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Pre-extension Demonstration of Improved Food Barley Varieties in Bale and West Arsi Zones

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Abstract

Pre-extension demonstration of improved food barley varieties was conducted in Sinana and Agarfa districts of Bale Zone and Dodola district of West Arsi Zone. The main objective of the study was to demonstrate and evaluate recently released (Adoshe) variety along with standard check. The demonstration was under taken on single plot of 10mx10m area for each variety with row planting, recommended seed rate of 120kgha^{-1} and fertilizer rate of 100/50kgha $^{-1}$ NPS/UREA. Mini-field day involving different stakeholders was organized at each respective site. Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the demonstrated varieties was identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Adoshe variety performed better than the standard check (Robera variety) with an average yield of 32.25qtha^{-1} and 25.88qtha^{-1} respectively. Adoshe variety had 24.61% yield advantage over the standard check. Furthermore, this variety was selected by farmers. Thus, Adoshe variety was recommended for further scaling up.

Key words: Demonstration, food barley, Adoshe, Farmers' preference, selection criteria

Introduction

Barley is the fourth most important cereal crop in the world after wheat, maize, and rice, and is among the top ten crop plants in the world. Globally, European Union, Russian Federation, Ukraine, Turkey and Canada are the top five largest world barley producers where, On the African continent, Morocco Ethiopia, Algeria, Tunisia and South Africa were the top five largest barley producers (Samuel, 2016). Barley has a long history of cultivation in Ethiopian highlands (Eticha *et al*. 2010).

Among 10,358,890.13 hectares of land covered by cereal crops in Ethiopia barley shares 811,782.08 hectares of land and a total of 17,675,184.47 quintals were produced with average production of 21.77 quintals per hectare during 2018/2019 (2011 E.C) production season. In Oromia 386,569.22 ha of land was covered by barley and 9,325,076.44 quintals were produced with average production of 24.12 quintal per hectare (CSA, 2019). Similarly, in Bale Zone and West Arsi Zones 44,929.97ha and 63,085.81 ha and 1,108,131.50 and 1,882,627.79 quintals were produced with average production of 24.66 29.84 quintals per hectare respectively (CSA, 2017).

Besides, its potential productivity is limited by lack of sufficient improved food barley varieties. Moreover, low use of recommended full packages is also another yield limiting factor. Developing high yielding, disease tolerant and stable varieties that can meet increasing food demand of the growing human population, improve the income and livelihood of farmers are very important. Consequently, one improved food barley variety **(Adoshe**) recently released by Sinana Agricultural Research Center in 2017/18 copping season with full recommended packages for production. **Adoshe** has 15-42qt/ha yield potential with 15.6% yield advantage over standard check (**Biftu**) and 28.1% over local check (**Aruso**). It has moderate resistant to barley shoot fly.

Thus, undertaking participatory demonstration, evaluation, validation and dissemination of improved food barley technologies with the participation of farmers and other stakeholders for sustainable production and productivity is important.

Objectives

- To evaluate the yield performance of food barley varieties under farmers' condition in Bale and West Arsi Zones;
- To create awareness on the importance of food barley varieties among farmers, DAs, SMSs and other participant stakeholders;
- To collect farmers' feedbacks on food barley varieties for further development of food barley technologies;

Methodology

Description of the study area

The activity was conducted in Sinana and Agarfa districts of Bale Zone and Dodola district of West Arsi Zone, Oromia National Regional State (ONRS), Ethiopia. Bale and West Arsi Zones are among the 20 Administrative Zones located in South Eastern parts of Oromia, Ethiopia.

Site and farmers selection

The trail was implemented in Dodola district of West Arsi Zone, and Sinana and Agarfa districts of Bale Zone. Two PAs from Dodola and Sinana districts and one PA from Agarfa district were selected based on their accessibility and production potential of the crop**.** Farmers were selected based on having suitable and sufficient land to accommodate the trials, and willingness to contribute the land. Accordingly, one representative trial farmer from each PAs of Dodola district and two representative trial farmers from each PAs of Sinana and Agarfa districts were selected.

Materials used and Field design

Improved variety, Adoshe was demonstrated with Robera (standard check). Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full packages were applied in which, row planting with 20 cm between rows, Seed rate of 120 kg per hectare and

fertilizer rate of 100/50kg of NPS/UREA per hectare was applied. Twice hand weeding was done.

Data collection

Data were collected using direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Farmers' preference to the demonstrated varieties was identified.

Data analysis

Descriptive statistics was used to analyze the yield data. Pair wise ranking was used to compare traits of demonstrated varieties.

Farmers' variety evaluation and selection

Farmers have a broad knowledge based on their environments, crops and cropping systems built up over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger, 2000). The task of variety evaluation and selection was made by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Consulting the intended end users to assess which quality/ies of a particular variety they desire is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Accordingly, the task of variety evaluation and selection was carried out at Sinana, Agarfa and Dodola districts.

Focused Group Discussion (FGD)

Before leading the participant farmers and experts to focus group discussion, brief orientation was given to the evaluators on why variety/technology evaluation and selection is necessary in research process. Then evaluators were grouped in to small manageable groups (by selecting one group leader) and encouraged to set their own criteria to select the demonstrated varieties in order of their preference, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their respective group leaders.

Table 1: participants of variety selection

Districts	Farmers				Others	Total
	Men	Women	Youth	Total		
Sinana	14	1	10	25	6	31
Agarfa	16	1	9	26	6	32
Dodola	18	5	12	35	6	38
Total	48	6	31	85	18	103

Result and Discussion

Yield performance of Demonstrated varieties

The mean yields of demonstrated varieties of food barley collected from all sites were summarized in the following table.

Table 2: yield performance of the demonstrated varieties

District	PA	Yield obtained ($Qtha^{-1}$)	
		Adoshe	**Robera**
Sinana	Selka	35.5	32.5
	Gamora	37	29
	Mean	36.25	30.75
Agarfa	Ilani	28.5	22.9
Dodola	Ketchema Ch.	30.86	22.47
	Deneba	33.14	25.53
	Mean	32	24
Overall mean		32.25	25.88
Yield advantage over standard check		24.61%.	-

The demonstration result revealed that, the new variety (Adoshe) performed better than the standard check (Robera variety) all over the demonstration sites. It gave higher yield at all locations. The mean yield of Adoshe variety was 36.25$qtha^{-1}$, 28.5qt^{-1} ha, and 32$qtha^{-1}$ at Sinana, Agarfa and Dodola, respectively with all over mean yield of 32.25 $qtha^{-1}$. Similarly, the mean yield of Robera variety was 30.75 $qtha^{-1}$, 22.9$qtha^{-1}$, and 24$qtha^{-1}$ at Sinana, Agarfa and Dodola respectively with all over mean yield of 25.88 $qtha^{-1}$ (table 2). The yield advantage of Adoshe over Robera is 24.61%.

Table 3: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties Adoshe	Robera
1.	Yield obtained (qtha^{-1})	32.25	25.88
2.	Sale price (ETB/qt)	1800	1800
3.	Gross Returns (Price X Qt) TR	58050	46584
4.	Land preparation	4200	4200
	Seed purchase	2160	2160
	Fertilizers purchase (NPS)	1400	1400
	Fertilizers purchase (UREA)	600	600
	Herbicide purchase	1000	1000
	Labor for spray	400	400
	Insecticide purchase	600	600
	Labor for spray	400	400
	Fungicide purchase	800	800
	Labor for spray	200	200
	Combiner rent	3900	3140
	Packing, Loading and store	330	260
	Store (bag purchase)	330	260
	Total Variable Costs TVC (ETB/ha)	16320	15420
5.	**Fixed cost**	8000	8000
6.	**Total cost (TC)**	24320	23420
7.	**Net Return (GR-TC)**	33730	23164
8.	**Benefit cost ratio (NR/TC)**	1.39	0.99

As shown in the above table (table 3) the cost benefit ratio analysis showed that, the net return gained from Adoshe and Robera varieties was 33730 birr and 23164 birr per hectare, respectively. Adoshe variety had higher cost benefit ratio (1.39) than Robera variety (0.99). This means, Adoshe variety is more profitable than Robera variety with the same cost expenditure for both varieties per unit area.

Table 4: Result of Independent sample t test

	Test for Equality of Variances		**t-test for Equality of Means**				
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	.150	.718	1.916	4	.128	6.37	3.32

The independent sample t test showed that, there was no statistically significant difference between the mean yield of Adoshe and Robera varieties. But there was a mean difference of 6.37qtha^{-1} between both varieties (table 4).

Farmers' preference to demonstrated varieties

The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Table 5: Pair wise ranking result to rank variety traits in order of importance

Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, seed/spike and suitability for mechanization were the top three priority concern given by farmers (table 5).

No	Variety traits	A	B	C	D	E	F	Frequency	Rank
1	A							4	2nd
2	B	A						1	5th
3	C	A	C					2	4th
4	D	A	D	D				3	3rd
5	E	A	B	C	D			0	6th
6	F	F	F	F	F	F		5	1st

A=Seed/spike, B=crop stand, C= lodging resistant D=suitable for mechanization, E= seed size, F=yield.

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

Varieties were ranked based on the farmers' preference criteria. Their preference criteria were almost similar in all locations.

No	Variety	Rank	Reason
1	Adoshe	1st	Seed/spike, good crop stand, resistant to lodging, suitable for combiner harvester because of its stand and late maturity, high yielder, bigger seed size.
2	Robera	2nd	Susceptible to lodging, poor crop stand, not suitable for mechanization due to its poor stand and early maturity.

Conclusions and Recommendations

Pre extension demonstration and evaluation of food barely varieties was carried out on eight (8) representative trial farmers' fields. Improved variety viz. *Adoshe* was demonstrated along with Robera variety which is the standard check. Accordingly, Adoshe gave higher yield than Robera variety.

Moreover, Adoshe was selected by participant farmers in all districts due to it has higher number of seed/spike, good crop stand, resistant to lodging, suitable for combiner harvester because of its stand and late maturity, high yielder and bigger seed size. Based on these facts, Adoshe variety was recommended for further scaling up.

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Pre-extension Demonstration of Improved Maize Varieties in Potential Districts of Bale Zone

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Abstract

Pre-extension demonstration of improved maize varieties was conducted in Sinana and Gassera districts of Bale zone. The main objective of the study was to demonstrate and evaluate improved (Jibat) variety along with Local check. The demonstration was under taken on single plot of 10mx10m area for each variety. Row planting was used with the spacing of 25cm and 75cm between plants and rows respectively. The recommended fertilizer rate of 100/100 kgha^{-1} NPS/UREA was used. Mini-field day involving different stakeholders was organized at each respective site. Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the demonstrated varieties was identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Jibat variety performed better than the local check with average yield of 60.67qtha^{-1} and 47.72qtha^{-1} respectively. Jibat variety had 27.24% yield advantage over local check. Furthermore, this variety was selected by farmers. Thus, Jibat variety was recommended for further scaling up.

Key words: *Demonstration, Farmers' preference, Maize, Jibat, Selection criteria*

Introduction

Maize (Zea mays L.) is the third important cereal crop globally after wheat and rice (FAO, 2011). Out of the total grain crop area, 81.39% (10,358,890.13 hectares) was under cereals. Teff, maize, sorghum and wheat took up 24.17% (about 3,076,595.02 hectares), 18.60% (about 2,367,797.39 hectares), 14.38% (1,829,662.39 hectares) and 13.73% (1,747,939.31 hectares) of the grain crop area, respectively. Cereals contributed 87.97% (about 277,638,380.98 quintals) of the grain production. Maize, teff, wheat and sorghum made up 30.08% (94,927,708.34 quintals), 17.12% (54,034,790.51 quintals), 15.33% (48,380,740.91 quintals) and 15.92% (50,243,680.72 quintals) of the grain production, respectively (CSA, 2019).

In Oromiya out of 4,858,959.99 ha covered by cereal crops 1,324,274.98ha of land was covered by maize and 54,383,119.44quintals were produced with average production of 41.07quintls per hectare. (CSA, 2019). Similarly, in Bale Zone, 33,951.98 hectares of land was covered by maize and 1,083,848.72 quintals were produced with average yield 31.92 quintals per hectare during 2016/2017 (2008) main production season. The average production yield of Bale Zone is below the national productivity which is 36.75 quintals per hectare. (CSA, 2017).

In order to overcome this problem it is important to develop new improved varieties suitable for the area. Consequently, adaptation of recently released improved maize variety called Jibat was undertaken by SARC and recommended for Bale high lands. Therefore, this activity was initiated to demonstrate and validate this variety under farmers' management condition.

Objectives

- To evaluate the yield performance of maize varieties under farmers' condition in Bale zone;
- To create awareness on the importance of maize varieties among farmers, DAs, SMSs and other participant stakeholders;
- To collect farmers' feedbacks on maize varieties for further development of maize technologies;

Methodology

Description of the study area

The activity was conducted in Sinana and Gassera districts of Bale Zone, Oromia National Regional State (ONRS), Ethiopia. Bale Zone is among the 20 Administrative Zones located in South Eastern parts of Oromia, Ethiopia.

Site and farmers selection

Districts were selected purposely based on the potential of the crop. Three PAs from Sinana and one PA from Gassera district were selected based on their accessibility and production potential of the crop**.** Farmers were selected based on having suitable and sufficient land to accommodate the trials, and willingness to contribute the land. Accordingly, two representative trial farmers were selected from each PA.

Materials used and Field design

Improved variety, Jibat was demonstrated with local check. Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full packages were applied in which, row planting with 25cm and 75 cm between plants and rows respectively. Recommended fertilizer rate of 100/100kg of NPS/UREA per hectare was applied. Twice hand weeding was done on time.

Data collection

Data were collected using direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Farmers' preference to the demonstrated varieties was identified.

Data analysis

Descriptive statistics was used to analyze the yield data. Pair wise ranking was used to compare traits of demonstrated varieties.

Farmers' variety evaluation and selection

Farmers have a broad knowledge based on their environments, crops and cropping systems built up over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger, 2000). The task of variety evaluation and selection was made by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Consulting the intended end users to assess which quality/ies of a particular variety they desire is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Accordingly, the task of variety evaluation and selection was carried out at Sinana and Gassera districts.

Focused Group Discussion (FGD)

Before leading the participant farmers and experts to focus group discussion, brief orientation was given to the evaluators on why variety/technology evaluation and selection is necessary in research process. Then evaluators were grouped in to small manageable groups (by selecting one group leader) and encouraged to set their own criteria to select the demonstrated varieties in order of their preference, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their respective group leaders.

Table 1: participants of variety selection

Districts	**Farmers**				**Others**	**Total**
	Men	**Women**	**Youth**	**Total**		
Sinana	22	-	10	32	5	37
Gassera	21	2	12	35	5	40
Total	43	2	22	67	10	77

Result and Discussion

Yield performance of Demonstrated varieties

The mean yield of demonstrated varieties of Maize collected from all sites were summarized in the following table.

Table 2: yield performance of the demonstrated varieties

District	PA	Yield obtained (Qt ha^{-1})	
		Jibat	**Local**
Sinana	Shallo	60.45	48.94
	Hisu	62.36	49.06
	Hayko	68.29	52.09
	Mean	63.7	50.03
Gassera	Nake Negewo	57.64	45.41
Overall mean		60.67	47.72
Yield advantage over local check		27.24%	-

The demonstration result revealed that, the new variety (Jibat) performed better than the Local check all over the demonstration sites. It gave higher yield at all locations. The mean yield of Jibat variety was 63.7qtha^{-1} and 57.64 qtha^{-1} at Sinana and Gassera, respectively with all over mean yield of 60.67 qtha^{-1}. Similarly, the mean yield of Local variety was 50.03 qtha^{-1} and 45.41qtha^{-1} at Sinana and Gassera, respectively with all over mean yield of 47.72qtha^{-1} (table 2). The yield advantage of Jibat over Local is 27.24%.

