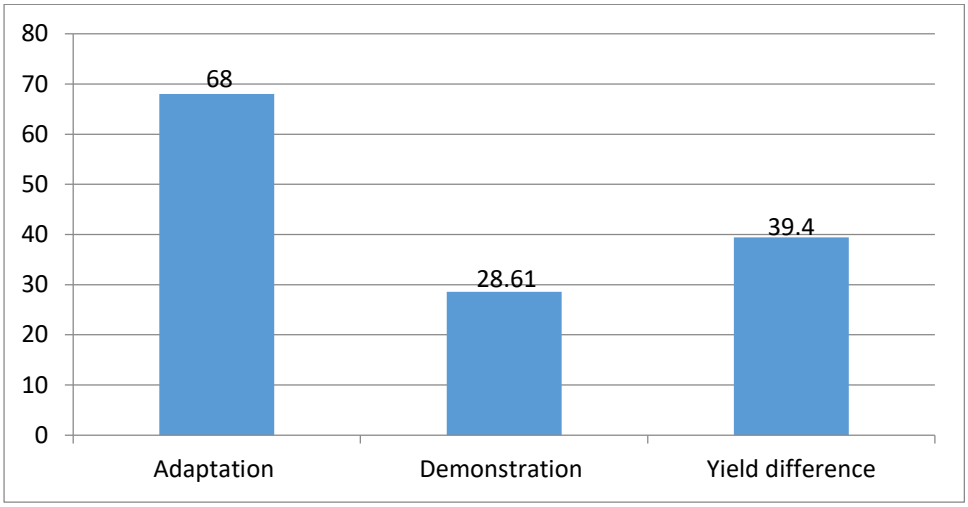

Fig. 3: yield performance of the variety at different stage

As it can be seen from the figure above, the yield potential of the variety during adaptation stage was 68 quintal per hectare, but the yield obtained during the demonstration was 28.61 quintal per hectare. The yield reduction was due to the late onset and early offset of the rainfall problem; the crop couldn't get rainfall more than three months which means it's drought affected at its critical time of grain filling stage and lasted without getting rainfall for more than a month and half up to harvesting. Although finger millet is relatively drought-tolerant, 100% yield losses can be incurred due to intense and early onset of drought stress (Wang et al., 2016).

Technology promotion and varietal selection

Mini field day was organized for different stakeholders at Gadissa kebele of Habro woreda and 70 printed materials (leaflets) were distributed for the participants regarding the production technology of the crop. In addition to this, the platform is made conducive for Oromia Broadcasting Network (OBN) to do the documentary program with others center's overall research activities to be disseminated over radio and television to promote the technology.

Table 2: Mini field day participants

No	Stakeholders	Number of Participants		Total
		Male	Female	
1	Farmers	65	1	66
2	Extension workers	3	1	4
3	SMSs	4	0	4
4	Others	12	1	13
Total		**84**	**3**	**87**

Table 3: Farmers' preference on finger millet varieties

Variety	Parameters										Av	Rank
	PH	EF	EM	NF	NT	LR	DsT	DrT	SC	BM		
Bako-09	4.2	4.7	4.9	4.7	4.9	4.6	4.7	4.9	4.5	4.5	4.6	1
Tesema	4.6	4.0	4.0	4.3	4.1	3.8	4.0	3.7	4.3	4.2	4.1	2

Note: Plant Height (PH), early flowering (EF), early maturity (EM), number of finger (NF), Number of tiller (NT), Lodging resistance (LR), Disease tolerance (DR), Drought tolerance (DT), Seed color (SC) & Biomass (BM)

As it's illustrated in the table above, the result of farmers' preference shows that, except plant height Bako-09 variety was selected with all parameters such as early flowering, early maturity, number of finger, number of tiller, lodging resistance, drought tolerance, seed color and bio mass by the interviewed farmers on mini field day.

Economic analysis

Table 4: cost-benefit analysis of the technology/ha

Items	Finger Millet Verities	
	Bako-09	Tesema
Yield Qt/ha) (Q)	28.61	23.06
Yield price of 1 quintal	2,800	2,800
Total Revenue (TR) = P*Q	80,108	64,568
Costs incurred		
Seed cost	336	336
Fertilizer cost	2,200	2200
Labor cost	7,800	7,800
Ploughing cost	4,000	4,000
Total cost (TC)	14,336	14,336
Profit = TR-TC	65,722	50,232

Conclusions and Recommendations

The demonstration was conducted to evaluate the performance of the adapted and high yielding Bako-09 finger millet variety in the study area of Daro Lebu and Habro districts of west Hararghe zone. The variety was evaluated with Tesema variety (standard check) on 10m*10m plot area at different location by employing the recommended agronomic practices.

The demonstration result indicated that, the highest mean yield 28.61 Qt/ha was obtained from Bako-09 and the lowest 23.04 Qt/ha was from the standard check, and Bako-09 variety has shown yield advantage of 24.1% over the standard check. The result of t-test showed that, there is statistically significant difference at less 1% probability level between the two varieties. With the exception of plant height, Bako-09 variety has been selected with many parameters by the farmers and ranked first. On the other hand, the analysis of cost-benefit

revealed that, 65,722 ETB net profits could be gained from Bako-09 variety and 50,232ETB from the standard check.

Based on our result, Bako-09 variety is recommended to be scaled up in the study area and similar agro-ecologies. So, Research center, agricultural offices and NGOs should work collaboratively in expanding the variety to increase production and productivity of finger millet and insure community's food security in the study area.

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Pre-extension demonstration and Evaluation of Oat Forage Technologies in selected districts of West Hararghe Zone, Oromia National regional State

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Abstract

*The study was conducted at Habro (Bareda), Chiro (Arba rakate) and Tullo (Gara kufa) districts of West Hararghe zone in 2020/2021 cropping season with the objectives to evaluate the performance of Oat forage under farmer's condition, to create awareness and linkage among different stake holders and to collect farmers' feedback on its production and management. From each location; 4 farmers and 1FTC; totally 12 farmers & 3 FTCs were selected. Bareda oat variety was evaluated with Bate (standard check) on 5m*5m side by side simple plots. Training was given prior to activity implementation for 12 farmers, 5 DAs and 9 SMSs. On the other hand, 3 DAs, 6 SMS and 83 farmers were participated on mini field day organized at Gara kufa kebele. The data were collected through close supervision, checklist, data record sheet and field observation. The result of farmers' preferences showed that, Bareda variety was selected by plant Height, plot cover, lodging tolerance, stand vigor, disease tolerance, early flowering, early maturity, Biomass and palatability. The result of grain yield was also revealed that, 30.19 qt/ha and 25.6 qt/ha mean yield was recorded from Bareda and Bate respectively with 17.79% yield advantage of Bareda over Bate under the same management. Based on the above yield, yield advantage and farmers' preferences result, Bareda Oat variety was recommended for pre-scaling up program in West Hararghe zone and similar agro-ecologies to improve production and productivity of oat forage as well as solve the problem of feed shortage.*

Key words*: Bareda, Bate, Oat, Grain yield & yield advantage*

Introduction

Oats (Avena sativa) is the main types of cereals crop which is domesticated in 2000BC by Hindu Kush (Malzew, 1930 and Loskuto, 005). From 2001 to 2008 Europe (16.25), Russia (5.49) North America (5.16), Canada (3.51) and Africa (0.19) produce million tons of oats (Vinod Tawari, 1981).

Oat is good source for human nutrition, poultry, cattle, sheep and other animals. Oat contains 2.31% ether extract, 9.33% total ash, 0.47% calcium, 0.22% phosphorus, 0.22% magnesium, 0.52% sodium and 2.84% potassium (SELF nutrition data, 2015). Many cultivars of oat have high feed value if cut at flowering stage for better yield and can meet the demand of rapidly growing livestock industry. In Ethiopia 10,502.18 hek of land was covered by Oat; on which 305,403.43 quintals of grain yield was obtained. In Oromia region, from 10,582 ha of cultivated land; 31,032.77 quintals gran yield was obtained.

As population number increase, food requirement also increases. Specifically meat and milk product is the major one. However in west Hararghe zone, feed shortage is the main challenge that smallholder farmers faces. Particularly in highland areas, due to variety shortage, farmers use different crop residue for animal feed which has low nutrient content. To solve this, Mechara Agricultural Research Center has been conducting study on improved oats forage genotypes and released Bareda oat variety in 2019/20. Bate (standard check) recorded 23qt/ha and 17 qt/ha grain yield on station and on farmers' field respectively. Bareda recorded grain yield of 33.4 qt/ha on station and 24 qt/ha on farmers' field with 41.2

% yield advantage. In terms of fresh biomass; Bate recorded 34.88 qt/ha on station and 32.1 qt/ha on farmers' field, while Bareda recorded 47.47 ton/ha on station and 44.5 ton/ha on famers' field which had 38.6% of yield advantage over standard check. Based on the above high performance with yield and fresh biomass, bareda variety was recommended for demonstration in West Hararghe zone and similar agro-ecologies. So the study was designed with objectives to evaluate performance of improved variety of oat under farmers' condition, to collect farmers' feedback on oat production and management in the study area and to create awareness and linkage among different stakeholders.

Methodology

Descriptions of the study area

The study was conducted in three districts: Habro, Chiro and Tullo of West Hararghe zone in 2020/2021 cropping season

Table 1: Description of experimental sites

Parameter	Locations		
	Chiro	**Habro**	**Tulo**
Capital town	Chiro	Galamso	Hirna
Distance from Addis Ababa	325km	410 km	370 km
Elevations	1826 m.a.s.l	1400 to 2400 m.a.s.l.	1750 m.a.s.l
latitude and longitude	9°05′N and 40°52′E	8.57° N to 8.91° N latitude and 40.34° E to 40.69° longitude	No
Mean annual rain fall	1800 and 900 mm	966.7mm	995mm
Mean annual temp	12°C -23°C	19.97°C	26.77°C
Soil type	No	Vertic Luvisols, Rendzic Leptosols, Haplic Luvisols, Eutric Vertisols and Eutric Leptosols	No

Source: (Wasihun, G. 2021; Fekede G. *et al.,* 2018 and Najib.U *et al,* .2019)

NB: 'No' means data is not available

Site and Farmer Selection

The experiment was conducted for one year in Habro, Chiro and Tullo districts of West Hararghe zone. Bareda (Habro); Arba rakate (Chiro) and Gara kufa from Tullo were selected purposively based agro-ecology and **oats** production potential with collaboration of woreda agricultural offices. Accordingly, from each kebele four (4) farmers and one (1) FTC were selected and total of twelve (12) farmers and three (3) FTCs were selected. Farmers selection was done based on criteria like willingness and interest, ability to allocate land, whether the research result or risk and promise to manage the field.

Experimental Design

Demonstration plots were arranged on 5m*5m area; with the distance between plots, rows and plant of 1m, 30cm and drilling respectively. For the two varieties; 50m^2 plot size was provided by each farmer; totally 750 m^2 land area was used to implement the activity. Accordingly, Bareda variety was compared with Bate (standard check). The activity was conducted by employing the recommended agronomic practices; 100 kg/ha seed rate, 50 kg/ha Urea and 100 kg/ha NPSB fertilizer.