Table 3: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties Jibat	Local
1.	**Yield obtained (qt/ha)**	60.67	47.72
2.	**Sale price (ETB/qt)**	1000	1000
3.	**Gross Returns (Price X Qt) TR**	60670	47720
4.	Land preparation	4200	4200
	Seed purchase	250	250
	Fertilizers purchase (NPS)	1400	1400
	Fertilizers purchase (UREA)	1200	1200
	Labor for weeding	2000	2000
	Insecticide purchase	300	300
	Labor for spray	200	200
	Labor for harvesting	1500	1400
	Labor for threshing	1500	1400
	Packing, Loading and store	610	480
	Store (bag purchase)	610	480
	Total Variable Costs TVC (ETB/ha)	13770	13310
5.	**Fixed cost**	8000	8000
6.	**Total cost (TC)**	21770	21310
7.	**Net Return (GR-TC)**	38900	26410
8.	**Benefit cost ratio (NR/TC)**	1.79	1.24

As shown in the above table (table 3) the cost benefit ratio analysis showed that, the net return gained from Jibat and Local varieties was 38900 birr and 26410 birr per hectare, respectively. Jibat variety had higher cost benefit ratio (1.79) than Local variety (1.24). This means, Jibat variety is more profitable than Local variety with the same cost expenditure for both varieties per unit area.

Table 4: Result of Independent sample t test

	Test for Equality of Variances		**t-test for Equality of Means**				
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	236702775440866	.000	3.399	2	.077	12.95	3.81012

As shown in table 1 independent sample t test revealed that, there was statistically significant difference between the mean yield of Jibat and Local varieties at 10%. Similarly, there was a mean difference of 12.95 $qtha^{-1}$ between the yields of both varieties.

Farmers' preference to demonstrated varieties

The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Table 5: Pair wise ranking result to rank variety traits in order of importance

Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, cob/plant and seed/cob were the top three priority concern given by farmers (table 5).

No	**Variety traits**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Frequency**	**Rank**
1	A									6	2nd
2	B	A								5	3rd
3	C	A	B							1	7th
4	D	A	B	D						3	5th
5	E	E	E	E	E					7	1st
6	F	A	B	F	D	E				2	6th
7	G	A	B	C	D	E	F			0	8th
8	H	A	B	H	H	E	H	H		4	4th

A=number of cobs/plant, B=seed/cob, C=early maturity, D=frost tolerance, E=yielder, F= Seed size, G=seed color, H=non availability of infertile plant.

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

Varieties were ranked based on the farmers' preference criteria. Their preference criteria were almost similar in all locations.

No	Variety	Rank	Reason
1	Jibat	1st	Higher number of cobs/plant, seed/cob, early mature, high yielder, more tolerate frost, bigger seed size, good seed color, non-availability of infertile plant.
2	Local	2nd	Lower number of cobs/plant, late mature, low yielder, less tolerate frost, smaller seed size, available infertile plant

Conclusions and Recommendations

Pre extension demonstration and evaluation of maize varieties was carried out on eight (8) representative trial farmers' fields. Improved variety viz. *Jibat* was demonstrated along with local check. Accordingly, Jibat gave higher yield than Local variety.

Moreover, Jibat was selected by participant farmers in all districts due to it has higher number of cobs/plant, seed/cob, early mature, high yielder, more tolerate frost, bigger seed size, good seed color and non-availability of infertile plant. Based on these facts, Jibat variety was recommended for further scaling up.

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Pre-extension Demonstration of Improved Sesame Varieties in Dalo Manna District of Bale Zone

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Abstract

Pre-extension demonstration of improved sesame varieties was conducted in Dalo Mana district of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Abasena) variety along with standard check. The demonstration was under taken on single plot of 10mx10m area for each variety with row planting, recommended seed rate of 5kgha^{-1} and fertilizer rate of 100kgha^{-1} NPS. Mini-field day involving different stakeholders was organized at each respective site. Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the demonstrated varieties was identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Abasena variety performed better than the standard check (Serkamo variety) with an average yield of 5.65 qtha^{-1} and 4.69qtha^{-1} respectively. Abasena variety had 20.47% yield advantage over the standard check. Furthermore, this variety was selected by farmers. Thus, Abasena variety was recommended for further scaling up.

Key words: *Demonstration, Farmers' preference, sesame, Abasena, Selection criteria*

Introduction

Sesame (Sesamum indicum L.) is an oilseed crop generally cultivated on small holdings by poor-resource farmers in the tropics. The crop was first grown in the middle belt of Nigeria in the late 1940s following the mandate given to West African Oilseeds Mission to investigate the possibility for the production of groundnut and other oilseeds (Idowu, 2002). Major sesame production areas in Ethiopia are located in the Humera area in the Tigray, in the Metema and Wollo areas of the Amhara region, in the Chanka area in Wellega of the Oromiya region and in the Pawi area in the Benshangul Gumuz region. (FAO, 2015)

Oilseeds refer to crops which are also classified within grain crops category, nonetheless. Oilseeds are grown to flavour the food consumed at home and earn some cash for peasant holders in the country. Oil seeds added 5.88% (about 747,803.78 hectares) of the grain crop area and 2.49% (about 7,850,196.94 quintals) of the production to the national grain total. Neug, sesame and linseed covered 2.03% (about 257,950.40 hectares), 2.32% (about 294,819.49 hectares) and 0.66% (about 83,626.93 hectares) of the grain crop area and 0.94% (about 2,963,227.47 quintals), 0.64% (about 2,016,646.44 quintals) and 0.31% (about 966,855.92 quintals) of the grain production, respectively (CSA, 2019).

In Oromiya 23,065.90 ha of land was covered by Sesame and 158,598.34 quintals were produced with average production of 6.88 during 2018/19 (2011) main production season. (CSA, 2019). In order to increase the productivity of sesame developing and promoting of improved varieties is very important. Therefore, this activity was initiated to demonstrate and validate improved and adapted sesame varieties in potential areas.

Objectives

- To evaluate the yield performance of sesame varieties under farmers' condition in Bale zone;
- To create awareness on the importance of sesame varieties among farmers, DAs, SMSs and other participant stakeholders;
- To collect farmers' feedbacks on Sesame varieties for further development of sesame technologies;

Methodology

Description of the study area

The activity was conducted in Dalo Manna district of Bale Zone, Oromia National Regional State (ONRS), Ethiopia. Bale Zone is among the 20 Administrative Zones located in South Eastern parts of Oromia, Ethiopia.

Site and farmers selection

The trail was implemented in in Dalo Manna district of Bale Zone. One PA was selected from the district based on accessibility and production potential of the crop**.** Farmers were selected based on having suitable and sufficient land to accommodate the trials, and willingness to contribute the land. Accordingly, two representative trial farmers were selected from the PA.

Materials used and Field design

Improved variety, Abasena was demonstrated with standard check (Serkamo variety). Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full recommended packages were applied. Twice hand weeding was done.

Data collection

Data were collected using direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Farmers' preference to the demonstrated varieties was identified.

Data analysis

Descriptive statistics was used to analyze the yield data. Farmers' preference to the varieties was assessed by ranking method.

Farmers' variety evaluation and selection

Farmers have a broad knowledge based on their environments, crops and cropping systems built up over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger, 2000). The task of variety evaluation and selection was made by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Consulting the intended end users to assess which quality/ies of a particular variety they desire is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Accordingly, the task of variety evaluation and selection was carried out at Dalo Mana district.

Focused Group Discussion (FGD)

Before leading the participant farmers and experts to focus group discussion, brief orientation was given to the evaluators on why variety/technology evaluation and selection is necessary in research process. Then evaluators were grouped in to small manageable groups (by selecting one group leader) and encouraged to set their own criteria to select the demonstrated varieties in order of their preference, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their respective group leaders.

Table: participants of variety selection

Districts	Farmers				Others	Total
	Men	Women	Youth	Total		
Dalo Manna	22	2	10	34	5	39

Result and Discussion

Yield performance of Demonstrated varieties

The mean yield of demonstrated varieties of Sesame collected from all sites were summarized in the following table.

Table 2: yield performance of the demonstrated varieties

District	Farmer	Yield obtained ($Qtha^{-1}$)	
		Abasena	Serkamo
Dalo Manna	F1	5.47	4.43
	F2	5.83	3.95
	Mean	5.65	4.69
Yield advantage over standard check		20.47%	-

The demonstration result revealed that, the new variety (Abasena) performed better than the Standard check (Serkamo variety) all over the demonstration sites. It gave higher yield at both locations. The mean yield of Abasena and Serkamo varieties were 5.65$qtha^{-1}$ 4.69$qtha^{-1}$ respectively (table 2). The yield advantage of Abasena over standard check is 20.47%.

Table 3: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties Abasena	Serkamo
1	Yield obtained ($qtha^{-1}$)	5.65	4.69
2	Sale price (ETB/qt)	3800	3800
3	Gross Returns (Price X Qt) TR	3805.65	3804.69
4	Land preparation	2200	2200
	Seed purchase	228	228
	Fertilizers purchase (NPS)	600	600
	Fertilizers purchase (UREA)	600	600
	Labor for weeding	1200	1200
	Insecticide purchase	300	300
	Labor for spray	100	100
	Labor for harvesting and threshing	500	500
	Packing, Loading and store	60	50
	Store (bag purchase)	60	50
	Total Variable Costs TVC (ETB/ha)	5848	5828
5	Fixed cost	5200	5200
6	Total cost (TC)	11048	11028
7	Net Return (GR-TC)	10422	6794
8	Benefit cost ratio (NR/TC)	0.94	0.62

As shown in the above table (table 3) the cost benefit ratio analysis showed that, the net return gained from Abasena and Local varieties was 10422 birr and 6794 birr per hectare, respectively. Abasena variety had higher cost benefit ratio (0.94) than Local variety (0.62). This means, Abasena variety is more profitable than Local variety with the same cost expenditure for both varieties per unit area.

Farmers' preference to demonstrated varieties

The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria.

Table 5: Rank of the varieties based on farmers' selection criteria

Varieties were ranked based on the farmers' preference criteria. Their preference criteria were almost similar in all locations.

No	Variety	Rank	Reason
1	Abasena	1st	High yielder, higher number of branched/plant, higher number of capsule/plant, higher number of seed/capsule, but rate maturity period.
2	Serkamo	2nd	Low yielder, lower number of branch/plant, lower number of capsule/plant, lower number of seed/capsule, but early maturity period.

Conclusions and Recommendations

Pre extension demonstration and evaluation of Sesame varieties was carried out on four (4) representative trial farmers' fields. Improved variety viz. *Abasena* was demonstrated along with standard check. Accordingly, Abasena gave higher yield than Local variety.

Moreover, Abasena was selected by participant farmers in all districts due to it is high yielder, has higher number of branch/plant, higher number of capsule/plant, higher number of seed/capsule, but, it has rate maturity period. Based on these facts, Abasena variety was recommended for further scaling up.

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Pre-scaling up of Improved Fenugreek Varieties in Potential Districts of Bale Zone

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Abstract

*Pre scaling up of improved and widely selected Fenugreek varieties was carried out at Goro and Ginnir districts of Bale Zone using two recently released (Burka and Hundaol) improved varieties. The main objective of the study was to make wider awareness on improved Fenugreek varieties. The activity was under taken on simple plot design of 32x32m (one midde) area for each variety with full recommended packages. Field day was arranged to create awareness and farmers shared experience and knowledge on fenugreek. Participant farmers were very interested with both Burka and Hundaol***.** *Furthermore, after such pre-scaling up activities, the wider scaling up/out activities should be owned and handled by extension organizations in collaboration with other key actors in the area including SARC. The genuine participation and interaction of relevant stakeholders on different promotional events organized during pre-scaling up activities should be increased so that Fenugreek value chain should be strengthened and strong linkage between farmers and agro-industries will created.*

Key words: *Pre scaling up, fenugreek, Burka, Hundaol*

Introduction

Fenugreek is mainly cultivated in India, Argentina, Egypt, Morocco, Southern France, Algeria, Ethiopia and Lebanon (Kakani *et al*., 2014). In Ethiopia, Fenugreek is one of the seed condiments grown for income generation and for flavoring purposes in solo or being intercropped with other crops (Fufa, 2013). In Ethiopia, 32,587.00 hectare of land was covered by fenugreek and a total of 436,373.92 quintals were produced with average productivity of 13.39 quintal per hectare. In Oromiya 16,418.43 hectare of land was covered by fenugreek and a total of 214,598.86 quintals were produced with average productivity of 13.07 quintal per hectare in 2017/2018 (2010) production season (CSA, 2018).

Ethiopia has suitable environmental condition for fenugreek production. However, the productivity of fenugreek is very low as compared with world average due to lack of stable, high yielding, and disease resistant genotypes (Mohamed B et al, 2016). The gap between current production and consumption levels could only be closed by expansion of improved fenugreek technologies through institutional innovation, making the research and extension system problem solving, demand-driven and client oriented for efficient distribution of the technologies among the end users.

Thus, developing high yielding, disease tolerant/resistant and stable variety/ies that can meet increasing demand of spice market, improve the income and livelihood of farmers are very important. Consequently, participatory on farm demonstration and evaluation of improved fenugreek technologies were carried out. At the end of the demonstration process Burka and Hundaol varieties were selected by farmers among the demonstrated improved fenugreek varieties. The yield potential (demonstration yield) of Burka was 9.3qtha^{-1} and 11.44qtha^{-1} respectively. The yield advantage of Burka over local check is 13.76% and 30.73% respectively. Hence, the task of pre-scaling up is important to disseminate Burka variety of fenugreek to potential districts.

Objectives:

- To create wider awareness and demand on selected improved fenugreek varieties in the targeted districts.
- To collect farmers' feedback on provided fenugreek for future technology generation.

Methodology

Description of the study area

The research was carried out at Goro and Ginnir districts of Bale zone, Oromia National Regional State (ONRS), Ethiopia. Bale is among the 20 Administrative zones located in south eastern parts of Oromia, Ethiopia.

Site and farmers selection

Purposive sampling methods were employed to select the districts based on the potential of the crop. Two PAs from each district were selected based on accessibility or vicinity to the road. Appropriate site and interested participant farmers were selected based on sufficient land and willingness. The activity was done on a total of 16 trial farmers.

Materials used and Field design

Two recently released improved Fenugreek varieties and widely selected by farmers during demonstration (**Burka and Hundaol**) were planted on the plot size of **32mx32m (1 midde).** The varieties were treated with full recommended fenugreek production and management packages.

Data collection and Data Analysis

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Farmers' feedback to the varieties was identified. Descriptive statistics was used to analyze the yield data.

Roles and responsibility sharing among actors for implementation of the activity

Cost-sharing participatory approach was used in this technology promotion in which hosting farmers provide their land without expecting compensation from Sinana Agricultural Research Center (SARC). Thus, one midde of plot size 32m x 32m was given by each trial farmer for the activity. SARC was the source of agricultural inputs (Seed and fertilizers). Besides, hosting

farmers agreed up on providing and covering the costs of farm inputs like agro-chemicals such as fungicides and insecticides needed during the implementation of the activity. The distributed initial seed was used as **revolving seed** to reach other farmers in the area. This system is a relatively good low-cost system that can maintain kind, quantity, quality and access (at right time, place and reasonable price) of the seed to a level satisfactory to neighboring farmers locally.