Data collected

- ✓ Training participants
- ✓ Field day participants
- ✓ Farmers preferences
- ✓ Grain yield

Method of data collection

- ✓ Check list
- ✓ Data record sheet
- ✓ Field observation
- ✓ Frequent supervision

Method of data analysis

Quantitate data were analyzed by SPSS software and T-test while qualitative data were analyzed by score ranking method and present in tabulation.

Results and Discussions

Method of Awareness creations and Communications

Training was organized and delivered at McARC for the selected 12 experimental farmers, 5 Extension workers and 9 SMSs.

Table 2: Training participants

Districts	Stakeholders participated								
	Farmers		DAs		SMSs		Total		
	M	F	M	F	M	F	M	F	T
Chiro	4	0	1	0	3	0	8	0	8
Habro	4	0	2	1	3	0	9	1	10
Tullo	4	0	1	0	3	0	8	0	8
Total	12	0	4	1	9	0	25	1	26

Source: Own result, 2021

At all locations experiment were supervised continuously and best preformed site Gara kufa PA was selected and field day was organized.

Table 3. Mini field day participants at Tullo

Location (PA)	DA	SMS	Farmers		Total
			M	F	
Gara Kufa	3	6	73	10	92

Source: own result, 2021

During the mini field day organized on the technology, different participant stakeholders have got awareness as well as raised lots of questions related to utilization, accessibility and management of the technology and the answer is forwarded by biological researcher to the whole participants. During the mini field day, 50 leaflets were distributed for the participants.

Farmers' preferences

Stakeholders and farmers participated on mini field day have used the criteria set by the researchers to choose the best variety from the two alternatives. Accordingly, Bareda oat variety was selected by plant height, plot cover, lodging tolerance, stand vigor, disease tolerance, early flower, early maturity, biomass and palatability.

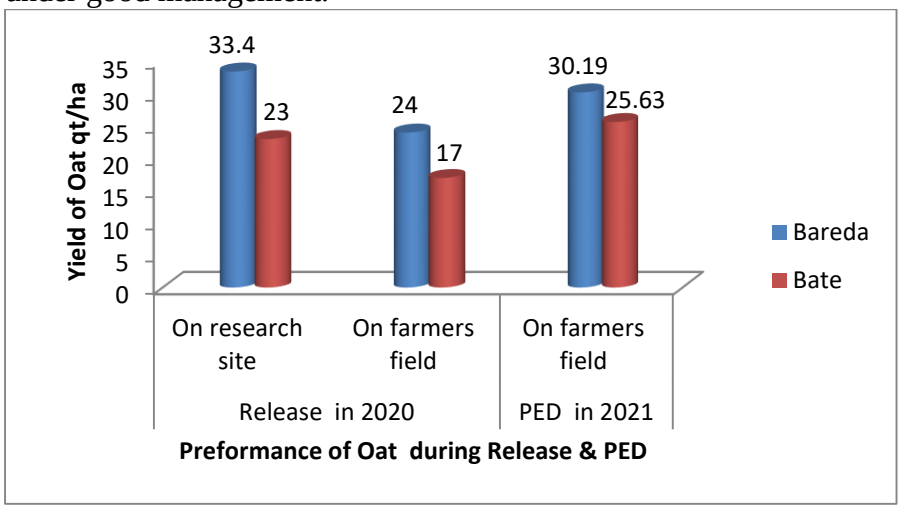
Table 4: Farmers' preference by simple score ranking (1-5)

Variety	Parameter									Total score	Mean score	Rank
	PH	PC	LT	SV	DT	EF	EM	BM	PL			
Bareda	4.87	4.74	4.50	4.74	4.84	4.95	4.89	4.79	4.79	43.11	4.79	1
Bate	3.76	3.55	4.00	4.03	4.37	3.82	3.71	4.11	3.92	35.26	3.92	2

Note: scale 5= excellent, 4= very good, 3= good, 2= fair and1= poor
Where plant height (PH), plot cover(PC), lodging tolerance (LT), stand vigor (SV), Disease tolerance (DT), early flower (EF), early maturity (EM), Biomass (BM) and palatability (PL)

Grain yield (qt/ha)

Bareda Oat variety gave different yield at different stages (release and demonstration) both on farmers' field and on station. During release, it gave 24qt/ha on farmers' field and 30.19qt/ha during demonstration. But Bate variety gave 17qt/ha during release and 25.63qt/ha during demonstration. From this, Bareda variety tried to show its potential on farmer's field under good management.



Source: Combined yield result during release & PED
Figure .1: Performance of Oat forage during at different stages

A/ Grain Yield by location

As shown in the table (5) below, the mean yield in Qt/ha of bareda variety at Chiro, Habro and Tulo was; 32.4, 15.2 and 42.3 respectively and for Bate variety; 26.5, 12.2 and 37.9 respectively as well. From this, it could be concluded that, Tulo district could be an excellent area for oat production, Chiro district is moderately the good area and Habro district is relatively less conducive environment for this forage production.

Table 5: Yield across location

Districts	Verities	Yield (qt/ha); N=15 Maximum	Minimum	Std. Dev.	Mean
Chiro	Bareda	38.4	28	4.5	32.4
	Bate	27.6	25.2	1.0	26.5
Habro	Bareda	22.8	6.8	6.8	15.2
	Bate	21.6	3.5	9.0	12.2
Tulo	Bareda	45.1	38.7	3.3	42.3
	Bate	42.8	32.8	5.0	37.9

Source: own result, 2021

B/ Grain Yield by variety

Both varieties were planted by respecting the same agronomic principle with the same management at all locations. However from the analyzed result, Bate variety gave 25.63 qt/ha; while Bareda variety gave 30.19 qt/ha with 17.9 % yield advantage over Bate variety. (Table 6)

Table 6: Yield summary of Oat forage (N=15)

Varieties	Yield (qt/ha); N=15 Min	Max	Mean	Std. Dev.	Yield Adv. (%)
Bareda	9.76	45.12	30.19	12.06	17.79
Bate	3.52	42.8	25.63	11.6	

Source: own result, 2021

T-test

So far; two varieties of oats (Bareda & Bate) had been tested under the same agronomic practices and management on farmers' field. The t-test result revealed that, there is significant difference at less than 1% between the two varieties.

Table 7: Paired sample t-test result

Variety	t-test	
	t- value	Sig.
Bareda Bate	3.294	0.009

Source: Own result; 2021

Conclusions and Recommendations

The experiment was conducted with objectives to demonstrate and evaluate performance of Oats forage under farmers' condition and to create awareness and linkage among different stake holders. From the analyzed result; Bareda oat variety gave 30.19 qt/ha and Bate variety gave 25.63 qt/ha and Bareda variety had 17.79% yield advantage over Bate variety (Table.6). Farmers' preferences result also indicated that, Bareda variety was selected under all parameters by interviewed mini field day participants. In addition, the t-test result also showed that there is a significant difference between the two varieties at less than 1% probability level. Therefore, Bareda Oat variety was recommended for pre scaling up program in West Hararghe Zone and similar agro-ecologies to improve production and productivity of Oats forage as well as to overcome feed shortage problem.

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Pre-Extension Demonstration and Evaluation of Sorghum Technologies in Midland of West Hararghe Zone, Oromia National regional State

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Abstract

The activity was conducted in 2019/20 main cropping season at Daro Lebu and Habro districts of West Hararghe zone. One improved sorghum variety namely Elemo was demonstrated and evaluated with local check with the objectives to evaluate improved variety of sorghum under farmer's condition and to create awareness on improved sorghum technology in the study area. Two kebeles (one kebele from each district) were selected purposively based on sorghum production potential. A total of seven farmers; Four from Daro Lebu and three from Habro district were used for demonstration. Single plot with 10mx10m area were used on each farmer's field for each variety. Yield of each variety was collected from each farmer and analyzed through descriptive statistics. On the other hand, farmers' preferences were collected and analyzed by using simple rank analysis. The result of the demonstration revealed that, the highest mean yield 35.5 Qt/ha was recorded by Elemo variety with 42% yield advantage over the local and the lowest mean yield 25.1 Qt/ha was recorded from local check. On the other hand, Elemo Variety was ranked 1st based on early maturity, drought resistance, high biomass, large head size and disease resistance identified as selection criteria by farmers. Therefore, Elemo variety was recommended for further scaling up to improve sorghum production and productivity under smallholder farmers.

Key Words: *Elemo, selection criteria, Demonstration, Training and Farmers*

Introduction

Sorghum (*Sorghum bicolor* [L.] Moench) is a valuable crop in the arid and semi-arid regions of the world. Sorghum is the 5th most-produced cereal crop, following maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), and barley (*Hordeum vulgare* L.) globally (Anderson et al., 2017). The largest world's sorghum producers are the USA with total annual grain production of 8.7 million tons from 2.0 million hectares, Nigeria (6.9 million tons and 5.4 million hectares), Ethiopia (5.3 million tons and 1.9 million hectares), and Sudan (3.7 million tons in 6.8 million hectares) (FAO 2019). Nigeria is the leading sorghum producer, followed by Ethiopia in Africa in terms of total production. It is a staple food crop in Africa and Asia and a vital source of industrial raw material to manufacture feed, bio-ethanol, and syrup (Andiku et al., 2020).

Sorghum is an ideal crop for dryland farming agriculture because of its vast flexibility and tolerance to unfavorable circumstances (Hossain *et al*., 2022). Ethiopia is the world's sixth largest sorghum producer and Africa's third-largest sorghum producer, after Nigeria and Sudan (Drub *et al*., 2021). After teff and maize, it is the third most important crop in terms of area covered and overall production. In lowland areas of Ethiopia, where moisture is the limiting factor, sorghum is one of the most important cereal crops planted as food insurance, especially in the lowlands of eastern Ethiopia and in the north and north-eastern parts of the country where the climate is characterized by unpredictable drought and erratic rainfall (Degu *et al*., 2009). Sorghum is grown and cultivated nearly in all regions of the country.
Sorghum is a staple food crop on which the lives of millions of poor Ethiopians depend. It has tremendous uses for the Ethiopian farmer and no part of this plant is ignored. Besides

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

In Ethiopia, the total land of Sorghum production under peasant holdings covers about 1.6 million ha with average yield of 26.9Qt/ha. The main sorghum producing regions are Oromia and Amhara, accounting for nearly 80 percent of the total production. The total sorghum production area in Oromia was 676, 075ha which produces annual production of 18,366,126.61 quintals (27.17 qt ha^{-1}). From Oromia region Eastern and Western Hararghe, most part of West Shoa and East Wollega are among the major producers, that covers 123,872.89, 133,829.57, 50,627.85, and 35,380.76 hectares of land with 2,789,427, 3,141,178, 1,594,545 and 1,079,023 quintals of sorghum production, respectively (CSA, 2021).

Even though sorghum dominantly grown in the zone, most of smallholders farmers use landrace variety of sorghum which result in low yield, susceptible to disease and take long period of time to harvest. To overcome this problem, Mechara Agricultural Research Center has been conducting selection of genotypes in different breeding nurseries from 2011-2012 and then advanced to variety trial to see its varietal performance across locations and years in sorghum producing areas of West Hararghe's midlands and released improved sorghum variety namely Elemo in 2019 cropping season for midland of the zone and similar agro-ecologies.

The newly released variety gave higher yield per hectare (ranges 41 to 48 qt ha^{-1}) and showed 42% yield advantage over standard check (Chiro) variety during the evaluation period. In addition, the variety showed comparable responses to diseases like grain mold, head smut, loose smut and early maturing as compared to standard check. Therefore, this activity was initiated with objectives to demonstrate and evaluate improved midland sorghum variety and create linkage & networking among researcher, farmers, extension agent & other stakeholders.

Materials and Methods

Descriptions 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).

Habro district is another district in West Hararghe zone of Oromia region. The district has an altitude range from 1600-2400 m.a.s.l. The mean annual rainfall of the district is 1010 mm and the annual temperature ranges from 5- 32ºC (HDANRO, 2016). The rainfall pattern in the area is uni-modal with high amount of rainfall occurring during the main rainy season between June to September (*Kiremt*) and the short rainy season stretching from March to June (Belg. The agroecology of the district comprises highland (19%), mid altitude (50%) and lowland (31%) areas (Mengistu *et al*., 2016). It occupies a total area of 725 km^2 i.e. about 4.2% of the zonal total area. The district has an estimated total population of 244,444; of whom 126,176 were men and 118,268 were women (CSA 2013). Mixed crop livestock agriculture is a common farming system in the study area. The main crops grown in the area are cereals such as *teff (Eragrostistef),* maize *(Zea mays),* wheat *(Triticumaestivum*), barley *(Hordeum vulgare*), haricot bean (*Phaseolus vulgaris*) and sorghum (*Sorghum bicolor*) and cash crops such as coffee (*Coffea arabica*), *chat* (*Cathaedulis*), pepper (*Capsicum species*) and onion (*Alluimcepa*) (Asfaw *et al*., 2018).

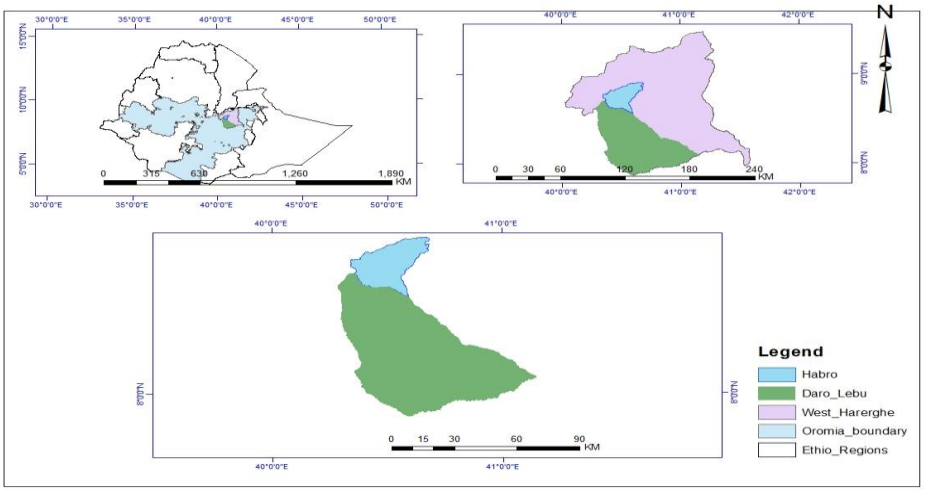

Figure 1: Map of the study area

Farmer's selection and demonstration field establishment

The study was conducted in Daro Lebu and Habro districts of west Hararghe zone in 2020/2021 cropping season. Site and farmers selection was conducted with participation of respective district of Agricultural and natural resource Office based on sorghum 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 seven (7) farmers were selected from both districts (four farmers from Daro Lebu district of Kotora kebele and three farmers from Habro district of Gadisa kebele).

Table 1: Summary of selected kebele, farmers and variety used for demonstration

Location/district	Kebele	No. of trial farmers	Varieties used for the trial
Daro Lebu	Kotora	4	Elemo & Local check
Habro	Gadisa	3	
Total		**7**	

The experiment was demonstrated on 100 m^2 demonstration plots for each variety on each trial farmers and seed rate of 12 kg/ha was used with 100 kg/ha NPSB at the time of sowing and 50 kg ha^{-1} Urea was applied at vegetative stage before booting. A spacing of 75cm X 25cm between row & plant spacing was used respectively during the demonstration. Before

conducting the trial, farmers were trained about improved sorghum production practices like seed rate, fertilizer 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 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 farmers and economic data cost incurred & benefit gained from the trial 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 simple ranking and summarization.

Results and Discussions

Yield performance of demonstrated variety on farmer's field

The mean yield gained from Elemo and local check was 35.5 Qt/ha and 25.1 Qt/ha respectively from demonstration result as indicated on table 2. The mean yield of Elemo variety gave higher yield than local check which indicated that using this variety could enhance the yield harvest of farmers from their land. The percentage increase in the yield of Elemo variety over local check was observed during demonstration time which is significant. Accordingly, Elemo variety gave higher yield (35.5 Qt/ha) with 42% yield advantage over the local check under farmer's condition which indicates using improved sorghum variety maximizes farmer`s profitability to get more yield from their acre of land.
The sample t-test was employed to identify the statistical difference of the yield among the varieties. The sample t-test result indicated that there was significant difference between varieties (Elemo & local check) in relation to yield per hectare which indicates that using improved variety along with agronomic recommendation was more advantageous even under farmer's condition.

Table 2: Yield summary of the variety on farmers' fields in Qt/ha (N=7)

Variety Name	Max.	Min	Mean	Std deviation	t-test	
					t-value	Sign
Elemo	24.7	56	35.5	10.8	10.7	0.000
Local Check	16.9	39.8	25.1	7.7		

Source: Our computation, 2020/21

Yield Advantage of ElemoVariety over local check across location

The result of the study indicated in (Table 3) shows that, Elemo variety revealed higher yield increment over the Local check across districts. The larger yield increment was gained from Habro district with 12.7 Qt/ha (41.5 %) increment over the local check. Study conducted by Asfaw *et al*., 2018 and Fekede *et al*., 2018 conclude that using improved variety was more advantageous than local variety under farmers` condition. From table 3 below we also

conclude that higher mean yield were recorded at Habro than Daro Lebu district which may be Habro district is more favorable for Elemo variety than Daro Lebu district.

Table 3**:** Yield advantage of Elemo variety over local check by location

District	Variety	Max	Min	Mean	Std. Deviation	Yield increment in Qt/ha	Yield advantage over local check (%)
Daro Lebu	Elemo	24.7	35	29.8	4.5	8.9	42.5
	Local Check	16.9	24.6	20.9	3.2	-	
Habro	Elemo	30.5	56	43.3	12.7	12.7	41.5
	Local Check	21.7	39.8	30.6	9	-	

Source: Our computation, 2020/21

Capacity building and technology promotion

Table 4: Training and mini field day participants

No	Stakeholders	Number of participants		Total
		Male	Female	
1	Farmers	73	3	76
2	Development agents	6	2	8
3	SMS	10	0	10
4	Researchers	33	1	34
5	Others	12	1	13
Total		134	7	141

Farmers` Preferences

Participants to select the best variety, parameters such as plant height, seed color, early flowering, biomass, early maturity, lodging resistance, drought tolerance, head size and stay green were settled by participants of mini field day.

Based on the farmers selection criteria, the result indicated that Elemo variety was preferred by contact farmers and other neighbor farmers during mini field day organized on farmer`s field. The mean scores of farmers' selection criteria ranged from 2.7 (local variety) to 4.8 (Elemo variety). The highest score (4.8) recorded for early maturity for Elemo and 2.7 for local variety. Feed shortage is the critical problem in the study area and farmers considered the biomass of the variety to feed their animals during feed shortage. Therefore, Elemo variety had high biomass, resistance to drought, big head size and good seed color than the local check which fit the interest of farmers (Table 4). In general improved variety (Elemo) got higher score in all parameters than local check and selected as 1st by farmers during mini field day.

Table 4: Farmers preference on the variety (score 1-5)

Varieties	Selection criteria(Score 1-5)									Total score	Mean score	Rank
	PH	SC	EF	BM	EM	LR	DRT	HS	SG			
Elemo	4.6	4.6	4.8	4.5	4.8	4.1	4.5	4.8	4.4	41.3	4.6	1
Local check	3.6	3.2	2.7	3.5	2.7	3.7	3.5	3.4	3.5	29.6	3.3	2

Note: Plant Height (PH), Seed color (SC), early flowering (EF), Biomass (BM), Early maturity (EM), Lodging resistance (LR), drought tolerance (DRT), Head size (HS), Stay green (SG)
Source: Our computation, 2020/21

Financial analysis of the technologies

Table 5: Cost-benefit analysis of the technologies/ha

Items	Verities	
	Elemo	**Local**
Yield Qt/ha) (Q)	35.5	25.1
Total Revenue (TR) = P*Q	106,500	75,300
Costs		
Seed cost	480	360
Fertilizer cost	2900	2900
Labor cost	7,800	7,800
Ploughing cost	4,000	4,000
Total cost (TC)	15,180	15,060
Gross Margin (GM) = TR-TC	91,320	60,240

As illustrated in the table above, net profit of 91,320 ETB and 60,240 ETB could be gained from using Elemo and local varieties respectively. On the other hand, using the new variety Elemo sorghum could make the grower to fetch 31,080 ETB additional net profit than using the local check.

Conclusions and Recommendation

The demonstration was conducted to evaluate yield performance of Elemo variety under farmers' condition. The result of the study indicated that, the highest mean yield of 35.5 qt/ha was recorded from the new variety Elemo and the lowest mean yield 25.1 qt/ha was from the local check. The result of paired t-test revealed that there is the yield difference between improved and local varieties in terms of grain yield and showed grain yield advantage over the local check by 42% with similar management. On the other hand ranking analysis also indicated that Elemo variety was preferred by mini field day participants with its seed color, resistance to drought, high biomass and head size under farmers' condition, and using improved Elemo sorghum variety could make the producer more profitable than the local check with an additional 31,080 ETB net profits. Therefore, this variety was recommended for wider production at midlands of west Hararghe Zone and similar agro-ecological conditions with the collaboration of districts agricultural offices, research center, unions and NGOs to improve sorghum production and productivity.