All farm operations and field management were also handled by the trial/hosting farmers with follow up/regular visit of SARC. Regular supervisions, monitoring and evaluation of the activity was under taken by SARC.

Field Day organized

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

Feedback and result of focused group discussion (FGD)

Participant farmers were very interested with Burka and Hundaol. Both of them are high yielder, disease tolerant, has good tillering capacity, higher number of pods/plant and good seed color. Good awareness and confidence were created among stakeholders about Burka and Hundaol variety (demand pull). Burka and Hundaol varieties were stable across locations. Farmer-to-farmers seed exchange mechanisms were designed to access seed of Burka and Hundaol for interested farmers in the area.

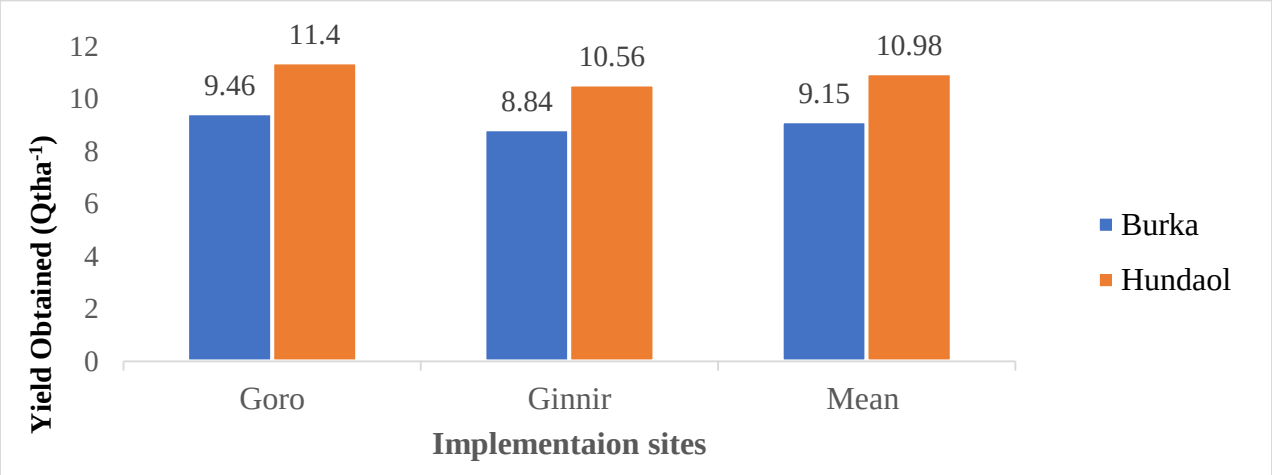
Communication Methods Used

Appropriate extension approaches (**participatory**) and all extension teaching methods were employed alone or in a judicious combination according to the situations during the implementation of the activity such as telephone (fixed and/or mobile), field visit or experience sharing, supervision, monitoring and evaluation, group meeting and discussion session, field day (to bring mass mobilization).

Result and Discussion

Yield Performance

The mean yield obtained from Goro and Ginnir districts were summarized in the graph below.



As indicated in the above graph the mean yield of Burka variety was 9.45 quintals per hectare and 8.84 quintals per hectare at Goro and Ginnir districts respectively with over all mean of 9.15 quintals per hectare. Similarly, Soressa variety gave the mean yield of 11.4 quintals per hectare and 10.56 quintals per hectare at Goro and Ginnir districts respectively with over all mean of 10.98 quintals per hectare.

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled by Agriculture and Natural Resource Office (ANRO) in collaboration with other key actors in the area and with close supervision by Sinana Agricultural Research Centre (SARC).Thus, in order to access the seed locally the selected varieties (Burka and Hundaol) will be multiplied at least on one hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (cereals and pulses and oil crops). Popularization of the varieties will be made on different extension/promotional events and during field Day that will be organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone Agricultural Development Partners Linkage Advisory Council (ADPLAC) annual meeting (in January 2020) and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Conclusion and Recommendations

Pre-scaling up of improved Fenugreek varieties was undertaken in the main season (Bona) in 2019/2020 at Goro and Ginnir districts of Bale zone. Two recently released improved Fenugreek varieties and widely selected by farmers during demonstration (**Burka and Hundaol**) was planted on the plot size of **32mx32m (1 midde).** The varieties were treated with full recommended Fenugreek production and management packages.

Mini Field day was arranged to create awareness and farmers shared experience and knowledge on fenugreek. Participant farmers were very interested with **Burka and Hundaol.** They are high yielder, disease tolerant, has good tillering capacity, higher number of pods/plant and good seed color.

Furthermore, after such pre-scaling up activities, the wider scaling up/out activities should be owned and handled by extension organizations in collaboration with other key actors in the area including SARC. The genuine participation and interaction of relevant stakeholders on different promotional events organized during pre-scaling up activities should be increased so that Fenugreek value chain should be strengthened and strong linkage between farmers and agro-industries is created.

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Pre-scaling up of Improved Black cumin Varieties in Potential Districts of Bale Zone

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Abstract

Pre scaling up of improved and widely selected Black cumin varieties was carried out at Goro district of Bale Zone using two recently released (Gemechis and Soressa) improved varieties. The main objective of the study was to make wider awareness on improved Black cumin varieties. The activity was under taken on simple plot design of 32x32m (one midde) area with recommended full package. Mini Field day was arranged to create awareness and farmers shared experience and knowledge on black cumin. Regular joint monitoring and evaluation (follow up actions) and provision of technical advice were undertaken at different crop stages based on necessary emerging knowledge/skill and technical advice needs. Participant farmers were very interested with ***Gemechis and Soressa.*** *Both varieties are high yielder,* drought tolerant, disease tolerant, have high number of branch/plant, good seed quality and good crop stand. *Furthermore, after such pre-scaling up activities, the wider scaling up/out activities should be owned and handled by extension organizations in collaboration with other key actors in the area including SARC. The genuine participation and interaction of relevant stakeholders on different promotional events organized during pre-scaling up activities should be increased so that Black cumin value chain should be strengthened and strong linkage between farmers and agro-industries is created.*

Key words: *Pre scaling up, black cumin, Gemechis, Soressa*

Introduction

Black Cumin (*Nigella sativa* L.) is a member of Apiaceae (Umbelliferae). This species is originated in Egypt and East Mediterranean, but is widely cultivated in Iran, Japan, China and Turkey (Shewaye, 2011). Ethiopia is one of the east African countries which produce and exports various spices to other countries. Black cumin is an important spice crop which is mainly produced by Ethiopian small holder farmers for medicinal value, commercial purpose, and flavorings of food items. It is an important stiff annual flowering plant which mainly grows by producers for its seeds (Abebe B. et al, 2020).

Black cumin occupy an important role in food flavors, perfumes and for preparation of medicine. However, diseases are major limiting factors for the cultivation and production of these plants in many agro-ecologies of the country (Merga J, et al, 2018). An increasing demand of black cumin seed and oil in local, national and international market for medicinal, consumption and commercial purpose makes the best alternative crop for small holder farmers in Ethiopia. In spite of its importance, not much has been done to improve its production and productivity in Ethiopia. (Abebe B. et al, 2020).

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

Consequently, participatory on farm demonstration and evaluation of improved black cumin technologies were carried out. At the end of the demonstration process farmers were selected Soressa and Gemechis varieties among the demonstrated improved black cumin varieties due to drought tolerance, high number of branch/plant, high number of seed/branch, disease tolerant, good uniformity, good plant height, good seed quality and good crop stand. The yield potential (demonstration result) Soressa and Gemechis varieties were 15.125 $qtha^{-1}$ and 14.57$qtha^{-1}$ respectively. The yield advantage of Soressa and Gemechis over local check was 36.52%and 30.73% respectively. Hence, the task of pre-scale up the selected variety with farmers' participation and other stakeholders is important.

Objectives:

- To create wider awareness and demand on selected improved Black cumin varieties in the targeted districts.
- To collect farmers' feedback on provided Black cumin for future technology generation.

Methodology

Description of the study area

The research was carried out in Goro district of Bale zone, Oromia National Regional State (ONRS), Ethiopia. Bale is among the 20 Administrative zones located in south eastern parts of Oromia, Ethiopia.

Site and farmers selection

Purposive sampling methods were employed to select the districts based on the potential of the crop. One PA from Goba and Sinana districts and two PAs from Dodola district were selected based on accessibility or vicinity to the road. Appropriate site and interested participant farmers were selected with the active participation of development agents (DAs) found in the participant PAs. The activity was done on a total of 10 trial farmers.

Materials used and Field design

Two recently released improved Black cumin variety and widely selected by farmers during demonstration (**Gemechis and Soressa**) was planted on the plot size of **32mx32m (1 midde).** The variety was treated with full recommended Black cumin production and management packages of 120kg/ha seed rate and fertilizer rate of 100/50kg/ha NPS/UREA.

Data collection and Data Analysis

Both qualitative and quantitative data were collected using appropriate data collection methods such as direct field observation/measurements, key informant interview and focused group discussion (FGD). Yield data per plot in all locations were recorded. Farmers' feedback to the variety was identified. Descriptive statistics was used to analyze the yield data.

Roles and responsibility sharing among actors for implementation of the activity

Cost-sharing participatory approach was used in this technology promotion in which hosting farmers provide their land without expecting compensation from SARC. Thus, one midde of plot size 32m x 32m was given by each trial farmer for the activity. SARC was the source of agricultural inputs (seed and fertilizers). Besides, hosting farmers agreed up on providing and covering the costs of farm inputs like agro-chemicals such as fungicides and insecticides needed during the implementation of the activity. The distributed initial seed was used as **revolving seed** to reach other farmers in the area. This system is a relatively good low-cost system that can maintain kind, quantity, quality and access (at right time, place and reasonable price) of the seed to a level satisfactory to neighboring farmers locally.
All farm operations and field management were also handled by the trial/hosting farmers with follow up/regular visit of SARC. Regular supervisions, monitoring and evaluation of the activity was under taken by SARC.

Field Day organized

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

Feedback and result of focused group discussion (FGD)

Participant farmers were very interested with **Gemechis and Soressa.** They are high yielder, drought tolerant, disease tolerant, have high number of branch/plant, good seed quality and good crop stand Good awareness and confidence were created among stakeholders about **Gemechis and Soressa** variety (demand pull). **Gemechis and Soressa** is stable across locations. Farmer-to-farmers seed exchange mechanisms were designed to access seed of **Gemechis and Soressa** for interested farmers in the area.

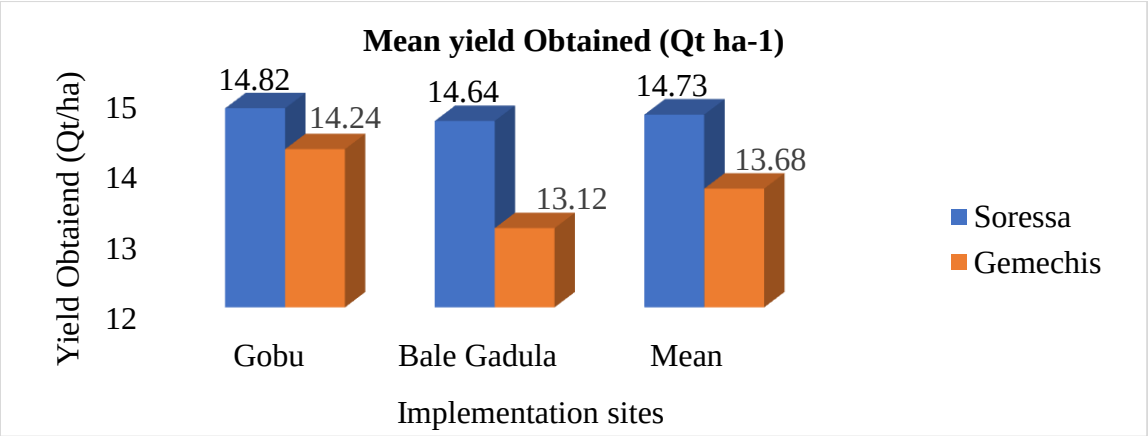
Communication Methods Used

Appropriate extension approaches (**participatory**) and all extension teaching methods were employed alone or in a judicious combination according to the situations during the implementation of the activity such as telephone (fixed and/or mobile), field visit or experience sharing, supervision, monitoring and evaluation, group meeting and discussion session, field day (to bring mass mobilization).

Result and Discussion

Yield Performance

The mean yield obtained from Goro district was summarized in the graph below.



As shown in the above graph the maximum yield of black cumin varieties Soressa and Gemechis was obtained from Gobu PA with 14.82 quintals per hectare and 14.24 quintals per hectare respectively. Similarly, the yield obtained from Bale Gadula PA was 14.64 quintals per hectare and 13.12 quintals per hectare for Soressa and Gemechis varieties respectively. The mean yield of Soressa was 14.73quintals per hectare and Gemechis was 13.68 quintals per hectare.

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled by Agriculture and Natural Resource Office (ANRO) in collaboration with other key actors in the area and with close supervision by Sinana Agricultural Research Centre (SARC).Thus, in order to access the seed locally (Gemechis and Soressa) will be multiplied at least on one hectare by trial/hosting farmers who already obtained the seed in clustering approach by integrating different technologies and other commodities (pulses and oil crops). Popularization of the variety will be made on different extension/promotional events and during field Day that will be organized by ANR Offices in the main cropping season. Furthermore, this report was presented on Bale Zone Agricultural Development Partners Linkage Advisory Council (ADPLAC) annual meeting (in May 2019) and tried to link relevant stakeholders (SARC, ANRO, Farmers, Cooperatives, Unions, OSE-Bale Branch, Private Dealers, NGOs and others) for sustainable seed supply.

Conclusion and Recommendations

Pre-scaling up of improved Black cumin varieties was undertaken in the main season (Bona) in 2018/2019 at Goro district of Bale zone. Two recently released improved Black cumin varieties and widely selected by farmers during demonstration (Gemechis and Soressa) was planted on the plot size of 32mx32m (1 midde). The variety was treated with full recommended Black cumin production and management packages.

Mini Field day was arranged to create awareness and farmers shared experience and knowledge on black cumin. Participant farmers were very interested with Gemechis and Soressa. They are high yielder, drought tolerant, disease tolerant, have high number of branch/plant, good seed quality and good crop stand.

Furthermore, after such pre-scaling up activities, the wider scaling up/out activities should be owned and handled by extension organizations in collaboration with other key actors in the area including SARC. The genuine participation and interaction of relevant stakeholders on different promotional events organized during pre-scaling up activities should be increased so that Black cumin value chain should be strengthened and strong linkage between farmers and agro-industries is created.