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Pre-extension demonstration and evaluation of Improved Finger Millet varieties in selected districts of East Hararghe Zone

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Abstract

*Finger millet is among the food security crops, widely used for food, local beverage preparation and animal feed. Regardless of its high nutritional contribution, the production of finger millet is not commonly known in eastern Ethiopia in general and east Hararghe zone in particular. Lack of sufficient knowledge and awareness of farmers about the production and benefits of the improved finger millet varieties is among the hindering factors. Demonstration of finger millet varieties is necessary to alleviate these problems. Therefore, this study was conducted to introduce finger millet varieties with improved management practices through demonstration and evaluation. It was conducted at Ido baso and Umarkule kebeles of Fedis district through FRG approach. A total of 10 trial Farmers were selected based on their interest and land ownership. Aksum and Tadesse finger millet varieties were provided to farmers with full packages. Each variety was planted on a plot size of 10mx10m/farmer, with seed rate of 15kg/ha and 40cm*10cm 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 combined mean yield for Aksum and Tadesse is 23 qt/ha and 20.1 qt/ha respectively. Based on their criteria, farmers have preferred and ranked Aksum variety as first. Therefore, it is better if this variety is pre scaled up to wider community.*

Keywords: *Demonstration, Evaluation, Finger millet*

Introduction

Finger millet (Eleusine coracana (L.) Gaertn) is an allotetraploid (2n = 4X = 36, AABB) belonging to the Family Poaceae and the genus Eleusine. The genome size of finger millet is 1,593 Mb and is a self-pollinated crop (Goron and Raizada, 2015). It is an annual herbaceous cereal crop widely grown and consumed by poor people in Africa and Asia. It contains rich amounts of protein, mineral nutrient as compared to other major cereals like wheat, rice, and sorghum (Gupta et al., 2017; Sharma et al., 2017). Finger millet is well known for its exceptionally high calcium (Ca) content having about 0.34% in whole seeds as compared with 0.01–0.06% in most other cereals (Gupta et al., 2017). The grain is used as flour in the preparation of cakes, bread and other pastry products, and also serves as a beneficial food for infants (Ceasar and Ignacimuthu, 2011). The seeds can be stored for more than 5 years without insect damage which makes it a most valuable crop in drought-prone areas of Africa (Latha et al., 2005). According to estimates, about 3.5 billion people were at the risk of Ca deficiency and about 90% of these people were living in Africa and Asia (Kumssa et al., 2015). As the increase in population and industrialization throughout the world reduced the availability of agricultural land, by the end of 2050, the world is expected to face a severe food demand (Gupta et al., 2017). To overcome such a situation, there is an urgent need to increase the production of cereals like finger millet, which has to be increased up to 4.5 t /ha by 2025 (Borlaug, 2002). Finger millet is assumed to be an ideal crop for climate resilient agriculture due to its adaptation in semi-arid tropics which are characterized by unpredicted

weather and erratic rainfall. Increasing the finger millet production will make high nutritional food available for the poor people of developing nations and will help to attain nutritional security. Crops such as rice and wheat can provide food security, but finger millet has nutritional properties superior to that of rice and wheat, so it has been suggested to help in strengthening the nutritional security in the developing countries of Asia and Africa (Puranik et al., 2017).

Finger millet is majorly grown in the semi-arid tropics of Asia and Africa. In Asia, finger millet is mostly grown in the Southern states of India which provide favorable growth conditions. Among the millets, finger millet ranks fourth on a global scale of production next to sorghum, pearl millet (Cenchrus americanus), and foxtail millet (Setaria italica) (Upadhyaya et al., 2007). Around 4.5 million tons of finger millet are produced worldwide every year. Africa produce 2.5 million tons and India produces 1.2 million tons annually. Finger millet accounts for about 85% all millets produced in India and is cultivated over 1.19 million hectares in India according to a recent report (Sakamma et al., 2018).

In Ethiopia, finger millet ranks 6th of the cereals in terms of area coverage and production which are 480,343.25 ha and 12,030,164.41 quintals, respectively. Its productivity is 25.04 Qt/ha (CSA, 2021). It also covers 97,266.93 ha with annual production of 2,515,632.41 Quintals and 25.86 Qt/ha of productivity in Oromia region. Finger millet is among the food security crops, widely used for food, local beverage preparation and animal feed (Mulualem and Melak, 2013). Nutritionally, the crop is rich containing high ash, calcium and iron content, which is essential for strengthening bone and teeth and reduce incidence of anemia (Shobana *et al.* 2013). It is widely grown cereal crop in western Oromia for food and brewing. It can be grown under condition of low rain fall and can with stand in drought, reviving again with a good shower of rain with remarkable vigor which is favorable agro-ecology for Hararghe condition. Eastern Hararghe has the potential for producing finger millet. However, production of finger millet is unfamiliar in the area. FARC cereal research case team has tested different improved finger millet varieties for adaptability, productivity, early maturity and disease resistance. Among those, Aksum and Tadese varieties were recommended with mean yield of 21.6qt/ha & 20.2qt/ha respectively.

Hence, introducing this crop in the area is very important due to its nutritional value. Therefore, this study was conducted to create awareness on production of improved finger millet varieties through demonstration and evaluation in order to enhance nutritional security in the study area.

Objectives

- To evaluate the productivity and profitability of improved Finger Millet varieties under farmers' condition.
- To demonstrate and select best performing Finger Millet varieties for pre-scaling up
- To strengthen linkage and create awareness among the different development practitioners on improved Finger Millet production technologies.

Materials and Methods

Description of the study area

The study was 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

Fedis district was selected from east Hararghe zone purposively. From the district, two kebeles (Ido baso and Umarkule) were selected. Farmers were selected based on their interest, land ownership and willingness to share experiences for other farmers in collaboration with experts from district agriculture office and development agents. The selected farmers were grouped as Farmers Research Group (FRG) with the member of 15 farmers per kebele taking gender into consideration (women, men and youth). Hence, a total of 30 farmers were grouped in 2 FRGs (One FRG/ PA). In the FRG, 5 farmers were trial farmers (3 male and 2 female) and 10 farmers were fellow farmers. Each FRG have one leader who had played facilitation and communication role with development agents and researchers in the process.

Implementation design

The improved (Aksum) finger millet variety and tadesse as standard check were used for the study. The varieties were replicated across three trial farmers per kebele. Each variety was planted on a plot size: 10mx10m, at seeding rate of 15kg/ha. Space between row and plant were 40cm*10cm respectively. Likewise, fertilizer (NPS) was applied with rate of 100kg/ha. The experimental Fields were managed by participant farmers with close supervision of researchers and development agents.

Capacity building and experience sharing

As part of the intervention activities, training on agronomic practices and post-harvest handling was organized and given to farmers, DAs and experts before plantation and harvesting time. Finally, field visit was 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.

Monitoring and evaluation

Frequent visits to farmers, monitoring and provision of technical advice, follow up actions were designed based on emerging knowledge/ skill and technical needs.

Data collection

Number of beneficiary farmers by age and sex, plot size and amount of input used were collected with checklist. The grain yield data of the varieties across all plots was taken through 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; seed size, seed uniformity, plant height, seed weight, seed color, maturity period, marketability, flour quality and productivity. The respondents had responded their perception level on the relative advantage of each characteristics of the variety compared to the standard check.

Data analysis

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

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

Finally data from different sources were triangulated to get reliable information.

Result and Discussions

Capacity building

A total of 65 farmers out of which 46 are males and 19 are females have participated on field day. 8 experts (7 males and 1 female) and 6 development agents have also participated on the event. Likewise, a total of 45 farmers (30 males and 15 females), 6 development agents and 4 experts have participated on training.

Demographic Characteristics of beneficiary farmers

The combined mean for age of trial farmers is 34.60 years, whereas the minimum and the maximum age are 20 years and 52 years, respectively. Out of the total participant farmers, 60% are males and the remaining 40% are females.

Table 3. Demographic Characteristics of trial farmers

Locations	Age of participant farmers				Sex of participant farmers	
	Minimum	Maximum	Mean	St.dev	Female	Male
Ido baso	20	52	36.2	10.17	2	3
Umarkule	22	51	33.00	10.64	2	3
Combined	20	52	34.60	10.26	4	6

Source: computed from own data (2021)

Descriptive Results for productivity of the varieties

The maximum yield estimated from harvested yield per plot for both aksum and tadesse is 26qt/ha which is recorded at Ido baso. The mean yield for aksum is 23.4 qt/ha and 22.6 qt/ha at Ido baso and UmarKule, respectively. Similarly, the mean yield obtained for tadesse is 20.8 qt/ha and 19.4 qt/ha at Ido baso and UmarKule, respectively. The combined mean yield for aksum and tadesse is 23 qt/ha and 20.1 qt/ha, respectively.

Table 2. Descriptive results for Finger Millet yield per plot and per hectare

Locations	Varieties	Parameter	Minimum	Maximum	Mean	St.dev
Ido baso	Aksum	Yield per plot	.20	.26	.234	.024
		Yield per hectare	20	26	23.4	2.408
	Tadesse	Yield per plot	.17	.26	.208	.037
		Yield per hectare	17	26	20.8	3.701
UmarKule	Aksum	Yield per plot	.21	.24	.226	.0114
		Yield per hectare	21	24	22.6	1.140
	Tadesse	Yield per plot	.15	.22	.194	.02702
		Yield per hectare	15	22	19.4	2.702
Combined	Aksum	Yield per plot	.20	.26	.23	01826
		Yield per hectare	20	26	23	1.826
	Tadesse	Yield per plot	.15	.26	.201	.03143
		Yield per hectare	15	26	20.1	3.143

Source: computed from own data (2021)

As clearly shown in table 3, the percentage of mean yield difference of the varieties indicates that Aksum variety has 14.4% yield advantage over tadesse variety.

Varieties	Yield (Qt/ha) (n=10)				Mean difference over standard check	Yield advantage over standard check
	Min	Max	Mean	St. dev	Qt/ha	%
Aksum	20	26	23	1.826	2.9	14.4%
Tadesse	15	26	20.1	3.143	0	0

Table 3. The mean yield of improved finger millet and its yield advantage.

Source: computed from own data (2021)

The result of t-test (table 4) for mean difference indicates that there is a significant combined mean difference between the two varieties at 5% significance level.

Table 4. The result of t-test for combined mean difference

Parameters	Aksum (n=10)		Tadesse (n=10)		
	Mean	St.Dev	Mean	St.Dev	T-value
Harvested Yield per plot	.23	01826	.201	.03143	14.45
Estimated Yield per hectare	23	1.826	20.1	3.143	14.45

Source: computed from own data (2021)

Table 5. Matrix ranking of finger millet Varieties

Parameters	Aksum		Tadesse	
	Point	Rank	Point	Rank
Seed size	2	1	1	2
Seed uniformity	2	1	1	2
Plant height	1	2	2	1
Seed weight	2	1	1	2
Seed color,	2	1	1	2
maturity period	1	2	2	1
Marketability	2	1	1	2
Flour quality	2	1	1	2
Productivity (yield/ha)	2	1	1	2
Total score	16		11	
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.

Aksum finger millet variety is preferred by farmers and ranked as first for the parameters such as: seed size, seed uniformity, seed color, seed weight, marketability, flour quality and productivity while Tadesse variety is ranked second for the same parameters.

Economic Analysis for Finger Millet production

The changes in net benefit between Aksum variety and Tadesse variety is 9485 whereas, the change in total cost is 3565. These indicate that if one left tadesse variety and produces aksum variety, about 5920 EB net benefit advantage will be obtained.

Table 6. Economic analysis of Finger Millet production

No		Finger Millet varieties	
		Tadeesse	Aksum
Gross Farm gate benefits			
1	Average yield(Kg/ha)	2010	2300
2	Farm gate price(Birr/Kg)	45	45
3	Gross farm gate benefits	90450	103500
Costs			
4	Land preparation	4000	4000
5	Seed	675	675
6	Sowing	3000	3000
7	Fertilizer(NPS)	1850	1850
8	Fertilizer(UREA)	1750	1750
9	Weeding	6800	6800
10	Harvesting	5400	7200
11	Threshing	6300	7600
12	Miscellaneous	4466.25	4931.25
13	Total cost	34241.25	37806.25
14	Net benefit	56208.75	65693.75
15	Change in net benefit		9485
16	Change in total cost		3565
17	Benefit-cost ratio	2.64	2.74

Source: computed from own data (2021)

Conclusion and Recommendation

Enhancing Finger millet production is important to alleviate food security problem. Introduction of Improved Finger millet varieties has a critical role to enhance the production. Two improved finger millet varieties, aksum and tadesse are demonstrated on farmers' field. The yield harvested from experimental plots is very promising. There is significant mean difference between Aksum and Tadesse varieties. The combined mean yield of the varieties indicates that Aksum variety has 14.4% yield advantage over tadesse variety. The benefit-cost ratio shows that producing aksum variety has economic advantage. Farmers have also preferred Aksum variety based on different technological characteristics. Hence, it is better if all farmers of the study areas and those living in the similar agro ecologies use the Aksum variety in sustainable way in order to increase their production. It is good if agricultural research center and agriculture and natural resource office cooperate to pre-scale up Aksum variety.