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

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Abstract

Rice is among the major cereal crops cultivated in Ethiopia nowadays next to teff, maize, wheat and sorghum. Considering this the demonstration and evaluation of rice technologies was conducted in Kellam Wollega Zone. Two varieties (Chawaka and Kokit) were used for the demonstration and evaluation trial on farmers' field under their management condition. The total area of 100 m^2 was used for each variety. Necessary data were collected from demonstration plots and were analyzed using simple descriptive statistics. Participatory variety evaluation and selection techniques were used. During PVES farmers' preferences feedbacks were collected and analyzed using pair wise and matrix rankings. During field visit, rice producer farmers were invited in the demonstration field to evaluate the performance of the verities setting their own criteria. In the ranking, chawaka was selected as the best-preferred variety than both the local and kokit varieties. The result indicates that chewaka provided average yield of 47.35 qt/ha while kokit and local varieties provided 22.10 qt/ha and 29.52 qt/ha, respectively. The yield advantage of 60.33 % and 114 % were obtained from chawaka over the local and kokit varieties, respectively. On the other hand, the local variety had yield advantage of 33.57 % over kokiet variety. Chewaka variety was preferred and selected first by farmers for its higher yield, high tillering capacity, most disease tolerance , medium finger number, white color and preferred at the market with good price which can be considered as a promising variety to be widely produced by rice producer farmers in the study area. Thus, offices of agriculture and research centers need to provide technical support to the farmers through different educational and extension method to reduce the extension gap.

Keywords: Demonstration, Evaluation, Rice Technology, FRG

Introduction

In Ethiopia, agriculture is the leading sector which contributes to nearly 36. 7% of GDP. It also serves as the main source of food and generates 88.8% of the foreign exchange earnings. Crop productions contribute the lion share, according to the report of CSA (2018). From the total cultivated area, a larger area (90%) was covered by grain crops (cereals, pulses, and oilseeds). Rice is among the major cereal crops cultivated in Ethiopia nowadays next to teff, maize, wheat and sorghum. It was introduced in the 1970s and since has been cultivated in different parts of the country. Although rice has just been recently introduced to Ethiopia, recognizing its importance as a food security crop and a source of income, and employment opportunities, the government of Ethiopia has named it the "millennium crop," and has ranked it among the priority commodities of the country. The potential rain-fed rice production area in Ethiopia is estimated to be about thirty million hectares based on GIS techniques and rice agro-ecological requirement (Tamirat and Jember, 2017). The area covered by rice during 2007 was 24,434 hectares rose to nearly 53,106 hectares in 2017 and the production from 713,160 quintals to

1,510, 183 quintals. At the same time, the number of rice farmers increased from 61,862 to more than 161,376 (CSA, 2007; 2018).

Ethiopia has a huge potential for rice production especially, in the area of the Gambella region, the Fogera plain around Lake Tana and Benshangul Gumuz Regional state. However, the productivity of the crop is very low (28.44 qt/ha) compared to the global average (CSA, 2018). In Kellam Wolega, the crop was introduced in 1985 during the resettlement program and establishment of HSARC agricultural research center (Dawit *et al.,* 2018). Currently, Kelam Wolega zone is one of the rice-producing areas, and it is considered as the major crop and cultivated by smallholder farmers for household consumption (injera, bread and alcoholic drinks) mixing either with teff, sourgum, finger millet and maize. It is also used as a cash crop and source of animal feed.

According to the report of Kellam Wolega zone agricultural office (2020), the total land used for rice production and the total yield over the period of 2014-2020 is increasing. This shows even if the rice has been recently introduced to the area, recognizing its importance as a food security crop and a source of income, the area coverage, production and productivity is increasing. Considering this in to account, Haro Sebu agricultural research center had conducted rice adaptation trial and released the most performed high-yielding and disease-tolerant rice varieties of chewaka and kokit. Based on this on farm demonstration and evaluation of these varieties was conducted on the farmers' field to promote the newly released varieties and evaluate them under farmers condition.

Objective

- To evaluate the productivity and profitability of the improved rice varieties under farmers' management practice.
- To increase the farmers' awareness toward the importance of rice in affording food security.

Methodology

Description of the Study Area

The trial was conducted selecting two districts of Kellam Wolega Zone.

Dale sadi district

Dale Sadi is a district which is located at east of Kellam Wollega Zone. It has borders with Illubabor to the South, Sadi Chanka and Dale Wabera in the west, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of 1150 meters above sea level. It is situated at about 550 km West of Addis Ababa. The area has temperature range of 30-35°C with more agricultural crops and people in rural of the country. The climatic condition alternates seasons from March to April. The winter dry seasons (November to February) with mean annual rain fall of 1200 mm.

Sadi Chenka

Sadi chanka is one of the districts of Kellam Wollaga zone. The district located at distance of 570 km west of Addis Abeba city. It has borders with Illubabor to the South, Dale Sadi to the east and Dale Wabera to the north, Hawa Gelan to the west directions. The district was separated from Dale Wabara districts in 2008/2016. The area has average altitude of 1145 meters above sea level and temperature range of 33-35°C with more agricultural crops and people in rural areas. The climatic condition alternates seasons from March to April.

Materials used

Two selected varieties of rice; Chawaka and Kokit were demonstrated and evaluated with previously under cultivating variety (which is considered as a local) on farmers' fields under their management condition.

Site and farmer selection

For this demonstration, two districts were selected based on rice production potentials from Kellam Wollega zone. Before starting field work, formation of FRG (farmers research group) were made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices (timely weeding and harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables.The trial was conducted selecting three hosting farmers from each FRG and the total of twenty farmers from each kebele was participated.

Table 1. Composition of FRG Members

No	District	Kebeles	Number of FRGs	Member of FRGs		Trial farmers	
				Male	Female	Male	Female
1	Dale Sadi	Awetu Birbir	1	13	6	3	-
2	Sadi Chanka	Mender 5	1	11	5	3	-
Total			2	24	11	6	-
Percentage				68.24%	31.58%	100%	-

Field Design

Chawaka and Kokit varieties of rice were planted along with a local check (the one that farmers are using) using an area of 10m x 10m (100m^2) for each variety. The row spacing of 25 cm and seed rate of 80 kg/ha were applied by drilling in the row. Recommended rate of 100 kg of NPS and 50 kg of UREA were also applied.

Data Collection

During this demonstration trial yield data were collected from a total of six (6) trial farmers' fields. Data were collected using direct field observation, focus group discussion, and key informant interviews. The collected data includes both quantitative and qualitative. Thus yield data, farmers selection criteria, economic data, total number of stakeholders participated on extension events such as training, PVS and group discussion were collected and analyzed. Farmer's preferences of the varieties were collected using focus group discussion during the evaluation process.

Data Analysis

The collected yield data were analyzed using simple descriptive statistics. To compare the parameters/traits of the demonstrated varieties, pair wise and simple matrix rankings were used. The yield advantages of the demonstrated varieties were also calculated and identified. In addition to this the economic data were also calculated and presented using table.

Technology evaluation and demonstration methods

Before starting the trial, trainings were made to each FRG members for one day. Participatory variety evaluation and selection were also made to identify the technologies that fit to farmers' needs and condition. In addition to this, different focused group discussions were made to collect farmers feed backs about the demonstrated technologies.

Result and Discussion

Yield Performance and Yield Advantages of the Varieties

Yield Performance

As it is summarized in the below table the mean yield obtained from newly demonstrated varieties and a local check were presented and compared. Accordingly the mean yield of chewaka variety was much higher than the mean yield obtained from kokit and local varieties. The mean yield obtained from chawaka, kokit and local varieties were 47.35 qt/ha, 22.1 qt/ha and 29.52qt/ha, respectively.

Table 2. Mean yield and yield advantage of demonstrated varieties

No	Varieties	Mean yield per hector
1	Chawaka	47.35
2	Local	29.52
3	Kokit	22.10

Yield Advantage of the Varieties

Table 3. Yield advantages of the Demonstrated Varieties

Yield advantage	Percentage
Yield advantage of chawaka over kokiet	114%
Yield advantage of chawaka over local	60.33
Yield advantage of Local over kokit	33.57%

Based on the demonstrated result the yield advantages of the three varieties were calculated using the following formula.

$$\textbf{Yield advantage} = \frac{\textbf{yield of new variety} - \textbf{yield of local vari}\boldsymbol{ety}}{\textbf{yield of local variety}}$$

Accordingly, the result showed that the yield advantage of 60.33 % and 114 % were obtained from chawaka over the local and kokit varieties respectively. On the other hand the yield advantage of local variety over kokiet variety was 33.57 %. Although one of newly demonstrated variety was failed to perform as the variety considered as the local a technology demonstrated yielded better to that of the farmers practice.

Economic Evaluation

The results of cost-benefit ratio analysis of all the three varieties are presented in the following table. As displayed clearly in the table the cost-benefit ratio analysis showed that the net return gained from chawaka, kokit and the local varieties were 35,234.2, 7,145.24, and 14,128.45 birr/ha, respectively. Accordingly the largest cost benefit ratio was obtained from chawaka with magnitude of (2.06) following by local (0.84) variety and lastly by kokit (0.43). These shows as that the chawaka variety is most profitable than the other two varieties. The result also showed that kokit variety was least profitable variety.

Table 3. Cost benefit analysis of the demonstrated varieties

Variables	Unit	Demonstrated Varieties		
		Chewaka	Kokit	Local check
Yield Obtained	Qt/ha	47.35	22.10	29.52
Sale price	Birr/Qt	1200	1200	1200
Gross Return (mean yield in Qt x price	Birr	56,820	26,520	35,424
Land preparation cost and planting	Birr/ha	1890	1890	1890
Seed purchase	Birr/ha	960	960	960
Fertilize purchase	Birr/ha	1565	1565	1565
Labour for weeding and other management	Birr/ha	11,250	11,250	11,250
Harvesting and threshing	Birr/ha	650	650	650
Packing, loading and storing	Birr/ha	770.8	359.76	480.55
Total Variable cost (TVC)	Birr/ha	17,085.8	16,674.76	16,795.55
Fixed cost (FC)	Birr/ha	4500	4500	4500
Total Cost (TVC + FC)	Birr/ha	21,585.8	21,174.76	21,295.55
Net return (GR- TC)	Birr/ha	35,234.2	7,145.24	14,128.45
Benefit cost ratio (NR/TVC)	Birr/ha	2.06	0.43	0.84

Source: Demonstration results of 2019 cropping season

Technology Demonstration and Evaluation Methods

To demonstrate and evaluate the rice technologies training, participatory variety evaluation and selection and group discussions were made.

Trainings:-Although all expected trainings were not given formally during the implementation of the demonstration trial due to the political crisis in the study areas and corona viruses' challenges trainings before establishing the trial and practical training during implementation of the trial were given in each kebeles.

Table 3. Participants of orientation and practical trainings

No	Districts	Farmers		DAs		Total
		Male	Female	Male	Female	
1.	Dale Sedi	13	3	3	-	19
2.	Sedi Chenka	11	5	1	-	17
Total		23	8	4	-	35

Participatory Variety Evaluation and Selection

Participatory variety evaluations and selections were conducted in Awetu Birbir kebele of Dale Sadi and Mender 5 kebele of Sadi Chanka districts at maturity stage of the demonstrated variety.

Table 4. Participants of PVES during Rice Demonstration.

No.	Kebeles	Participants	Gender		Total
			Male	Female	
1	Awetu Birbir	Farmers	13	3	16
		DAs and Supervisors	3	-	3
		Researchers	1	-	1
2	Mender 5	Farmers	11	4	15
		DAs and Supervisors	2	-	2
		Researchers	2	-	2
Total			32	7	39

To identify and select the best varieties among the provided technologies, both FRG members and farmers those had rice producing experience were invited to make important decisions on selection criteria. During PVES, participant farmers were organized to make small groups (not more than eight members in a group) and were asked to make their own selection criteria. This is because farmers have their preference criteria to accept and use a specific variety or technology (Semagn *et al.*, 2017).

Based on this, farmers had set grain yield, disease tolerance, seed size, early maturity, seed color, finger and tiller numbers as their selection criteria. Accordingly farmers selected chewaka variety for its higher yield potential, small seed size, medium maturity, most tolerance to disease, white seed color, optimum finger number and tiller number, and marketability. Next to chewaka farmers preferred their own local varieties for its high yielder, disease tolerance, seed size, than kokit. This result also indicated that although variety kokit was early maturing, larger seed size, early maturing variety than chewaka and the local varieties farmers rejected the variety due to its lower yield potential, susceptibility to disease, and less marketability.

Table 4. Variety traits' pair wise ranking matrix result

Code	Parameters	GY	DT	SS	SC	EM	MP	TC	FN	Frequency	Rank
1	GY	x	1	1	1	1	1	1	1	7	1st
2	DT		x	2	2	2	6	2	2	5	3rd
3	SS			x	4	5	6	7	8	0	7th
4	SC					5	6	4	4	3	4th
5	EM						6	5	8	3	4th
6	MP							6	6	6	2nd
7	TC								8	1	5th
8	FN									3	4th

GY=Grain Yield, DT=Disease Tolerance, Seed Size=SS, SC= Seed color, EM= Maturity, MP=market preference, TC= Tillering Capacity, FN=Finger Number

Table 5. Farmers' preference ranking of the rice varieties based on the above criteria

No	**Varieties**	**Reasons for Its Selection**	**Varieties Rank**
1	Chawaka	Highest yield potential, most tolerance to disease, smaller seed size, relatively early maturity, white seed color, greater finger numbers (6-8), optimum tiller numbers (8-12), medium maturity, and market preference	1st
2	Kokit	Early maturity, Large seed size, least tolerance to disease, relatively white seed color, optimum marketability (better than the local)	3rd
3	Local	Optimum yielder, smaller seed size, relatively disease tolerance than kokit, late maturity, highest tillering capacity (6-13), medium finger numbers(5-6), and least marketability	2nd

Conclusion and Recommendations

In general creating effective awareness for farmers and delivering of technical advices and support to farmers is highly required to improve rice production and productivity. During the demonstration trial, farmers' needs and their preferences were identified. Accordingly farmers preferred and selected the variety with higher yield, most disease tolerant, higher tillering potential, finger number, seed size and color and market preferences.

The overall harvested mean yield of chawaka, kokit and local was 47.35 qt/ha, 22.10 qt/ha and 29.52 qt/ha respectively. Agronomic data and farmers feedback results showed that chawaka and check varieties were selected when compared to the newly demonstrated kokit variety.

Strengthening the pre-extension demonstration, participatory evaluation of newly released rice technologies under farmers' condition is paramount important to make demand driven research and enhance rice production and productivity. To make clear differences on farmers' preferences, the needs of farmers should be considered during development of new technology in order to save resources in terms of preferred variety promotion time and make technology adoption faster.

Based on farmers assessment feedback only one newly demonstrated varieties was selected and recommended for pre-scaling up activity on wider areas in West Wollega and Kellam Wollega zones and similar agro-ecologies.

Thus, further popularization of the demonstrated and selected chawaka variety with its full package should be made on different extension events by both HSARC and Agricultural and Natural Resource Offices at different districts in order to create higher demand for these demonstrated improved rice technologies. To achieve this goal, coordination among stakeholders is paramount important.