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Pre-extension demonstration and evaluation of Improved Sorghum varieties in selected districts of East Hararghe Zone

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Abstract

*Sorghum is the main staple food crop which is widely adapted to different agro-ecological environments of Ethiopia. Despite the wider area coverage in cultivation, the national average for sorghum productivity is low as compared to the world's average. Limited improved sorghum varieties, inadequate adoption of the existing improved sorghum varieties, drought and striga weed are among the major constraints. Popularization of improved sorghum varieties with best management practices has paramount importance to improve production and productivity of sorghum. Therefore, this study was conducted to demonstrate and evaluate the productivity and profitability of improved sorghum varieties under farmers' condition in order to select best performing varieties for pre-scaling up. It was conducted at Ido baso, Umarkule and Risqi kebeles of Fedis district through FRG approach. A total of 15 trial Farmers were selected based on their interest and land ownership. Fedis-01 and Melkam sorghum varieties were provided to farmers with full packages. Each variety was planted on a plot size of 10mx10m/farmer, with seed rate of 10kg/ha and 75cm*20cm space between row and plant respectively. Similarly, fertilizer (NPS) was applied with rate of 100kg/ha. Training and field visit were organized to facilitate distribution of technologies through farmers as well as to evaluate performance of the varieties and share the lessons with different stakeholders. The combined mean yield for Fedis-01 and Melkam is 37.67qt/ha and 33.67qt/ha respectively. The result of t-test for combined mean difference shows insignificant yield difference between the two varieties. Therefore, it is better if both varieties are widely promoted to larger farming societies in the study area.*
Keywords: *Demonstration, Evaluation, Improved Sorghum varieties*

Introduction

Sorghum is the main staple food crop in Ethiopia, ranking fourth after Tef, maize, and wheat, both in area coverage and production (CSA, 2016). It is adapted to a wide range of environment and hence can be produced in the highlands, medium altitude and lowland areas. It can survive and give production more than any other crop, in areas where there is moisture stress. During 2020/21 cropping season, sorghum was produced on about 1,679,277.06 hectares of land from which 4,517,350.2 tons of yield were obtained (CSA, 2021). It accounts for 15 percent of the total cereal produced in the country and covers about 16 percent of the total area under cereals. The national average sorghum productivity in Ethiopia is 2.69 tons/ha (CSA, 2021). At Oromia region, sorghum covers 676,075 ha of land with total production of 1,836,612.7 tons and average yield of 2.72 tons/ha. It also covers 123872.89 ha with total production of 278,942.8 tons and average yield of 2.25 tons/ha in eastern hararghe zone (CSA, 2021). The average yield at all level is far below the global average which is 3.2 tons/ha. This is because of factors such as: drought, striga, insect pest (stalk borer, midge, and shoot fly), diseases(anthracnose and smut), soil fertility decline, inadequate adoption of existing improved varieties, lack of high yielding and good quality sorghum varieties, and post-harvest management practices.

Wortmann et al. (2006) reported that drought, low soil fertility, insect stem borers, insect shoot fly, quelea birds and Striga weeds as major production constraints affecting sorghum in eastern Africa. In Ethiopia, drought and Striga weed have been found to be the most important constraints in the northern and north-eastern parts of the country (Gebretsadik et al. 2014). To solve these problems, Fedis Agricultural Research center (FARC) has conducted adaptation trials and evaluated a number of early maturing and striga resistant varieties in some districts of East Hararghe Zone. Specially, taking into consideration the importance of developing and providing new options of variety, FARC cereal case team had made great effort to develop and release new varieties with high yield potential, early maturing and good level of resistance to *Striga*. Accordingly, Fadis01 variety was evaluated and officially released in 2019 for its best stable yield performance and *Striga* resistance for wider production in the lowlands of Eastern Hararghe and areas with similar agro-ecologies. It was tested together with 7 sorghum genotypes including hormat as standard check in regional variety trial at 6 environments in major sorghum producing areas in lowlands of Eastern Hararghe. Fadis01 is characterized by early maturing, medium plant height (160cm), and white seed color with average thousand-kernel weight of 30g, semi compact head habit with average days to flowering and maturity period of 77 and 120 days, respectively. The combined mean grain yield (3.9 tons ha^{-1}) of this variety was better than all genotypes evaluated. In addition, *Fadis01 variety* has 25% yield advantage over the standard check (*Hormat)*. On research field *Fadis01* gave yield ranging from 3.8 to 4.1 ton ha^{-1}, whereas 3.5 to 4.0 tons ha^{-1} on farmers‟ field. Currently, local sorghum varieties which are easily affected by drought and striga infestation are under production in the area. These local varieties need higher amount of rain fall and they take 7-8 months to be matured. This results in low sorghum production in the study area. To alleviate the problems, demonstration and evaluation of improved early maturing and striga resistant sorghum varieties (Fadis01) under farmers' condition has paramount importance. Therefore, this activity is initiated to demonstrate and evaluate the productivity and profitability of improved sorghum varieties under farmers' condition in order to select best performing varieties for pre-scaling up.

Objectives

- To evaluate the productivity and profitability of improved sorghum under farmers condition.
- To demonstrate and select best performing sorghum varieties for pre-scaling up
- To strengthen linkage and create awareness among the different development practitioners on improved sorghum 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

Fedis district was purposively selected from east Hararghe zone. From the district, three kebeles were selected. Farmers were selected based on their interest, land ownership, labor contribution and willingness to 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 per kebele in consideration of gender issues (women, men and youth). A total of 45 farmers were grouped in 3 FRGs (One FRG/ PA). In the FRG, 5 farmers were trial farmers (3 male and 2 female) and 10 farmers were fellow farmers. Each FRG have one leader who had played facilitation and communication role with development agents and researchers in the process.

Implementation design

The improved (Fadis01) sorghum variety and melkam as standard check were used for the study. The varieties were replicated across five trial farmers per kebele. Each variety was planted on a plot size: 10mx10m, at seeding rate of 10kg/ha. Space between row and plant was 75cm*20cm respectively. Likewise, fertilizer (NPS) was applied with rate of 100kg/ha. The experimental Fields were managed by participant farmers with close supervision of researchers and development agents.

Capacity building and experience sharing

As part of the intervention activities, training on agronomic practices and post-harvest handling was given to farmers, DAs and experts before plantation and harvesting time.
Finally, field visit was 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 will attend the field visit.

Monitoring and evaluation

Frequent visits to farmers, monitoring and provision of technical advice, follow up actions were designed based on emerging knowledge/ skill and technical needs.

Data collection

Number of beneficiary farmers by age and sex, plot size and amount of variable input used were collected with checklist. The grain yield of the varieties was taken from all experimental plot. Farmers' perception related to attributes of the varieties was collected using semi-structured interview schedule. The perception data on the varieties attributes were grouped into; seed size, seed uniformity, plant height, seed weight, seed color, maturity period, marketability, flour quality and productivity. The respondents will respond their perception level on the relative advantage of each characteristics of the variety compared to local cultivar or previously introduced varieties.

Data analysis

Quantitative data were analyzed using SPSS software version 26. Descriptive statistics such as frequency, mean, standard deviation, minimum and maximum, were used and presented using tables. Cost-benefit analysis was used for economic evaluation. Qualitative data were analyzed using narrative explanation and argument. The yield advantage of improved sorghum variety over the standard check was calculated by the following formula.

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

Finally data from different sources were triangulated to get reliable information.

Result and Discussions

Capacity building

A total of 58 farmers out of which 42 are males and 16 are females have participated on field day. 6 experts (5males and 1female) and 5 development agents have also participated on the event. Likewise, a total of 55 farmers (35males and 20females), 7 development agents and 4 experts have participated on training.

Demographic Characteristics of beneficiary farmers

The combined mean for age of trial farmers is 37.20 years, whereas the minimum and the maximum age is 21 years and 50 years respectively. Out of the total trial farmers, 60% are males and the remaining 40% are females.

Table 4. Demographic Characteristics of trial farmers

Locations	Age of trial farmers				Sex of trial farmers	
	Minimum	Maximum	Mean	St.dev	Female	Male
Ido baso	23	47	35.10	7.608	2	3
Umarkule	21	46	35.70	9.696	2	3
Risqi	27	50	40.80	7.162	2	3
Combined	21	50	37.20	8.356	6	9

Source: computed from own data (2021)

The maximum yield recorded for fedis01 and melkam is 46qt/ha and 44qt/ha respectively; and both are recorded at Risqi. The mean yield for fedis01 is 41.8qt/ha, 31qt/ha and 40.2qt/ha at Ido baso, UmarKule and Risqi respectively. Similarly, the mean yield obtained for Melkam is 35qt/ha, 30.8qt/ha and 35.2qt/ha at Ido baso, UmarKule and Risqi respectively. The combined mean yield for fedis01 and melkam is 37.67 and 33.67, respectively.

Table 2. Descriptive results for Sorghum yield per plot and per hectare

Locations	Varieties	parameter	Minimum	Maximum	Mean	St.dev
Ido baso	Fedis01	Yield per plot	.39	.45	.418	.024
		Yield per hectare	39	45	41.8	2.387
	Melkam	Yield per plot	.32	.38	.35	.026
		Yield per hectare	32	38	35	2.549
UmarKule	Fedis01	Yield per plot	.29	.33	.31	.016
		Yield per hectare	29	33	31	1.581
	Melkam	Yield per plot	.28	.33	.308	.019
		Yield per hectare	28	33	30.80	1.924
Risqi	Fedis01	Yield per plot	.29	.46	.4020	.066
		Yield per hectare	29	46	40.20	6.648
	Melkam	Yield per plot	.27	.44	.3520	.074
		Yield per hectare	27	44	35.20	7.362
Combined	Fedis01	Yield per plot	.29	.46	.3767	.063
		Yield per hectare	29	46	37.67	6.264
	Melkam	Yield per plot	.27	.44	.3367	.048
		Yield per hectare	27	44	33.67	4.776

Source: computed from own data (2021)

As indicated by table 3, the percentage of mean yield difference of the varieties shows that fedis-01 variety has 11.9% yield advantage over melkam variety.

Varieties	Yield (Qt/ha) (n=15)				Mean difference over standard check	Yield advantage over standard check
	Min	Max	Mean	St. dev	Qt/ha	%
Fedis-01	29	46	37.67	6.264	4	11.9%
Melkam	27	44	33.67	4.776	0	0

Table 3. The mean yield of improved *Sorghum* and its yield advantage.

Source: computed from own data (2021)

The result of t-test (table. 4) for mean difference indicates that there is no significant combined mean difference between the two varieties.