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Pre-Extension Demonstration and Evaluation of Finger millet Technologies in West and Kellem Wollega Zones

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Abstract

Pre-Extension demonstration and evaluation of finger millet technologies was carried out to evaluate yield performance of finger millet technologies, create awareness and *analyze cost benefit ratios of newly introduce finger millet technologies in Kellam Wollega and West Wollega Zones. Two varieties (Adis 01, and Meba) were used for the demonstration and evaluation on farmers' field under their management condition on plot area of 100 m^2 for each variety. All data were collected from demonstration plots and yield data and farmers' preferences were analyzed using simple descriptive statistics and matrix rankings respectively. Average yield performances that were obtained from farmers' field were 30.5 qt/ha, 28.3 qt/ha, and 25.83 qt/ha, of Meba, Adis 01 and local varieties respectively. Meba variety showed better yield performance than the other two (Adis-01 and local) varieties. During field visit, finger millet producer farmers were invited in the demonstration field to evaluate the performance of the verities setting their own criteria. In the ranking, meba was selected as the best-preferred variety than both the local and adis-01 varieties. Accordingly meba was ranked first for its higher yield potential, tolerance to disease (head blast), early maturity, plant height, finger size, seed color, and marketability. Thus, offices of agriculture and research centers need to provide technical support to the farmers through different educational and extension method to reduce the extension gap.*

Keywords: Demonstration, Evaluation, finger millet

Back ground & Justification

Finger millet is one of the neglected and underutilized crops of Africa. It is extensively cultivated in the tropical and sub-tropical regions of Africa and India and is known to save the lives of poor farmers from starvation at times of extreme drought (Kotschi, 2006). Finger millet is a dietary staple food crop in potentially drought-exposed regions of the world, and it is immensely considered as an important component in assuring food security. The crops grain posse's excellent storage quality, which can be preserved without any harm for years, confers it a perfect food grain quality. Crop leftovers are an excellent source of dry matter for the livestock, especially in dry seasons. After harvesting, the crop's residue makes good animal feeds and consists of up to 61% total digestible nutrients (National Research Council, 1996). It has the capacity to produce a higher yield than other crops under multiple stresses such as drought, soil acidity, and land marginality (Barbeau and Hilu, 1993). In addition to its drought resistance capacity, the crop has a high nutritional value and excellent storage qualities (Dida et.al, 2007). Indigenous to the highlands of Uganda and Ethiopia, finger millet is widely produced by small scale landholders and consumed locally (Adugna*et al.,* 2011).

In Ethiopia the grain of finger millet is consumed in different forms as food and the straw serves as animal feed, fuel, and to make hats in rural areas. However, the national average grain yield of finger millet is low, 2.01 ton/ha, although it has a potential to yield up to 3 ton/ha (CSA, 2017).

In Oromia region, 93,831.88 hectares of land was covered with finger millet during 2017/18 cropping season with an estimated production not less than 2,195,373.97 Qt with average yield per hectare 23.40 quintals (CSA, 2018). Finger millet is also well known produced crops in west and KelamWolega zones of Oromia region. CSA (2014) reported that the national finger millet production area coverage during the production year of 2013/14 was 454,662.33 hector with average yield of 18.67qt/ha. According to the report finger millet production in Kelam Wollega zone during the 2013/14 cropping season was covered an area of 18,979.47 hectares with an average yield of 19.02 qt/ha. During the same season the area coverage of finger millet in West Wolega was 42,441.39 hectares with average yield of 15.40qt/ha.

In West and Kellam Wollega areas, finger millet is largely produced next to maize, sorghum and pepper and used in addition to human consumption as cash crops (field observation).However varieties of finger millets that have been used by most farmers in West and Kellam Wollega areas were low yielding and less disease resistance. Lower productivity of finger millet is due to lack of stable high yielding and adaptable improved varieties (Bezawuletaw et al., 2006). To solve this problem HSARC had conducted different adaptation trials using different finger millet varieties and selected Meba with average yield of 29.58qt/ha and Addis-01 with average yield of 26.79qt/ha under on station condition while that of check provided yield of 18.03qt/ha. Moreover, no study had conducted on this variety demonstration so far and there is lack of improved finger millet varieties. Therefore, there was the need to demonstrate and popularize these well adapted and high yielding varieties of finger millet in the study area.

Objectives

- To evaluate yield performance of finger millet technologies.
- To analyze the cost-benefit ratio of the demonstrated technologies.
- To assess farmers' and other stakeholders' feedbacks for further technology improvement.
- To create awareness on finger millet technologies.

Methodology

Description of the Study Area

The trial was conducted selecting three districts of the study area. Two districts were selected from Kellam Wollega and one district from West Wollega zones.

Guliso

Guliso is one of 19 districts of West Wollega Zone, with the capital located at 490 km West of Addis Ababa. It has an estimated area of 631.90 square km; it is bounded by Boji Chokorsa in the northeast, Dale Wabara in the west, Aira in the south and south west and Lalo Asabi in the east. Total human population of the district is estimated at 125,471. Of the total households 89.5 % is rural agricultural households (GWAO, 2019). The district has a total of 28 kebeles, of which 26 are rural based peasant associations and 2 are urban kebeles. From total rural passant associations 18 of them categorized to mid-land agro-ecology while 8 kebeles located in lowlands agro-ecology. The district has an annual temperature range of 9^0c-18^0c. It receives average annual rainfall of 720 mm. The altitude of the district varies from 1650 meters to 1700 meters above sea level.

Dale Sadi District

Dale Sadi is a district which is located at east of Kellam Wollega Zone. It has borders with Illubabor to the South, Sadi Chanka and Dale Wabera in the west, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of 1150 meters above sea level. It is situated at about 550 km West of Addis Ababa. The area has temperature range of 30-35°C with more agricultural crops and people in rural of the country. The climatic condition alternates seasons from March to April. The winter dry seasons (November to February) with mean annual rain fall of 1200 mm.

Dale Wabera District

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

Materials

Two selected varieties of finger millets; Meba and Addis-01 were grown side by side on farmers' fields with a local variety as standard checks.

Site and farmer selection

This project was conducted in Dale Sadi district of Kellam and Guliso districts of West Wolega Zones. Accordingly the demonstration was conducted selecting Chamo Kebele of Dale Sadi

district and Moga Kobara kebele of Guliso districts purposively. From each kebele one FRG consisting of 15-20 members was established considering their interest, gender balance, land ownership and other important socioeconomic behavior of the society. Among FRG members three trial farmers were selected purposively.

Design

The total plot area of 10 mx10 m for each variety with row spacing of 40cm was used for this trial. The seed was drilled by the rate of 15 Kg/ha. Recommended fertilizer rate of 50 kg NPS and 50 kg/ha Urea.

Data Collected

In this study both qualitative and quantitative data were used. Therefore, yield data, disease and pest incidence, economic data such as input and management cost incurred and income gained farmers' selection criteria and preference data were collected analyzed. Data were collected by the researcher and development agents of hosting peasant association. Development agents were provided with data recording sheet and oriented on how and when to record data. The collected data were analyzed using simple description statistics like mean and table using SPPS software.

Data Management and Statistical Analysis: SPSS software version 20 was used to analyze the collected yield data. To present the results tables and charts were used. On the other hand farmers' feedback was analyzed using PRA tools pair wise and direct matrices rankings and the results were presented using table.

Technology evaluation and demonstration methods

Before starting the trial, trainings were made to each FRG members for one day. Participatory variety evaluation and selection were also made to identify the technologies that fit to farmers' needs and condition. In addition to this, different focused group discussions were made to collect farmers' feedbacks about the demonstrated technologies.

Result and Discussion

Awareness Creation and Feedback Collection Methods

Training: - although all expected trainings were not given during this demonstration trial due to security and COVID-19 problems short time trainings were given in different locations before establishment of the trial. Accordingly, the total number of 52 peoples, which included 36 male and 10 female farmers with five (5) male and one (1) female DAs were participated.

Table 1. Participants of Trainings by Location

No	Districts	Kebeles	Farmers		DAs		Total
			Male	Female	Male	Female	
1.	Dale Sedi	Camo	12	3	3	-	18
2.	Dale Wabara	Dogonu Bile	11	5	1	-	17
3.	Guliso	M/Kobara	13	2	1	1	17
Total			36	10	5	1	52

Field Day: - even though expected field days could not be arranged at all trial location/sites it was arranged at chamo site due to the known security problems perpetuated in the study areas. On this field day a total of 141 peoples consisting of 119 male and 22 female were participated. The demonstrated technologies were evaluated and selected by participants based their own criteria. All participates that came from different backgrounds and areas were motivated to use and expand both the two newly demonstrated varieties. On this field day important feedbacks were collected.

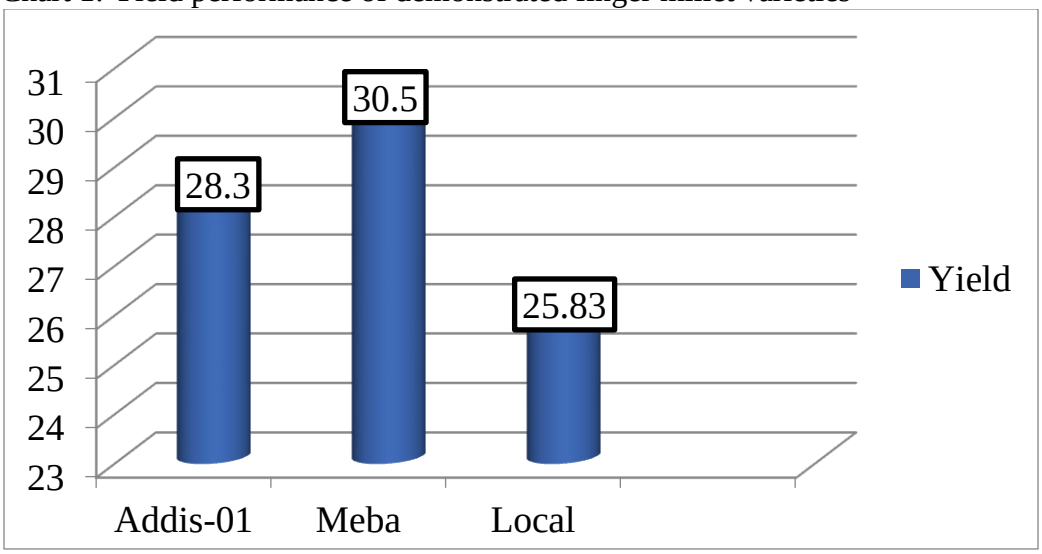
Table 1. Participants of field day at Chamo kebele

Participants	**Gender**		**Total**
	Male	**Female**	
Farmers	64	16	80
DAs and agricultural experts	52	6	58
Others	3	-	3
Sub total	119	22	**141**

Yield Performance and Yield Advantages of the Varieties

During demonstration trial yield data were collected from a total of nine (9) trial farmers' fields over three locations. The obtained average yields of the varieties were presented in the following bar chart. As it has shown on clearly in the following chart Meba variety gave the highest mean yield with magnitude of 30.5 qt/ha following by Addis-01 and Local with magnitude of 28.3 qt/ha and 25.83 qt/ha respectively.

Chart 1: Yield performance of demonstrated finger millet varieties



The Yield Advantage

The yield advantage of each variety was calculated using the following formula.

$$yield\ Advantage = \frac{A - B}{B}\ X\ 100$$

Where A=newly demonstrated variety, B= local check.

Based on this, the yield advantage of Meba over Adis -01 was 7.77 % and the yield advantage of Meba over local check was 18.1%. On the other hand the yield advantage of Addis-1 over local was 9.56%.

Economic Evaluation

The cost-benefit ratio analysis of all the three varieties were calculated and presented in the following table. As displayed clearly in the table the cost-benefit ratio analysis showed that the net return gained from meba, Adis-01 and the local varieties were 15,230, 12,612 and 9,672.7 birr/ha respectively. The largest cost benefit ratio was obtained from meba with magnitude of (**0.90**) following by Adis-01 (0.74) variety and lastly by local (0.57). This shows that meba variety is the most profitable variety than the other two varieties.

Table-3. Cost benefit analysis of the demonstrated varieties

Variables	Unit	Demonstrated Varieties		
		Meba	Adis -01	Local check
Yield gained	Qt/ha	30.5	28.3	25.83
Sale price	Birr/Qt	1200	1200	1200
Gross Return (mean yield in Qt x price	Birr obtained	36,600	33,960	30,996
Land preparation cost and planting	Birr/ha	1890	1890	1890
Seed purchase	Birr/ha	960	960	960
Fertilizer purchase	Birr/ha	1565	1565	1565
Labour for weeding and other management	Birr/ha	11,250	11,250	11,250
Harvesting and threshing	Birr/ha	750	750	750
Packing, loading and storing	Birr/ha	455	433	408.3
Total Variable cost (TVC)	Birr/ha	16,870	16,848	16,823.3
Fixed cost (FC)	Birr/ha	4500	4500	4500
Total Cost(TVC + FC)	Birr/ha	21,370	21,348	21,323.3
Net return (GR- TC)	Birr/ha	15,230	12,612	9,672.7
Benefit cost ratio (NR/TVC)	Birr/ha	**0.90**	**0.74**	**0.57**

Source: Demonstration results of 2019 cropping season

Participatory Variety Evaluation and Selection

Participatory Variety Evaluations and Selections were conducted in Dogonu Bile kebele of Dale Wabara, Chamo kebele of Dale Sadi and Moga Kobara kebele of Guliso districts at maturity stage of the demonstrated variety.

Table 4. Participants of PVS during Finger millet Demonstration.

No.	Kebeles	Participants	Gender		Total
			Male	Female	
1	Dogonu Bile	Farmers	13	3	16
		DAs and Supervisors	3	-	3
		Researchers	1	-	1
2	Chamo	Farmers	11	4	15
		DAs and Supervisors	2	-	2
		Researchers	2	-	2
3	Moga Kobara	Farmers	14	1	15
		DAs and Supervisors	1	1	2
		Researchers	1	-	1
Total			48	9	57

To identify and select the best among the provided technologies farmers were invited to make important decisions on selection criteria. During PVS, participant farmers were organized to make small groups (not more than eight members in a group) and were asked to make their own selection criteria.

Farmers' selection criteria

During implementation of the trial, farmers were informed to set their own selection criteria to identify and select the best varieties that fulfilled their needs. Accordingly, grain yield, seed color, disease tolerance, early maturity, stem length, number of fingers, finger size, grain color and size were common criteria that were used to prefer and select the varieties.

Accordingly the participants selected Meba variety for its higher yield potential, tolerance to disease (head blast), early maturity, plant height, finger size, seed color, and marketability. Next to Meba farmers preferred Adis -01 variety for its medium yielder, seed color, early maturity, medium finger number, head compactness and seed color.

Table 3. Variety traits' pair wise ranking matrix result

Parameters	GY	DT	EM	SC	PH	MP	TC	FN	HC	Frequency	Rank
GY		GY	GY	GY	GY	GY	GY	GY	GY	7	1st
DT			DT	DT	DT	MP	DT	DT	DT	6	2nd
EM				**SC**	EM	MP	TC	FN	HC	1	6th
SC					**SC**	MP	**SC**	**SC**	**SC**	5	3rd
PH						MP	TC	FN	HC	0	7th
MP							MP	MP	**MP**	**7**	1st
TC								FN	TC	1	6th
FN									FN	4	4th
HC										2	5th

GY=Grain Yield, DT=Disease Tolerance, SC= Seed color, EM= Maturity, MP=market preference, TC= Tillering Capacity, FN=Finger Number, PH = plant height, HC = head compactness

Table 5. Farmers' preference ranking of the finger millet varieties

No	**Varieties**	**Reasons for Its Selection**	**Varieties Rank**
1	Meba	Higher yield potential, tolerance to disease, early maturity, white seed color, greater finger numbers, optimum tiller numbers, early maturity, plant height and market preference	1st
2	Adis-01	Medium maturity, least tolerance to disease, relatively white seed color, optimum marketability (better than the local), compatibility of the head	2nd
3	Local	Disease tolerance (head blast), late maturity, highest tillering capacity (6-13), medium finger size and least marketability	3rd

Conclusion and Recommendation

During the demonstration of this trial, grain yield, seed color, disease tolerance, early maturity, stem length, number of fingers, finger size, grain color and size were the best selection criteria identified by the participants. The overall harvested mean yield of meba, Adis-01 and local was 30.5 qt/ha, 28.3 qt/ha and 25.83 qt/ha respectively. Agronomic and farmers feedback data result showed that Meba and Adis-01 varieties were selected when compared to the local variety.
Strengthening the pre-extension demonstration, participatory evaluation of newly released finger millet technologies under farmers' condition is paramount important to make demand-driven research and enhance finger millet production and productivity. Generally, creating effective awareness for farmers and delivering of technical advices and support to farmers is highly required to improve finger millet production and productivity, and bring the targeted impact.

To make clear differences on farmers' preferences the needs of farmers should be considered during development of new technology in order to save resources in terms of preferred variety promotion time and make technology adoption faster. Based on farmers assessment feedback both of newly demonstrated varieties were selected and recommended for pre-scaling up activity on wider plot area in West Wollega and Kellam Wollega zones and similar agro-ecologies. Thus, further popularization of the demonstrated and preferred finger millet technologies should be made on different extension events and field day organized by HSARC and Agricultural and Natural Resource Offices in order to create higher demand for these demonstrated improved bread finger millet technologies. To achieve this goal, strengthening the linkage among stakeholders is paramount important.

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Pre-Extension Demonstration and Evaluation of Food Barley Technology (Hordeum vulgare L.) in West and Kellem Wollega Zones

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Abstract

Pre extension demonstration of food barley varieties was carried out during 2010/11 and 2011/12 E.C cropping season with the objective of evaluating the best performed and preferred food barley varieties under farmer's management condition. The trial was carried out selecting one kebele from each Anfilo, Hawa Gelan and Boji Dirmaji districts and selecting two kebeles from Seyo district. Three improved varieties of food barley (dinsho, abdane and biftu) with a local check were evaluated with full participation of FRG members under their management condition. The best fit variety was selected with the participants. The total of five (5) FRGs which incorporated a total of 59 male and 23 female was established. Each experimental plot had gross area of 100 m^2 and rows spacing of 25 cm were used. All recommended agronomic practices were equally applied to all plots. Yield of varieties were collected and analyzed using descriptive statistics. Accordingly the yield performances of varieties were 28.66 qt/ha, 26.02 qt/ha, 23.96 qt/ha and 21.15 qt/ha for dinsho, abdane, biftu and local respectively. Accordingly, the yield advantage of dinsho over local is 35.5% while the yield advantage of abdane over local is 23.02% and yield advantage of biftu over local is 13.28%. Farmers were enhanced to evaluate the technology using their own criteria. Accordingly they selected dinsho variety as their first choice by its grain yield, disease resistance, finger size and abdane variety secondly by its merits of early maturity, lodging tolerance and biftu and local thirdly and fourthly respectively. Generally based on farmer's preference and objectively measured trait variety dinsho should be scaled up/out in Sayo, Hawa Galan, Anfilo and Bodji Dirmaji districts and similar agro ecology of West and Kellam zones.

Key words: - Demonstration, Food barley, Grain yield, , Pair wise ranking and PRA.

Background and justification

Barley (*Hordeumvulgare* L.), is a member of the grass family, a major cereal grain grown in temperate climates globally. “It is a major crop, grown worldwide and in a wide range of climatic conditions; despite its importance as a crop species, little is known about the population genetics of barley and the effects of bottlenecks, adaptation, and gene flow on genetic diversity within and between landrace populations (Leino and Jenny, 2010; Tanto et al., 2010). Barley has been produced in Ethiopia since ancient time. It has great importance in social and food habit of people .There is two types of barley that farmers grow in Ethiopia, food and malty barley. The majority of barley that farmers grow is food barley and it is the main ingredient for several staple dishes like Enjera (leavened bread), porridge, and bread (Yelamtesfa Firew, 2017). Barley has been used as animal fodder, as a source of fermentable material for beer and certain distilled beverages, and as a component of various health foods. It is used in soups and stews, and in barley bread of various cultures. In Ethiopia, the national average yield of food barley was estimated to be 1.965 and 1.966 t/ha during 2014/15 and 2015/16, respectively. Similarly, average grain yield of 2.228 t/ha (Oromia), 1.20 t/ha (West Wollega zone) and 1.613 t/ha (Kellem Wollega zone) was obtained (CSA,2016), indicating below national productivity of the crop in the zones. Barley grains are commonly made into malt in a traditional and ancient method of preparation. During 2016/17 cropping calendar the crop holds an area 959,273.36 ha from which a total production of 20,249,216.79qts were harvested. Compared with 2015/16 there is an increment of production from 1856042.76 in 2015/16 to 20249216.76 with production difference of 1682174 (CSA, 20016/17).

As a result of this production potential, adaptation trial of improved food barley varieties was made on station and sub sites by HSARC researchers for three years(2007-2009), and released the top promising and adopted varieties for west and Kellem Wollega zones. Moreover participatory on farmers' field evaluation and demonstration of the technology were done in order to taste the feasibility, relative advantage and compatibility of the technology in line with the existing local condition. This could in turn hasten the adoption rate and dissemination of the technology. Accordingly, the two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development. The activity was intended to achieve the following objectives

Objectives of the activity

- To demonstrate and evaluate the productivity of food barley technologies under farmers management conditions.
- To assess farmers’ and other stakeholders’ feedbacks for further technology development/improvement

Methodology

Description of the study area

Field experiment was conducted in Seyo, Hawa Gelan and Anfilo districts of Kellem Wollega and Boji Dirmaji District of West wollega zones for two consecutive years (2010/11-2011/12).

Sayo

Sayo district is located in the south western part of Kellam Wollega Zone & the zonal capital was found in it (Sayo district). Astronomically the district is located between $8^0$12'-$8^0$44' north latitude and $34^0$41'-$35^0$00' east longitude. It is bounded by Gambella Regional State in the south, Ilubabor Zone in the south east, Hawa Galan &Yemalogi Walal districts in the north and east and Anfilo district in the west and North West. The district has a total area of 127,800 km^2.The district generally lies within an altitudinal range of 1300-2000 m.a.s.l. The major rainy seasons in the district include spring (April-May), summer (June-August) and autumn (September-November).

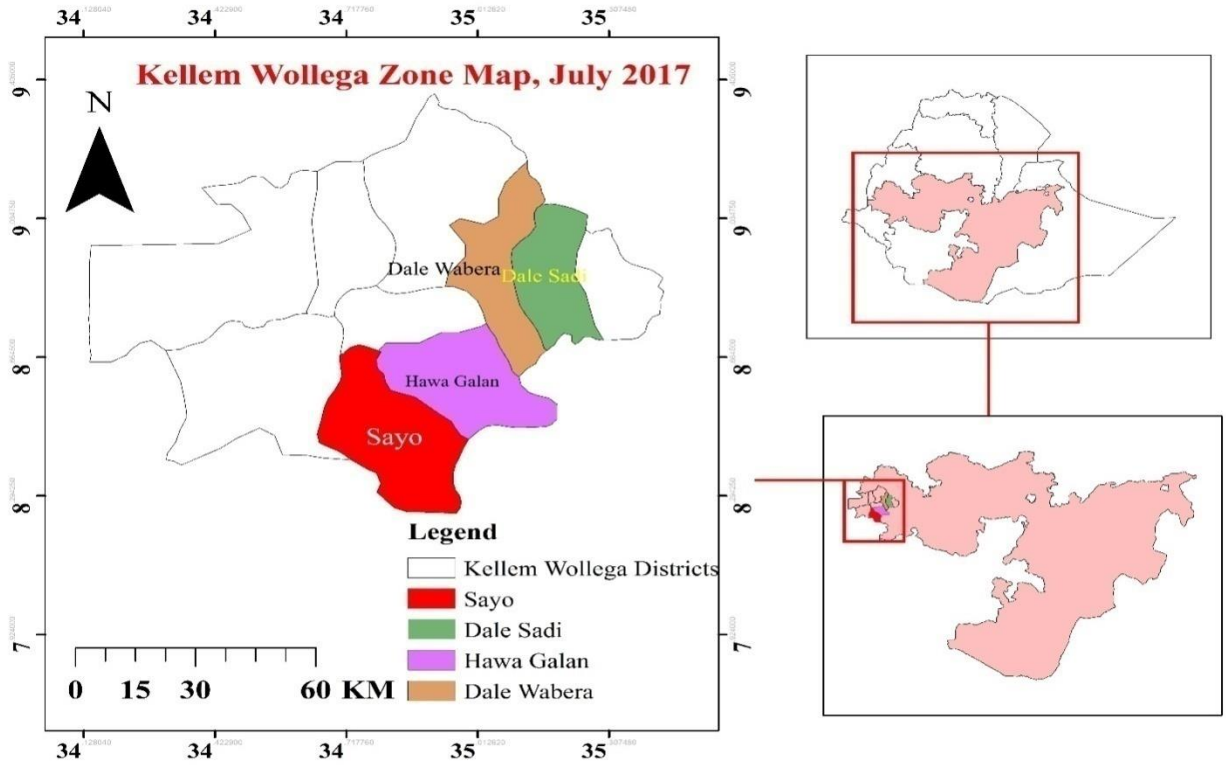
Anfilo

Anfilo district is located in the western part of Oromia regional state & the zonal capital was found in it (Mugi). Astronomically the district is located between $8^0$17'-$8^0$49' north latitude and $34^0$13'-$34^0$46' east longitude. The district generally lies within an altitudinal range of 500-2500 m.a.s.l. The major rainy seasons in the district include spring (April-May), summer (June-August) and autumn (September-November). The administrative center of this woreda is Mugi

Hawa Gelan

Hawa Gelan is one of the woredas in the Oromia Region of Ethiopia. Part of the Kellem Wollega Zone, Hawa Gelan is bordered on the south and southwest by Sayo, on the north by Yemalogi Welele, on the northeast by Dale Wabera, and on the south and southeast by the Illubabor Zone. The administrative center of this woreda is Rob Gebeya. Hawa Gelan was separated from former Hawa Welele woreda. The 2007 national census reported a total population for this woreda of 95,976, of whom 49,312 were men and 46,664 were women; 5,562 or 5.8% of its population were urban dwellers.

Map of Anfilo, Hawa Gelan and Sayo districts with in Kellam Wollega zone



Boji Dirmaji

Boji Dirmaji is one of the woredas in the Oromia Region of Ethiopia. It is part of the West Wollega Zone and a part of former Boji woreda. It is bounded by Benishangul Gumuz Regional state in the north, Nedjo in the west, Boji Chokorsa in the south and Lalo Asabi in the southeast where as Bila is the administrative center of the district.

Site and Farmers Selection

Four potential districts, three districts from Kellem Wollega zone and one district from West Wollega zone were selected purposively based on access to transport service, agro-ecology suitability and Food barley production potential. These Districts were Anfilo, Hawa Gelan and Seyo of Kellem Wollega and Boji dirmaji district of West Wollega. From Anfilo, Hawa Gelan and Boji Dirmaji districts one each kebeles and from Seyo district two representative model kebeles were selected based on their potential for food barley production and accessibility.

A single FRG was established in each operational kebeles considering their interest to cooperate within team, land ownership, gender balance (the participation of male, female and the youth group as well).

Before starting the field work, selection of experimental farmers was done in collaboration with researchers, extension agents and the FRG members by taking in to consideration the farmers' interests and motivation, land ownership, and other important socio-economic aspects

Table1:- Composition of FRG member (2017/18 and 2018/19)

No	**District**	**Kebeles**	**Number of FRGs**	**Member of FRGs**		**Trial farmers**	
				Male	Female	Male	Female
1	Sayo	Tabor	1	12	5	4	2
		H/Karo	1	13	2	3	2
2	H/Gelan	H/Mo'i	1	11	6	2	1
2	Anfilo	Sudi	1	10	5	2	1
	B/Dirmaji	G/King	1	13	5	2	1
Total			5	59	23	13	7
Percentage				71.9%	28.1%	65%	35%

Materials used

Three improved variety of food barley namely; abdane, biftu and dinsho with local check were demonstrated and evaluated by stakeholders. The recommended fertilizer rate of NPS 100Kg/ha and UREA 50 kg/ha was used. The spacing between rows was 20 cm and sowing was done by drilling 100 Kg of seed per hectare. Each experimental plot had 10m x 10m with a gross area of 100 m^2.

Data type and Method of data collection and analysis

Grain yield, farmers' selection criteria and number of stakeholders participated on promotional events like training and field days were objectively measured and analyzed to see the performance of varieties under farmer's management condition. Data were collected both by the researcher and development agents of hosting peasant association. Development agents were provided with data recording sheet and orientation on how to record data since they were nearby to the trial and can frequently supervise the trial. The collected data were analyzed using simple description statistics like mean and table using SPPS software.

Technology evaluation and demonstration methods

Before starting field work training were given on role and responsibility of FRG members and important agronomic practices needed, seed and fertilizer rate and management practice. Participatory technology evaluation and selection methods were employed to demonstrate and evaluate food barley technologies. The demonstrated technology was evaluated using PRA tools like pair wise ranking, focused group discussion & direct matrix rankings.

Result and discussion

Training

Before the trial establishment, orientation on roles of farmers and experts and development agent as well as importance of FRG approach and during trial establishment, practical training on very important agronomic practice such as spacing between row and plant, seed and fertilizer rate and management practice was given to 72 member farmers out of which 50 of them are male and 22 of them are female and also 6 (six) DAs were trained out of which 4 (four) of them are male and 1(one) of them are female. But training that planned to be given to farmers and other stake holders on Necessary packages of Food barley production, marketing and post harvest handling was not given due to severe security problem, limited logistic and occurrence of Corona virus.

Table-2: Training given for farmers, DA's and Experts

Districts	**Participants**	**Male**	**Female**	**Total**
Sayo	Farmers	20	8	28
	DA'S	1	1	2
H/Gelan	Farmers	8	4	12
	DA'S	1	0	1
Anfilo	Farmers	10	5	15
	DA'S	0	1	1
B/Dirmaji	Farmers	12	5	17
	DA'S	2	0	2
Sum		54	24	78
Percentage		**69.23**	**30.77**	**100**

Yield performance of Demonstrated Food Barley varieties

The yield results of the demonstration manifested that dinsho variety superiority over other varieties with magnitude of 28.66 qt/ha followed by abdane, biftu and local with magnitude of 26.02 qt/ha, 23.96 qt/ha and 21.15qt/ha respectively. The yield advantages of dinsho variety over local was 35.5% and whereas, yield advantage of abdane and biftu varieties were 23.02% and 13.28% respectively.