Table 4. The result of t-test for combined mean difference

Parameters	Fedis01 (n=15)		Melkam (n=15)		
	Mean	St.Dev	Mean	St.Dev	T-value
Harvested Yield per plot	.3767	.063	.3367	.048	1.967
Estimated Yield per hectare	37.67	6.264	33.67	4.776	1.967

Source: computed from own data (2021)

Table 5. Matrix ranking for sorghum Varieties

Parameters	Fedis01		Melkam	
	Point	Rank	Point	Rank
Seed size	2	1	1	2
Seed uniformity	1	2	2	1
Plant height	2	1	1	2
Seed weight	2	1	1	2
Seed color,	1	2	2	1
maturity period	1	2	2	1
Marketability	1	2	2	1
Flour quality	1	2	2	1
Productivity (yield/ha)	2	1	1	2
Total score	13		14	
Final Rank	2		1	

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.

Melkam sorghum variety is preferred by farmers and ranked as first for the parameters such as: Seed uniformity, Seed color, maturity period, Marketability and Flour quality while Fedis-01 sorghum is preferred by farmers for parameters such as: Seed size, seed weight, plant height and productivity.

The changes in net benefit between Fedis01 sorghum variety and melkam variety is 9590 whereas, the change in total cost is 1610. These indicate that if one left melkam variety and produces Fedis01 variety, about 7980 EB net benefit advantage will be obtained.

Table 6. Economic analysis for improved sorghum production

No		Improved sorghum varieties	
		Melkam	Fedis01
Gross Farm gate benefits			
1	Average yield(Kg/ha)	3367	3767
2	Farm gate price(Birr/Kg)	28	28
3	Gross farm gate benefits	94276	105476
Costs			
4	Land preparation	4000	4000
5	Seed	280	280
6	Sowing	3600	3600
7	Fertilizer(NPS)	1850	1850
8	Fertilizer(UREA)	1750	1750
9	Weeding	5800	5800
10	Harvesting	6700	7200
11	Threshing	6500	7400
12	Miscellaneous	4572	4782
13	Total cost	35052	36662
14	Net benefit	59224	68814
15	Change in net benefit		9590
16	Change in total cost		1610
17	Benefit-cost ratio	2.69	2.89

Source: computed from own data (2021)

Conclusion and Recommendation

Improving sorghum production is important to attain the increasing food demand. Popularization of Improved sorghum varieties has a decisive role to improve sorghum production. Two improved sorghum varieties, fedis-01 and melkam are demonstrated on farmers' field. The yield harvested from experimental plots for both varieties implies that using improved varieties help to increase the production. The t-test for mean difference revealed non-significant mean difference between fedis-01 and melkam varieties. But, farmers have evaluated the two varieties based on their own criteria and preferred melkam variety. Nevertheless, the combined mean yield of the varieties indicates that fedis-01 variety has 11.9% yield advantage over melkam variety. The benefit-cost ratio also shows that producing fedis-01 variety has economic advantage. Hence, it is better if both varieties are adopted by all farmers of the study areas and those living in the similar agro ecologies in sustainable way in order to increase their production. It is also good if agricultural research center and agriculture and natural resource office cooperate to pre-scale up the varieties.

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Pre-extension Demonstration of Common-bean Technology in Low land of East Hararghe Zone, Oromia

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Abstract
*Pre extension demonstration of common bean varieties was conducted at Fadis and Babile districts of East Hararghe zone one kebele from one FRG established and 10 trial farmers. Both varieties sown on 10*10 plot size of demonstration plots with full package technology. Farmers were trained and well capacitated by relevant researchers. After the provision of training, farmers sown on their farm and regular follow up were undertaken by research centers. The yield performance of the improved varieties (Awash-2 and serie-125) were* 18.26, 23.64*qt/ha at Ifadin and* 20.46, 23.64 *qt/ha Ifadin Kebele respectively. The result showed that there is statistically significant difference at 5% probability level between Awash-2 and serie-125 variety and also serie-125 has 22.5% yield advantage over Aawash-2. Therefore, it is batter to be promote Awash-2 for scaling-up on wider area and reach large number of farmers because of its color , market demand and market price though its yield lower than serie-125 .*
Key words: *Demonstration, Common bean, FRG*

Introduction

Ethiopia is one of the top twelve producers of total pulse in the world, third largest producer of haricot bean in COMESA member countries and the leading exporter in Africa (Agitu, 2014). However, despite their importance from a community perspective, caloric intake from consumption of pulses and oilseeds combined was reported at 9% for rural and 14% for urban communities ((Kebebu, *et al*., 2013; Roba, *et al*., 2015).Of a total of 12.4 million hectares of farmland in Ethiopia, the majority is used for production of cereals (9.16 million hectares); a relatively small area is seeded to pulses 1.41 million hectares (FAO, 2019).

Haricot bean is one of pulse crop considered as the main cash crop and protein source of many lowlands and mid-altitude zones of Ethiopia and crop has a high nutritional value with important protein contents (22%), minerals (calcium, copper, iron, magnesium, manganese, zinc), and vitamins necessary to warrant the food security of people (Wondimu *et al.*, 2017 and Kabata *et al.*, 2017).

On the other hand, the current productivity level of haricot bean falls significantly below the demonstrated potential. The current national average productivity of haricot bean in Ethiopia is 1.48 tons per hectare that is below average research demonstrated productivity potential (3.4 tons per hectare) in the country (Mulugeta *et al.*, 2015). This is attributed to combined effects of edaphic, climatic, disease, and pest problems and lack of improved varieties is one of the top problems for low yield (Gurmu, 2013). The crop is widely grown in areas between 1400-2000 m.a.s.l. The main production areas include the East Hararghe, West Wellega, East shewa, West Arsi, Sidama, Wolayita, Wollo and East Gojam (EIAR, 2014).In East Hararghe haricot-bean is the most important pulse crop that farmers cultivate as intercropping with sorghum, maize and even in some area in sole. However, they cultivate in much, lack of improved varieties which can stand with variable climate condition is challenges farmers face. Therefore, this proposal is initiated to curtail the challenges farmers face in case lacking of improved Haricot-bean varieties as the recommendation packages with the following objectives.

Objectives

- ✓ To evaluate the productivity of common bean Technology under farmers' condition.
- ✓ To create awareness among farmers, developmental agents, subject matter specialists on improved common bean production technology.
- ✓ To build farmers' knowledge and skill of production and management technique

Materials and Methods

This pre-extension demonstration of common bean was conducted selected districts of Fadis and Babile Districts of East Haraghe Zone

The study of 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 – 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. Ifadin and Riski 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 Keeble Riski and Ifadin were selected. The selected farmers were grouped in the form of Farmers Research Group (FRG) with the member of 15 (3 male trial farmers and 2 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 farmers	Area covered
Fadis	Riski	5	10mx 10m for each plots
Babile	Ifadin	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 common bean 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 Awash-2 & Serie-125 replication-replicate across five trial farmers per PAs. Two improved varieties 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 40cm between rows and 10 cm between plants (10cm* 10cm) gives higher yield. Fertilizer rate depends on the soil fertility of an area 100 kg NPS is recommended and seed rate 100kg/ha.

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

Agronomic and yield performance

The following table describes the yield performances of the demonstrated Awash-2 and Serie-125, common bean varieties across the study site. The yield performance of the improved Awash-2 variety and serie-125 were 18.26, 23.64 20.46 and 23.64 qt/ha at Ifadin and Riski Kebeles respectively.

Table 2.Yield performance of improved varieties across districts

PA	Varieties	N	Std. Deviation	Mean (qt/ha)	Maximum	Minimum
Ifadin	Awash-2	5	1.39	18.26	20.00	16.40
	Serie-125	5	2.40	23.64	27.00	20.80
Riski	Awash-2	5	2.25	20.46	23.00	18.00
	Serie-125	5	2.40	23.64	27.00	20.80
Total		**10**	**2.86**	21.06	27.00	16.40

The average yield performance of Serie-125 is higher than Awash-2 at Ifadin and Riski.

Independent t-test

Table.3 Sample t-test

	Test for variances	equalt-test for equality of means					
	F	Sig.	t	df	Sig.(2tailed)	Mean difference	Std. Error Differences
Equal variances assumed	6.94	.030	2.76	8	.025	3.64	1.31

Statistically significant difference 5% probability level

Yield Advantage

Yield advantage of the demonstrated varieties was calculated using the following formula.
Yield advantage % = Yield advantage of new variety – Yield advantage of st; check X 100
Yield advantage of standard check

Table.4.Yield Advantage

Varieties	Average yield qt/ha	Yielddifference ton/ha	Yield advantage over the local check (%)
Awash-2	23.64	4.2	21.5
Serie-125	19.45		

Economic Analysis

Table 5: Financial analysis for Common bean varieties across the districts

Financial analysis				
	Location: Babile		Location: Fedis	
Parameters	Varieties		Varieties	
	Awash-2	Serie-125	Awash-2	Serie-125
Yield qt/ha(Y)	18.26	23.64	20.46	23.64
Price(P) per quintal	6000	4000	6000	4000
Total Revenue (TR)=TR=Y*P	109,560	94,560	122,760	94,560
Variable costs				
Seed cost	5,500	4,000	5,500	4,000
Fertilizer cost	3800	3,800	3,800	3,800
Labor cost	15,000	15,000	15,000	15,000
Total Variable costs(TVC)	24,300	22,800	24,300	22,800
Fixed costs				
Cost of land	6,000	6,000	6,000	6,000
Total fixed costs (TFC)	6,000	6,000	6,000	6,000
Total cost (TC) =TVC+TFC				
Gross Margin (GM) = TR - TVC	85,000	71,760	98,460	71,760
Profit=GM-TFC	79,000	65,760	92,460	65,760

Farmers' Opinion/Perception

Farmers in the study area selected the best performing common bean 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, seed/grain color, market demand and market price

Table.8 Ranks of the varieties based on farmers' selection criteria

Varieties	Farmers rank	Reasons
Awash-2	1st	Medium maturity ,high yield, better diseases tolerance, Red in seed/grain color ,medium market demand, medium market price
Serie-125	2nd	Medium maturity ,high yield, better diseases tolerance, Red in seed/grain color ,medium market demand, medium market price

Discussion

The trial farmers in the two locations are aware of the physical characteristics and field performance of all varieties used in the common bean production 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 (Aawash-2 and serie-125) were 18.26, 23.64 20.46 and 23.64 qt/ha at Ifadin and Riski Kebeles respectively. The average yield performance of Serie-125 and Awash-2 at both location statistically significant difference at 5% across the location. It was recommended that, it is better to disseminate the variety that has market demand, better market price and good color variety for scaling up to enhance dissemination. Based on the criteria Awash-2 variety was recommended for further scaling up

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Pre-extension Demonstration of Black Cumin Technologies in Goro and Ginnir Districts of Bale and East Bale Zones

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Abstract

Pre-extension demonstration of black cumin technologies was carried in Goro and Ginnirs districts during 2013/14 Ethiopian main cropping season with the objective of evaluating the newly released variety under farmers' condition applying full recommended agronomic packages. The trial was implemented on 10 (ten) trial farmers' field on plot size of 100 m^2 using FRG approach. Training, filed visit and mini-field days were used as technology demonstration and evaluation methods. Data were collected using measurements and focus group discussion while descriptive statistics were used to analyze the collected quantitative data. Moreover, pari wise ranking and direct matric ranking were used to analyze and summarize qualitative data. Accordingly, the result of t-test depicts that the new variety (Keneni) gave higher yield of 12.18 qt/ha with standard deviation of 1.15 while the standard check, Gemechis, gave 9.52 quintals per hectare with standard deviation of 1.14. The yield difference between Keneni and Gemechis varieties is statistically significant at less than 1 % significance level. Direct matrix ranking was carried out to identify the variety of their interest. Accordingly, farmers gave the highest score for Keneni variety based on the varietal traits set during focus group discussion. The financial analysis also depicts producing Keneni variety is economically more profitable than Gemechis variety. Therefore, based on farmers' preference Keneni variety is recommended for further pre-scaling up.