Chart showing yield performance over locations

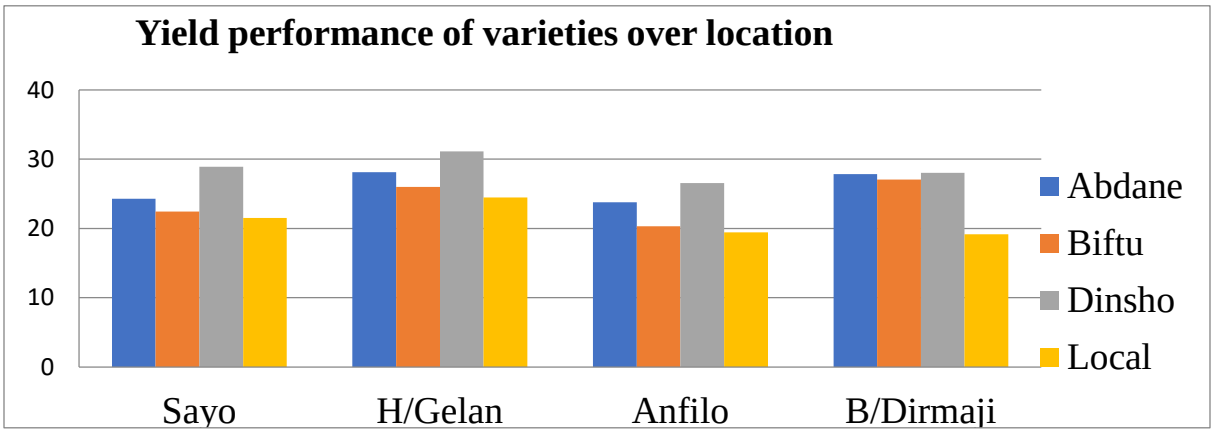


Table 3: Mean Yield performance of demonstrated Food Barley Varieties

Variety	Mean yield qt/ha	Yield advantage over local%
Dinsho	28.66	35.5%
Abdane	26.02	23.02%
Biftu	23.96	13.28
Local	21.15	-

Source: On Farm Demonstration Data

The study found that abdane, biftu and dinsho had shown higher mean values of grain yield and yield advantage over the local check. This demonstration trial indicates that; in all study area dinsho variety gave highest yield than abdane, biftu and local varieties of food barley and in all study area local variety of food barley gave least yield than both those demonstrated improved variety of food barley. Economic cost of production was collected. But since there is no difference in cost of production only the yield advantage of varieties was compared.

Based on this demonstration trial results, farmers get yield advantage of 35.5% when they produce dinsho variety rather than producing the local variety and 23.02% and 13.28% yield advantage than local when produce abdane and Biftu varieties respectively. Therefore, scaling up and popularization of the two identified varieties viz., dinsho and abdane is important to improve food barley productivity in the study areas and other similar agro-ecology of West Wollega and Kellam Wollega Zones.

Participatory Varietal Selection, Preference and Ranking of varieties

Participatory evaluation of the technology by the farmers is another important part of this study. Hence farmers evaluated technology by setting their own criteria, and shown their own way of selecting a variety for their localities. Accordingly different stakeholders (mainly farmers, development agents, and agricultural experts) participated on participatory evaluation and selection. Thus a total of 74 (50male and 24 Female) participants participated on the process at maturity stage. During the assessment farmers were assisted to list their own selection criteria

which may help them to identify best varieties/variety that can fit their demand. These parameters include grain yield, pest tolerance, early maturity, effective tiller per plant, disease tolerance, lodging tolerance, seed color. Accordingly, farmers selected dinsho variety first based on its grain yield, disease tolerance and lodging tolerance and abdane variety selected second and biftu and local thirdly and fourthly respectively. Therefore, based on objectively measured traits and farmers' preferences, dinsho and abdane varieties of food barley were selected in the study areas.

Table 4: Pair wise ranking of varieties by farmers

Traits	GY	**DT**	**LT**	**EM**	**PT**	**SC**	**ETP**	Frequency	Rank
GY	X	GY	GY	GY	GY	GY	GY	6	**1**
DT		X	DT	DT	DT	DT	DT	5	**2**
LT			X	LT	LT	LT	LT	4	**3**
EM				X	EM	EM	EM	3	**4**
PT					X	PT	PT	2	**5**
SC						X	SC	1	
ETP							X	0	**6**

GY=Grain yield, DT=Disease Tolerance, LT=Lodging Tolerance, ETP=Effective Tiller per plant, EM=Early maturity, PT Pest Tolerance, SC= Seed Color

As shown in above table the most important trait among farmers criteria was grain yield, disease tolerance, lodging tolerance, early maturity, pest tolerance and effective tiller per plant of demonstrated food barley variety respectively.

Table 5: Direct Voting Ranking of Varieties

No	**Criteria (N=74)**	**Farmers Preference and ranking of Food barley Varieties**			
		Dinsho	**Biftu**	**Abdane**	**Local**
1	Grain yield	42	5	24	3
2	Early maturity	22	40	8	4
3	Disease Tolerance	35	0	39	0
4	Effective Tiller per plant	26	6	14	28
5	Pest Tolerance	40	11	19	4
6	Lodging Tolerance	53	10	0	11
7	Seed Color	33	0	38	3
	Total	**251**	**72**	142	53
	Percentage	**48.45%**	**13.9%**	**27.41%**	**10.3**%
	Rank	**1**	**3**	**2**	4

As shown in the above table farmers preferred and selected dinsho variety as their first choice when compiled by all criteria of their choice followed by dbdane, Biftu and Local respectively. Generally farmers preferred and ranked variety dinsho first with the total percentage of **48.45%**, bbdane second with **27.41%**, biftu and Local thirdly and Fourthly with the total percentage of **13.9%**, and **10.3**% , respectively.

Lessons Learned

It is well known that farmers do have best indigenous knowledge of their environment and farming practice. Thus demonstration of these food barley varieties gave farmers, researchers and agricultural experts considerable knowledge of food barley production in different ways. Farmers aware and identified and selected/preferred food barley varieties which suited their actual condition while researchers got farmers preference to different traits of food barley technologies which will provide the base for future technology generation.

Conclusion and Recommendation

During pre extension demonstration and evaluation of food barley varieties different stakeholders (which mainly included farmers, experts and researchers) were participated. The yield performances of the varieties were compared and the best performed varieties were identified. The yield performances of the varieties were 28.66 qt/ha, 26.02 qt/ha, 23.96 qt/ha and 21.15qt/ha for dinsho, abdane, biftu and local respectively. The yield advantages of dinsho variety over local was 35.5% and whereas, yield advantage of abdane and biftu varieties were 23.02% and 13.28% respectively. Farmers had listed important selection criteria and selected the variety that fit to their criteria. Accordingly grain yield, disease tolerance, early maturity, pest tolerance, effective tiller per plant capacity, seed color and lodging tolerance were common traits used to enable farmers to prefer demonstrated food barley varieties. Different participatory technology evaluations were used to evaluate the technologies. Among them PVES, Pair wise ranking and direct voting ranking of varieties were used. A total of 74 (20 Female and 54 male) stakeholders evaluated and selected varieties based on their selection criteria. Dinsho variety was selected first by 48.45% of participants and abdane second with total of 27.41% of participants based on the above listed criteria. The feedback collected from stakeholders and identified farmers preferences to the varieties provided a base for technology generation and fasten the rate of adoption of food barley technology.

The participated farmers have now developed a better capacity in identifying best fit varieties and management practices of food barley technology ,thus they should be given the opportunity to share their experience to other farmers thereby strengthen farmers to farmers extension. Those identified farmers' preferences should be taken in to account for further technology development. Generally based on farmer's preference and objectively measured trait dinsho and abdane varieties were recommended to be scale up/out to address many more farmers and popularize these varieties in agro ecology of West Wollega and Kellem Wollega Zones.

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On Farm Demonstration and Evaluation of Maize-haricot bean inter cropping practices in West Wollega and Kellem Wollega Zones

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Abstract

Intercropping is considered as one of crop intensification strategies to increase agricultural productivity per unit area of land. The trial was carried out with the objective of evaluating and identifying profitable and feasible agricultural production method in Kellem and West wollega zone. In this participatory approach, farmers used different criteria to assess the profitability of the demonstrated method at maturity and crop harvesting stages. Major selection criteria included economically preferability, environmentally pleased, labor intensiveness and practicability. Accordingly farmers preferred intercropping of maize and haricot bean than sole cropping method of maize and haricot bean considering economically preferability and environmentally pleased. The combined T-test analysis showed statistically no significant difference for yield of sole maize compared to intercropped maize, but, significant yield difference for haricot bean (P<0.05). The result of the computed land equivalent ratio (LER) indicated that, a total of 1.2130 ha of sole cropping area (maize/haricot bean) would be required to produce the same yield as 1ha of the intercropped area of maize and haricot bean. The partial budget analysis of the demonstrated production method technology indicates that the net benefit that was gained from producing by intercropping maize and haricot bean was higher than the one that obtained from producing sole crop of each commodity. The actual values obtained from intercropping of maize and haricot bean was 30,422.5 ETB whereas the net benefit gained from sole cropping of maize and haricot bean were 29,480 ETB and 22250 ETB respectively. This manifest that using intercropping production method makes more net benefit to farmers over sole cropping of maize and haricot bean by the percent of 3.09% and 26.86% respectively. Training was given to farmers to create awareness on importance of intercropping of the two crops during sowing. Based on objectively measured trait and farmers preference intercropping of maize and haricot bean will be popularized by large scale in west and Kellam wollega zones.

Key words: Demonstration, farmer's preference, intercropping, participation.

Background and Justification

Intercropping is the production of two or more crops simultaneously in both space and time. It is considered as one of crop intensification strategies to increase agricultural productivity per unit area of land. Intercropping is commonly used agricultural cropping practice and is growing more crops. (Tamiru H, 2013). Maize haricot bean intercropping is one of the commonly practiced agronomic practices in Ethiopia. Maize and haricot bean plays key role in human nutrition as a food and economic value for small and large scale farmers. Maize contains many nutrient factors and is highly nutritious (Dahmardeh M. et al 2009). Haricot bean is a good source of protein for people in Ethiopia. One way towards better farming is to look for the most effective associated cropping of leguminous crops with non-leguminous one (Berglund P (2004).

In west and Kellam Wolega Zones maize-haricot bean intercropping has been practicing in traditionally without knowing the negative effect of the system on each other. Based on this fact HSARC conducted research on the effect of varieties and planting time of haricot bean varieties with maize intercropping on performance of component crop and productivity and identified and recommended the promising high yielder combination of inter cropping of haricot bean varieties with maize and their planting time for West Wollega and Kellam Wollega zones. The yield advantage obtained at HSARC on station from maize-haricot bean intercropping for maize component was 59.79 qt/ha while the yield obtained from sole cropping of maize was 60.43 qt/ha and the yield obtained from haricot bean sole crop was 16.03 qt/ha and the yield obtained of haricot bean intercropping was 9.37qt/ha. The highest yield advantage was obtained from Nasir and Maize combination when haricot bean when sowed after 10 days of maize planting. The productivity of this experiment was evaluated by calculated total land equivalent ratio (LER) and Gross Monetary Value (GMV). The total land equivalent ratio (LER) was calculated by adding up partial land equivalent ratio of maize and haricot bean. The partial land equivalent ratio (PLER) of haricot bean and total land equivalent ratio (TLER) were significantly ($P<0.01$) affected by time of intercropped. In all the intercrops, the LER was more than unity, which showed that intercropping of maize and haricot bean was advantageous than sole cropping. The highest LER (1.43) was obtained from haricot bean planted after ten days of maize planting and the lowest LER (1.15) was obtained from haricot been planted after thirty days of maize planting. The highest LER (1.43) indicates that haricot bean planted after ten days of maize planting gave 43% yield advantage than planting maize or haricot bean independently as sole crops.

However this combination of technology had not evaluated and proved under farmer's condition. Therefore, participatory technology evaluation is paramount important to identify the best technologies which fit the farmers' local condition for enhancing maize-haricot bean intercropping adoption in these areas.

Objective

- To evaluate the yield performance of Maize -Haricot bean inter cropping practices under farmers management condition.
- To create awareness on maize –haricot bean intercropping practices.
- To analyze the cost- benefit ratio of demonstrated practice
- To assess farmers and other stakeholders feedback on further technology development.

Methodology

Description of the study area

Seyo

Seyo district is located in the south western part of Kellem Wollega Zone & the zonal capital is found in it (Seyo district). Astronomically the district is located between $8^0$12'-$8^0$44' north latitude and $34^0$41'-$35^0$00' east longitude. It is bounded by Gambella Regional State in the south and south west, Ilubabor Zone in the south east, Hawa Galan and Yemalogi Walal districts in the north and east and Anfilo district in the west and North West. The district has a total area of 127,800 km^2. The district generally lies within an altitudinal range of 1300-2000 m.a.s.l. The major rainy seasons in the district include spring (April-May), summer (June-August) and autumn (September-November).

Nedjo

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

Site and Farmers Selection

Two kebeles from Seyo district of Kellem Wollega and one kebele from Nedjo district of West Wollega zone were selected purposively based on haricot bean and maize production potential. Before starting field work, formation of FRG (farmers research group) were made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices (timely weeding and harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables.

Materials used

One improved variety of maize(BH661) were used with one improved variety of haricot bean(Nasir) to compare whether intercropping of the two crops(Maize and Haricot bean) is better than sole cropping(Traditional practice) of haricot bean and maize on different plots or lands. The trial was conducted with full farmers participation from trial establishment to harvesting time. The recommended fertilizer rate of NPS 100 Kg/ha was used for sole cropping of Haricot bean and fertilizer rate of NPS 50 Kg/ha was used for haricot bean intercropping and also recommended fertilizer rate of NPS 100 Kg/ha and UREA 200 Kg/ha were used for both sole and intercropped maize

Field design

BH661 Maize variety was planted on equal size plot of 10mx10m. The distance between maize rows was 75cm and distance between maize kernels was 25cm. Haricot bean variety (Nassir) was planted between rows of maize at distance of 37.5cm and distance between haricot bean kernels was 10cm. Haricot bean was planted 10 days after maize has been planted. Eight (8) trial farmers and one FTC were used as replication.

Technology demonstration and evaluation methods

Training

Before implementing demonstration trial on farmers' field, training was given to farmers on approaches and principles of FRG, the role and responsibility of the FRG members in managing the trial, necessary packages to practice intercropping of maize and haricot bean and management practices, and monitoring required for the trial and during trial establishment and harvesting period, practical training on improved production method (Intercropping) was given.

Data type and method of data analysis

Grain yield, and number of stakeholders participated on promotional event like training and field days and participatory evaluation of demo plot and Economic cost incurred for single demonstration plot return obtained from each plot was objectively collected. Data were collected through personal observation of the field and using different PRA tools like focused group discussion and key informant interview. The collected data were subjected to SPSS version 20 and descriptive statistic like mean, frequency and percentage. Pair wise ranking and direct matrix ranking wer used to rank farmers preference of these technologies and also Partial budget analysis used to analyze the profitability of the two practices. Independent T-test was used to compare the mean of Intercropping with the mean of sole cropping of each crop. Field days was conducted to promote experience sharing between different stake holders in Tabor kebeles of Seyo district.

Result and discussion

Training

Though, formal and scheduled training that focus on necessary packages for maize-Haricot bean intercropping method, relative advantage of intercropping practice over the traditional one and deep training on all agronomic practice was not given due to security problem, before the trial establishment, orientation on roles of farmers and experts and development agent as well as importance of FRG approach and also during trial establishment, practical training on very important agronomic practice such as spacing (between maize row and plant, Haricot been Row and plant, maize and haricot been), sowing day difference for maize and haricot bean when intercropped, seed and fertilizer rate and management practice was given to 48 member farmers out of which 37 of them are male and 11 of them are female and also 5(five) DAs were trained out of which 3(three) of them are male and 2(two) of them are female.