Key Words: *Black cumin, Farmers' preference, Farmers' feedback, FRG approach, Pre-extension demonstration*

Introduction

Spices, being a cash crop, have an immense potential for countries economic development through improving smallholder farmers' creation and expansion of employment opportunities and distribution of income and foreign exchange earnings. Ethiopia has become one of the largest consumers of spices in Africa. People use spices to flavor bread, butter, meat, soups, and vegetables. The country is a homeland for many spices, such as korarima (Aframonum korarima), long red pepper, black cumin, white cumin/bishops weed, coriander, fenugreek, turmeric, sage, cinnamon, and ginger (International Trade Centre, 2010).

Black cumin (Nigella sativa) is a short-lived annual flowering plant that belongs to the family Ranunculaceae (Habtewold *et al.*, 2017). It is used predominantly to flavor food, either as whole grain or in powdered form or as an oleoresin extract. In Ethiopia, its main use is as a spice, which is typically ground and mixed with other spices. Black cumin seed oil was used traditionally in different countries for many medical complains. The seeds are used for culinary purposes, medicinal treatment and also used as food additives (Shimeles, 2017). Black cumin is mainly produced within an altitudinal range of 1750–2200 m a s l. It can grow in well drained black vertisols with residual moisture. A rainfall of 120–400 mm during its growing season could be enough for its optimum production. It grew in temperature ranges of 5–25°C, with 12–14°C is being the optimum (Habtewold *et al.*, 2017).

Even though black cumin has the aforementioned economic and social advantages, the production of this spices crop has been characterized by low output per unit of land allocated arising from lack of high yielding improved varieties. Cognizant of this, Sinana Agricultural

Research Center had released a few improved black cumin varieties in the recent past years. Among these black cumin varieties, **Keneni** variety was released in 2019 with yield potential of 17-23.2 qtha^{-1}. Keneni variety has yield advantage of 18% over Darbera (standard check). However, still, it is not demonstrated and evaluated under farmers' condition which helps to build farmers' confidence and create demand for wider dissemination of this new variety.
As a result, this pre-extension demonstration of Keneni variety with its associated full packages was initiated to create demand and build confidence about black cumin technologies for further promotion and dissemination of this spices crop in Goro and Ginnir districts of East Bale zone.

Objectives of the Study

- To evaluate yield performance and profitability of improved black cumin technologies under farmers' condition
- To create awareness on the importance of improved black cumin technologies among farmers and agricultural experts
- To collect farmers' feedbacks on improved black cumin technologies for further variety development of black cumin production.

Materials and Methods

Site Selection

The study was carried out in Goro and Ginnir districts of Bale and East Bale zones. Purposive site selection was carried out due to these districts are a niche to spice production. Similarly, two kebeles were selected from each district purposively based on road accessibility for trial management and supervision. Accordingly, the trial was implemented in four kebeles which have a good potential for black cumin production and easily accessible.

Farmer Research Group (FRG) Establishment and Trial Farmer Selection

Pre-extension demonstration of black cumin technologies was implemented following FRG approach. As a result, one FRG in each kebele was established which contains 15-20 members. Trial farmer selection was carried out with consultation of FRG members and experts of respective district and DAs of each kebele. While nominating farmers for hosting replicative trial, status of the field (fertility, slope), and accessibility for crop management and supervision was considered. Accordingly, the activity was carried out on ten (10) hosting farmers' field.

Materials and Field Design

The study used a simple plot design of 10 m*10 m in which one improved variety of black cumin (Keneni) and one standard check (Gemechis) were planted side by side. Recommended seed rate of 10 kg ha^{-1} was used for both varieties. Row planting was also applied with the spacing of 30 cm between rows. Fertilizer application was carried out during planting at a rate of 100 kg NPS per hectare. Moreover, twice hand weeding was carried out for both varieties to control weed infestation at proper time.

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 representative sites. Training, field visit, mini-field day were used as to enhance farmer-to-

farmer learning and information exchange. Training by multidisciplinary team of SARC was given for FRG member farmers and agricultural experts (DAs, supervisors and SMSs). The purpose of the training was to improve the awareness of the participant farmers and agricultural experts toward the technology. Similarly, mini-field days were organized at representative sites during variety evaluation and selection at maturity stage of the crop. The aim of organizing mini-filed day was to enhance farmers to select the better performing black cumin variety by setting their own selection criteria. Accordingly, group discussion was carried by selecting a group leader who finally reported the result of their discussion.

Types of Data Collected

Types of data include: number of farmers who participated in training, mini-field days and yield data. Besides, input costs (fertilizers, seeds, Labor, fungicides, herbicides, transportation and harvesting costs), local market price of the out puts at harvesting time, economic data (gross benefits obtained) such as costs incurred and revenues gained were recorded. Farmers' feedback about the technology (farmers` perceptions/preferences and farmers' variety selection criteria) was collected.

Methods of Data collection and Analysis

Field observation, measurement and focus group discussion (FGD) were employed as methods of data collection for the study. Quantitative data were analyzed using descriptive statistics like mean, standard deviation, frequency and percentage. Independent t-test was used to test yield difference between two varieties. Furthermore, cost-benefit analysis was used to calculate the economic return. Direct matrix ranking and pair wise ranking were used to analyze qualitative data.

Result and Discussion

Yield Performance of Black cumin Varieties

Yield evaluation for the demonstrated black cumin varieties was carried out over location. Accordingly, the new variety, Keneni, gave relatively higher yield of 12.18 quintals per hectare with standard deviation of 1.15 while the standard check, Gemechis, gave 9.52 quintals per hectare with standard deviation of 1.14 (Table 1). The yield difference between Keneni and Gemechis varieties is statistically significant at less than 1 % significance level.

Table 1: Yield evaluation of black cumin varieties under farmers' condition

Variety	Yield obtained (Qt/ha)		Standard deviation	t-value
	N	Mean		
Gemechis (check)	10	9.52	1.14	-5.186**
Keneni (new variety)	10	12.18	1.15	

Training

Training was provided for FRG members and experts concerning concepts and principles of FRG approach, agronomic practices recommended for black cumin production. Table 2 below indicates participants of theoretical training in Goro district. Training was given for a total of 51 participants from which 40 of them were farmers and 11 of them were agfricultutal experts (SMS and DAs) (Table 2).

Table 2: Participants of Training

District	Farmers		Total	DAs		SMS		Total
	Male	Female		Male	Female	Male	Female	
Goro	35	5	40	3	3	4	1	11
Total participants 40 + 11 = 51								

Mini-field day

Mini-field days were organized at representative sites in which farmers were encouraged to select the variety/ies of their interest setting their own variety selection criteria. It was organized at maturity stage of the crop. On this extension event, 24 male farmers and 4 agricultural experts were participated (Table 3). During mini-field day, farmers shared their experience toward black cumin production to each other and then compared and selected the variety of their interest.

Table 3: Participants of Mini-field days

Kebele	Number of farmers participated			Number of Experts participated		
	Male	Female	Total	Male	Female	Total
Weltai Gobu	10	0	10	2	0	2
Bale Anole	14	0	14	1	1	2
Total	24	0	24	3	1	4

Farmers' Preference towards the Demonstrated Varieties

Scholars argued that 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 *et al.*, 2000). Accordingly, after field visit, farmers were encouraged to discuss what they had observed while comparing the field performance of black cumin varieties by selecting a group leader who finally reported the result of their discussion in evaluating and selecting the two black cumin varieties.

Finally, matrix scoring was carried out to rank demonstrated varieties based on the criteria identified by farmers during group discussion. Direct matrix ranking is used to list black cumin varieties to be compared along horizontal line and criteria on the vertical line to rank choices from most important to least important (i.e. 1^{st} and 2^{nd}). The score was given on the scale of 1 to 5 where 1 stands for the lowest score and 5 indicates the highest score.

Accordingly, they selected Keneni variety of black cumin in the first stage due to its relative advantages than Gemmchis (Table 4).

Table 4: Direct matrix score ranking

Varietal Traits	Score given for Black cumin varieties	
	Keneni	Gemechis
Early maturity	3	4
Tillering capacity	4	3
Plant height	5	4
Number of branches per plant	4	3
Number of capsules per plant	3	3
Number of seeds per capsule	4	3
Disease tolerance	4	3
Total Score	27	23
Rank	1st	2nd

Farmers' feedback assessment

Farmers' feedback assessment is important to prioritize their criteria and incorporate their interest in the breeding program in order to develop demand driven technologies for sustainable production of that specific crop. Accordingly, farmers' feedback about black cumin varieties was assessed and prioritized using pair wise ranking method (Table 5).

Table 5: Result of pairwise ranking of demonstrated black cumin varieties

Code	Varietal Traits	Code of Varietal Traits								Frequency	Rank
		1	2	3	4	5	6	7	8		
1	EM		1	1	1	1	1	1	8	6	2nd
2	DT			3	2	5	6	7	8	1	7th
3	TC				3	5	6	7	8	2	6th
4	PH					5	6	7	8	0	8th
5	NBP						6	5	8	4	4th
6	NCP							6	8	5	3rd
7	NSC								8	3	5th
8	Yield									7	1st

Note: EM= Early maturity, DT=disease tolerance, TC=Tillering capacity, PH= plant height, NBP= Number of branch/plant, NCP= Number of capsule/plant, NSC= Number of seed/capsule

Profitability Analysis

The result of financial analysis illustrated in the Table 6 below shows that the farmer who decided to produce Keneni and Gemechis varieties can earn the net profit of 126,835.00 (ETB) and 87,595.00 (ETB) per hectare, respectively in a single production season (Bona Season). However, those farmers who use own land and family labor could earn an additional net profit of 45,950 birr from the production of these new black cumin varieties.

Table 6: Financial analysis of the demonstrated black cumin varieties

Variables	Varieties	
	Keneni	**Gemeshis**
Yield obtained (qtha^{-1})	12.18	9.52
Sale price (ETB/qt)	15,000.00	15,000.00
Total Revenue (Price * Qt)	182,700.00	142,800.00
Variable Costs		
Land preparation (tractor rent)	3000	3000
Seed purchase	3600	3000
Fertilizers purchase (NPS)	3975	3975
Cost of Insecticide	2100	2100
Cost of labor for weeding	4200	4200
Labor cost for insecticide spray	2450	2450
Cost of Labor for harvesting	2100	2100
Cost of labor for threshing	4200	4200
Store (bag purchase)	240	180
Total Variable Costs (ETB/ha)	25,865.00	25,205.00
Fixed costs		
Cost of Land	30,000	30,000
Total cost (TVC + TF C)	55,865.00	55,205.00
Gross Margin (GM)=TR-TVC	156,835.00	117,595.00
Net Profit=TR-TC or GM-TFC	126,835.00	87,595.00
Benefit-cost Ratio=Total Revenue/Total Cost	3.27	2.56

Conclusion and Recommendations

Pre-extension demonstration of black cumin technologies was carried in Goro and Ginnir districts during main season in 2014/15 Ethiopian cropping year with objective of evaluating the newly released varieties under farmers' condition in order to create awareness for further pre-scaling up. The new variety (Keneni) was planted with Gemechis variety on plot size of 10 m*10 on 10 farmers' field in which similar agronomic practices were applied. Based on the result of t-test the new variety (Keneni) gave higher yield of 12.18 qt/ha with standard deviation of 1.15 while the standard check, Gemechis, gave 9.52 quintals per hectare with standard deviation of 1.14. The yield difference between Keneni and Gemechis varieties is statistically significant at less than 1 % significance level. Direct matrix ranking was carried out to identify the variety of their interest. Accordingly, farmers gave the highest score for Keneni variety based on the varietal traits set during focus group discussion. The financial analysis also depicts producing Keneni variety is economically more profitable than Gemechis variety. Therefore, based on farmers' preference Keneni variety is recommended for further pre-scaling up.

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Pre-extension Demonstration of Coriander Technologies in Bale and East Bale Zones

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Abstract

The trial was carried during 2013/14 Ethiopian main cropping season in Goro and Ginnir districts with the objective of evaluating the newly released variety under farmers' condition applying full recommended agronomic packages. It was implemented on 10 (ten) trial farmers' field on plot size of 100 m^2 using FRG approach. Training, filed visit and mini-field days were used as technology demonstration and evaluation methods. Data were collected using measurements and group discussion. Descriptive statistics were used to analyze the collected quantitative data while summarization was used to present the qualitative data. Accordingly, the result of t-test depicts that the new variety (Gadisa) gave higher yield of 11.26 qt/ha with standard deviation of 2.96 while the standard check, Weltei, gave 9.48 quintals per hectare with standard deviation of 3.21. Gadissa variety is relatively more stable variety because its yield evaluation indicates lower standard deviation than Weltei. However, the statistical result indicated that yield difference between the two varieties is not statistically significant. Moreover, Gadissa variety has yield advantage of 18.78 % and it is 24.9% feasible than the standard check (Weltei). Farmers also selected Gadissa variety due to it has higher number of branch/plant, higher number of head/plant, higher number of seed/head and tolerant to disease. The profitability analysis reveals, farmer who prefer to produce Gadissa variety than Weltei could get extra net profit of 12,220 (ETB). Considering farmers' preference and its profitability, Gadissa variety is recommended for pre-scaling up

Key Words: *Coriander, Farmers' preference, FRG approach, Profitability, Pre-extension demonstration*

Introduction

Coriander (Coriandrum sativum L.) belongs to the family Umbelliferae (Diedrichsen and Hammer, 2003). In Ethiopia, it is known by different local names i.e. dembilal in Amharic and debo/shucar in A/Oromo (Jansen, 1981). Coriander seed is widely used as a spice in diversified societies of the country. In addition the leaves and the immature fruits are used as an ingredient for the preparation of ''data'' (Diederichsen, 1996). It is also used in honey bee production due to its high nectar.

Despite, there are very limited improved varieties of coriander in Ethiopia. Except a few efforts undertaken by Debrezeit Agricultural research center, the crop has no research attention. By understanding the existing research gap, Sinana Agricultural Research Center had released one improved variety of coriander namely Gadisa. Gadisa variety was released in 2019 with yield potential of 15-33 qt/ha. Gadisa variety has yield advantage of 16% over weltai (standard check). Therefore, undertaking pre-extension demonstration of Gadisa variety with full package required for coriander production is important to build farmers' confidence about the technology for wider scaling up.

Objectives

The current study was initiated with the following objectives.

- To evaluate yield performance and profitability of improved coriander technologies under farmers' condition
- To create awareness on the importance of improved coriander technologies
- To collect farmers' feedbacks on improved coriander technologies

Materials and Methods

Site and Farmers Selection

The study was carried out in Goro and Ginnir districts of Bale and East Bale zones. These districts were purposively selected due to they are a niche to spices production. Based on potential and accessibility, two kebeles were selected from each district. Accordingly, the trial was implemented in four kebeles. Farmer selection for establishing FRG was carried out in collaboration with DAs and the farmers themselves. One FRG, with 15-20 members, was established in each kebele. From one FRG, two to three trial farmers were selected. During trial farmer selection, farm accessibility and farmers' willingness were considered. Accordingly, a total of ten (10) trial farmers were selected for implementation of the study.

Materials and Field Design

The study was carried out using a simple plot design of 10m*10m in which one improved variety of Coriander (Gadisa) and one standard check (Weltai) were planted side by side. Recommended seed rate of 12 kg ha^{-1} was used for both varieties. Row planting was applied with the spacing of 30 cm between rows. Fertilizer also was applied with the recommended rate of 100 kg NPS per hectare. Moreover, twice hand weeding was carried out for both varieties to control weed infestation at proper time.

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. Training on capacity building (by SARC multidisciplinary team) was given for FRG member farmers and agricultural experts (DAs, supervisors and SMSs) before, mid and at the end of the demonstration process 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 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 charge of this activity.

Types of data collected

Types of data collected include number of farmers who participated during training, mini-field day and field visits, yield data, production 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.

Methods of Data Collection and Analysis

Methods of data collection were simple interview schedule, measurements and focus group discussion (FGD). The collected quantitative data were analysed using descriptive statistics such as mean and standard deviation. T-test also used test the yield difference between the two coriander varieties. On the other hand, the collected qualitative data were presented using summarization technique. Furthermore, yield advantage and technology index were calculated to identify the relative advantage and feasibility of the introduced new variety over the standard check.

Accordingly, it will be calculated using the following simple formula.

i. The yield advantage of new variety = $\frac{\text{Yield of new variety-yield of standard check}}{\text{Yield of standard check}} * 100$

ii. Technology Index = $\frac{\text{Potential yield-Demonstration yield}}{\text{Potential yield}} * 100$

Result and Discussion

Yield Performance of demonstrated Coriander Varieties

Combined yield performance analysis of coriander varieties was carried out over location using t-test. The result of analysis depicts higher yield performance for Gadissa variety which gave 11.26 quintals per hectare with standard deviation of 2.96 while the standard check (weltai variety) gave 9.48 quintals per hectare with standard deviation of 3.21 (Table 1). However, the statistical result indicated that yield difference between the two varieties is not statistically significant.

Table 1: Yield evaluation of Coriander varieties under farmers' condition

Variety	Yield obtained (Qt/ha)		Standard deviation	t-value
	N	Mean		
Gadissa (new variety)	10	11.26	2.96	1.295
Weltai (standard check)	10	9.48	3.21	

Moreover, yield advantage and technology index of the demonstrated coriander varieties were calculated to identify the relative advantage and feasibility of the introduced new variety over the standard check. Accordingly, the yield advantage and technology index of the new variety of coriander (Gadissa) over the standard check (Welati variety) were 18.78% and 24.9%, repectively (Table 2).

Table 2: Yield advantage of Gadissa variety over the standard check

No.	Variety	Yield ($qtha^{-1}$)	Yield advantage (%)	Technology Index (%)
1	Gadissa (new variety)	11.26	18.78	24.9
2	Weltai (standard check)	9.48		

Awareness Creation

To create awareness on the importance of coriander technologies multidisciplinary training was given on agronomic practices required for coriander production, postharvest practices and the importance of FRG approach in technology demonstration and evaluation process for a total of 51 participants from which 40 of them were farmers and the remaining 11 participants attributed for agricultural experts (Table 3).

Table 3: Participants of training given on coriander technologies

District	Farmers		Total	DAs		SMS		Total
	Male	Female		Male	Female	Male	Female	
Goro	35	5	40	3	3	4	1	11
Total participants 40 + 11 = 51								

Mini-field day

Mini-field days were organized to enhance variety demonstration and evaluation in which a total of 24 farmers and four (4) experts were participated.

Table 4: Participants of Mini-field day on Coriander Technologies

Kebele	Number of farmers participated			Number of Experts participated		
	Male	Female	Total	Male	Female	Total
Weltai Gobu	10	0	10	2	0	2
Bale Anole	14	0	14	1	1	2
Total	24	0	24	3	1	4

Farmers' Preference

During mini-field day, farmers were enhanced to evaluate and select the demonstrated coriander varieties using their own selection criteria. Accordingly, farmers evaluated the new variety with the standard check where they mainly focus on important criteria such as number of branch per plant, number of head per plant, number of seed per head, disease tolerance and days to maturity. Based on these major criteria, farmers selected Gadisa variety at first stage (Table 5).

Table 5: Farmers' varietal presence

Varieties	Rank	Reason
Gadisa	1st	• Higher number of branch/plant, • Higher number of head/plant • Higher number of seed/plant • Tolerant to disease
Weltai	2nd	• Relative early maturity

Profitability Analysis

The profitability analysis shows farmers who prefer to produce Gadisa variety could get total revenue of 78,820.00 birr whereas those who prefer to produce Weltei variety could get 66,360.00 birr. Similarly, the net profit obtained by producing Gadisa variety in one growing season per hectare is 24,975.00 birr while the net profit of Weltei variety is 12,755.00 in a single production season per hectare. Likewise, benefit-cost ratio for the two varieties was calculated and the result revealed that 1.46 and 1.23 for Gadisa and Weltai varieties, respectively. Thus, farmers who prefer to produce Gadisa variety than Weltei could get the net profit of 12,220.00 Ethiopian birr in single production season per hectare. Since, the value of benefit-cost ratio is greater one producing the two varieties is economically profitable.

Table 6: Profitability analysis of demonstrated coriander varieties

Variables	**Varieties**	
	Keneni	**Gemeshis**
Yield obtained ($qtha^{-1}$)	11.26	9.48
Sale price (ETB/qt)	7,000.00	7,000.00
Total Revenue (Price * Qt)	78,820.00	66,360.00
Variable Cost		
Land preparation (tractor rent)	3000	3000
Seed purchase	1600	1400
Fertilizers purchase (NPS)	3975	3975
Cost of Insecticide	2100	2100
Cost of labor for weeding	4200	4200
Labor cost for insecticide spray	2450	2450
Cost of Labor for harvesting	2100	2100
Cost of labor for threshing	4200	4200
Store (bag purchase)	220	180
Total Variable Costs (ETB/ha)	23,845.00	23,605.00
Fixed costs		
Cost of Land	30,000	30,000
Total cost (TVC + TF C)	53,845.00	53,605.00
Gross Margin (GM)=TR-TVC	54,975.00	42,755.00
Net Profit=TR-TC or GM-TFC	24,975.00	12,755.00
Benefit-cost Ratio=Total Revue/TC	1.46	1.23

Conclusion and Recommendations

The result of descriptive analysis revealed that Gadissa variety gave higher average yield performance over location than weltei. Gadissa variety gave 11.26 quintals per hectare with standard deviation of 2.96 while the standard check (weltei variety) gave 9.48 quintals per hectare with standard deviation of 3.21. Gadissa variety is relatively more stable variety because its yield evaluation indicates lower standard deviation than Weltei. However, the statistical result indicated that yield difference between the two varieties is not statistically significant. Moreover, Gadissa variety has yield advantage of 18.78 % and it is 24.9% feasible than the standard check (Weltei). Farmers also selected Gadissa variety due to it has higher number of branch/plant, higher number of head/plant, higher number of seed/head and tolerant to disease. The profitability analysis reveals, farmer who prefer to produce Gadissa

variety than Weltei could get extra net profit of 12,220 (ETB). Considering farmers' preference and its profitability, Gadissa variety is recommended for pre-scaling up.

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