Table 1: Training given for farmers, DA's and Experts

District	Participant	Male	Female	Total
Sayo	Farmer	24	7	31
	SMS(Expert+ DA'S)	2	1	3
Nedjo	Farmer	13	4	17
	SMS(Expert+ DA'S)	1	1	2
Total		40	13	53

Field Day

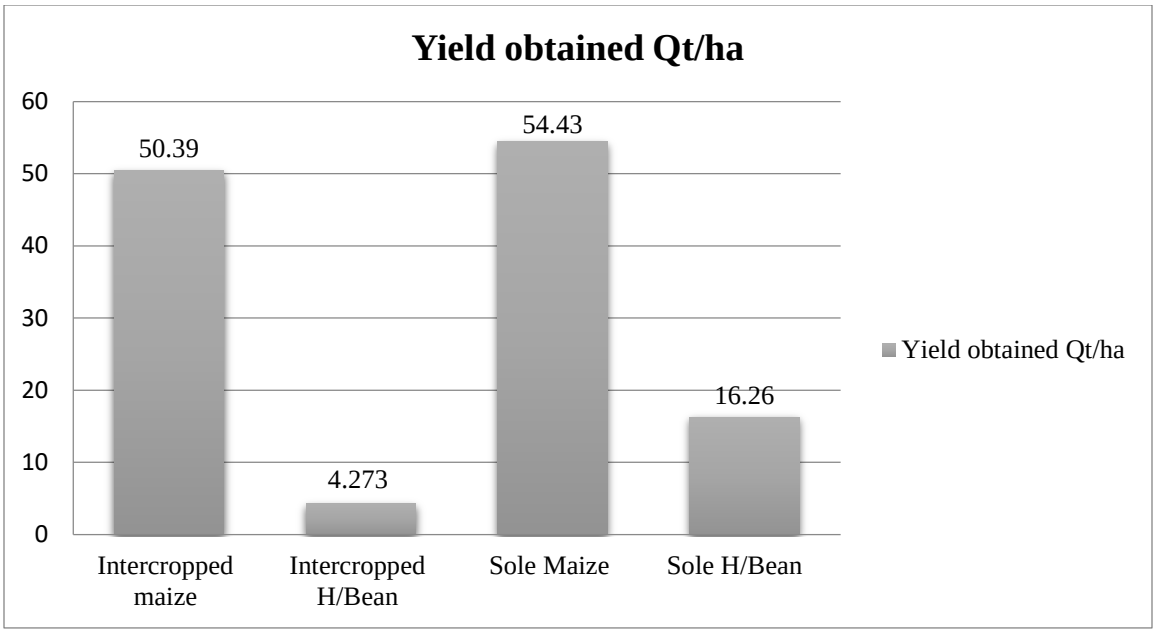
Field day was among the strategy used to create demand for stakeholders. Accordingly field day was organized in Sayo district (Tabor PA) to facilitate experience sharing among agricultural stakeholders. During field day a total of 71 stakeholders out of whom 45 were male 26 female were participated.

Table 2. Showing Participants of Field Day Organized at Tabor kebele

No	District	Kebele	No of participants of field day				Total
			Farmers		SMS		
			M	F	M	F	
1	Seyo	Tabor	34	18	11	8	71

Yield Performance of Demonstrated Intercropping Practice Vs Sole Cropping

Production Methods	Yield obtained Qt/hac
Intercropped maize	50.39
Intercropped H/Bean	4.273
Sole Maize	54.43
Sole H/Bean	16.26



The yield results of the demonstrated methods indicated the superiority of sole cropping of the two commodities over intercropped maize and haricot bean but it is difficult to decide based on yield gained per individual plot rather it is important to evaluate land equivalent ratio and profitability analysis of the two practices.

Land Equivalent Ratio (LER)

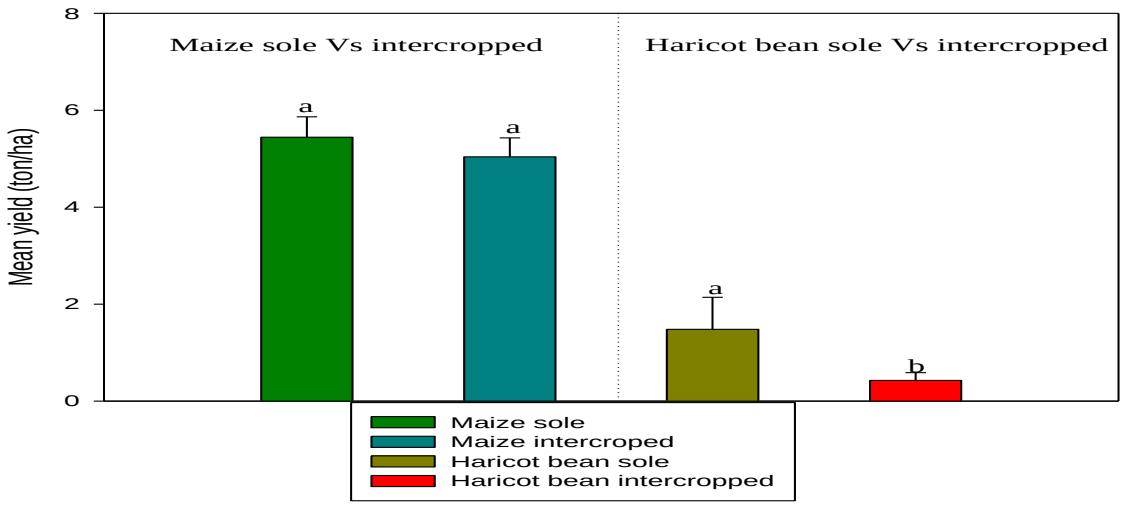
$$LER = \frac{\text{Yield of sole maize}}{\text{Yield of intercropped maize}} + \frac{\text{Yield of sole haricot bean}}{\text{yield of intercropped haricot}}$$

=5.443/5.039 + 1.48/0.427= 0.9257+0.2873= 1.2130

Crop	Sole yield (ton/ha)	Intercropping yield (ton/ha)	Equivalent Area
Maize	5.443	5.039	0.9257
HB	1.48	0.427	0.2873
	LER		1.2130

The result indicated that, a total of 1.2130 hector of sole cropped area (maize/haricot bean) would be required to produce the same yield as 1 hectare of the intercropped area of maize and haricot bean. So that intercropping need 0.213 more hectare of land to produce the same yield as 1 hectare of sole cropping of the two commodities.

Independent T-test result to compare the mean of the two Method



The result indicated, statistically no significant difference for yield of sole maize compared to intercropped maize, but, significant yield difference for haricot bean ($P<0.05$).

Participatory Varietal Selection, Preference and Ranking of Varieties

The target communities were highly inclined to their preference of demonstrated production methods which may help them to identify which practices they prefer more and which practice they prefer less. Accordingly different stakeholders (mainly farmers, development agents, and agricultural experts) participated on participatory evaluation and selection. In the process of participatory production practice/method selection and evaluation it is not only resource that could be saved but also time and fast adoption of technologies (Dan, 2012), thus a total of 52 participants participated on the process at maturity stage. Yet, before commencing on the selection, brief orientation was given to the evaluators on how to integrate researcher' criteria to their own criteria to select the demonstrated practices in order of their importance and during the assessment farmers were assisted to list their own selection criteria which may help them to identify best practice that can fit their demand. Accordingly, economically preferability, environmentally pleased, labor intensiveness and feasibility (practicability) were identified as the most important farmer's selection criteria.

Pair wise ranking of varieties trait by farmers.

Code	Variety trait	EP	LI	F/P	ENP	Frequency	Rank
1	EP	X	EP	EP	EP	3	1st
2	LI		X	F/P	LI	1	3rd
3	F/P			X	F/P	2	2nd
4	ENP				X	0	4rth

EP= economically Preferable, LI= Labor Intensiveness, F/P =Feasibility or practicability and ENP= environmentally pleased

Among the above listed criteria farmers ranked economically preferability of the demonstrated practice as their first criteria and feasibility or practicability, labour intensiveness or tediousness and environmentally conduciveness as a second, third and the last criteria respectively.

Consequently, suitable and widely accepted production practice/method for the study areas were identified and ranked based on these criteria. So, intercropping of Maize and haricot bean was identified as better production method due to environmentally conduciveness, economically preferability of the method than sole cropping of each crop on separate land.

Direct matrix ranking of varieties based on farmers selection criteria

Number	**Practice/system of production**	**Rank**	**Traits**
1	Intercropping of maize and Haricot bean	1	Environmental pleased Economically preferability, Labor intensiveness and Feasibility (practicability)
2	Sole Cropping	2	Labor intensiveness andFeasibility (practicability), Economically preferability

Profitability analysis

No	Items	Description	Quantity	Practices/Methods		
				Intercropped Maize and H/Bean	Sole maize	Sole H/Bean
1	Average yield		-	50.39 & 4.273	54.43	16.26
3	Sale price		Qt/birr	1000 & 2500	1000	2500
Total revenue (gain)				50390 + 10682.5 = **61,072.5**	54,430	40,650
3	Seed cost	Seed for one hectare/Birr		1500 +1250 = 2750	1500	2500
4	Fertilizer cost in (Birr)	UREA	200Kg	3400 +0= 3400	3400	0
		NPS	100Kg	1700 +850 =2550	1700	1700
		Total		5100 +850 =5950	5100	1700
5	Land preparation	Oxen or tractor/ha		4000	4000	4000
6	Labor cost per day	Sowing	20	2000	1500	1500
		Hilling and Weeding	40	3000	2000	2000
		Harvesting and transportation	35	3000	1750	1000
8	Opportunity cost of land	Hectare	1	4000	4000	4000
9	Total Cost			30650	24950	18400
10	**Net benefit**	**TR-TC**		**30422.5**	**29,480**	**22,250**

Source- demonstration data

The net benefit that was gained from producing by intercropping maize and haricot bean was higher than the one that obtained from producing sole crop of each commodity. The actual values obtained from intercropping of maize and haricot bean was 30422.5, whereas the net benefit gained from sole cropping of maize and haricot bean were 29,480 and 22250 ETB respectively**.** This manifest that using intercropping production method makes more net benefit to farmers over sole cropping of maize and haricot bean by the percent of 3.09% and 26.86% respectively.

Conclusion and Recommendation

One improved production method/Practice with the local practice as a check were demonstrated on eight (8) farmer's field and one FTC serving as replications. Maize yield, haricot bean yield, yield of haricot bean and maize in intercropping method and profitability of each Production method/practice were objectively measured and analyzed. The yield performances of sole maize and sole haricot bean were 5.443 ton ha^{-1} and 1.626 ton ha^{-1} while that of intercropped maize and haricot bean were 5.039 ton ha^{-1} & 0.4273 ton ha^{-1} respectively. The profitability analysis revealed that using intercropping production method makes more net benefit to farmers over sole cropping of maize and haricot bean by 3.09% and 26.86% respectively. The result of the calculated independent T-test indicated, statistically no significant difference for yield of sole

maize compared to intercropped maize, but, significant yield difference for Haricot bean ($P<0.05$).

PVES, pair wise ranking and direct matrix ranking were also used to identify farmers selection criteria. Farmers were used their own selection criteria to prefer and select production method or practice of their choice. Their criteria were profitability, feasibility or practicability, labour intensiveness and environmentally conduciveness of the demonstrated method/practices. Accordingly a total of 52 (13 Female and 39 male) stake holders evaluated and selected their best production method based on their selection criteria. Generally farmers preferred intercropping method of production than sole production of maize and haricot bean on different land.

To enhance production and productivity of both maize and haricot bean which can help maintain soil fertility in scarce farmer land in West and Kellam Wollega Zones the agricultural and natural resource of each zones and districts should capacitate farmers to promote intercropping method, full management practice, capacity building on appropriate fertilizer package use and agronomic practice such as spacing between maize and haricot bean and maize Generally based on farmer's preference and objectively identified criteria intercropping of maize and haricot bean should be promoted in the study areas.

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Pre-extension demonstration of selected Lablab varieties at midlands of Guji Zone, Southern Oromia, Ethiopia

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Abstract

The activity was conducted during 2018 and 2019 main cropping season at Adola Rede, Wadera and Odo Shakiso districts of Guji zone, Oromia, Ethiopia with the objectives of to demonstrate lablab varieties in midland areas of Guji Zone, to develop and promote lablab varieties and assess farmers' feedbacks for further development of lablab variety production. Two Kebeles per district were selected based on livestock production potential and 15 farmers were selected from each Kebele and grouped as one FRGs considering gender. Two improved lablab varieties (Gabis and Baresa) was demonstrated on plot size of 100 m2 area per variety at 50 cm inter- and 20 cm intra- row spacing and with recommended seed and fertilizer rates. Capacity building methods like; training, exchange visit and field day were organized to promote lablab and enhance farmer to farmer learning with and between FRGs members on lablab production. Observation, measurement and face to face interview were employed to collect the data and the collected data were analyzed by descriptive statistics while farmer's perception was analyzed qualitatively. The demonstration result revealed that Gabis variety gave 4.63 ton/ha and 24.96 qt/ha of biomass and grain yield respectively. Whereas Baresa variety gave 4.18 ton/ha and 23.59 qt/ha of mean biomass and grain yield. Limited farmland resource coupled with lablab life span on the farm was problems at study areas. Both varieties were almost comparable average biomass and grain yield. Thus, both varieties are recommended for further scaling up/out either on low land agro-ecological areas or intercropped with cereal crop like maize.

Keywords: FRGs, Lablab varieties, Demonstration, Guji Zone.

Introduction

Livestock sector has considerable economic and social importance at household and national levels and provides significant export earnings. The sector contributes 15 to 17% of gross domestic product (GDP) and 35 to 49% of agricultural GDP and 37 to 87% of the household income (Behnke and Metaferia, 2011). However, the productivity of the sector is very low due to a number of constraints, among which feed shortage both in quality and quantity is very crucial. Livestock development in Ethiopia is mainly limited by technical problems (insufficient and low-quality feed sources) and institutional factors (poor linkages between research centers and end users, limited extension and financial services (MOA, 2013). However, the Ethiopian government's second Growth and Transformation Program (GTP II) has envisaged increasing by 2020 the productivity and total production of livestock through improving genetics and feed services (MOA, 2015).

In order to mitigate the feed shortage problems production of improved forage like Lablab is highly important (Getnet et al., 2003). Berhanu et al., (2003) also reported that improved animal nutrition through adoption of sown forage could substantially increase livestock productivity. Utilizing improved forage varieties has several advantages. Not only does it improve animal nutrition resulting in higher producing livestock; it also compliments crop production by maintaining soil fertility through nitrogen fixation, while as grazing depletes the fertility of the land, forage growing improves soil health. (GIZ, ILRI October 2013). Lablab (lablab purpureus) is a summer-growing annual or perennial forage legume. Lablab is a multipurpose legume. Its immature seeds and pods, and young leaves are edible and cooked as vegetables. Mature dry beans are edible but they require prolonged cooking with several changes of water (Cook et al., 2005; Adebisi et al. 2004).

Midland districts of Guji Zone were well known by the livestock production potential and suitable agro ecologies for the production forage like Lablab (lablab purpureus). However, Tegegne et al. (2013) has mentioned low accessibility of extension services and inadequacy of practical demonstrations as the causes of poor performance of the livestock extension service among small dairy holders. The production of Lablab (lablab purpureus) variety is not only used for improve animal nutrition resulting in higher producing livestock; it also compliments crop production by maintaining soil fertility through nitrogen fixation. While grazing depletes the fertility of the land, forage growing improves soil health. Therefore, to obtain the advantage of forage for livestock production and crop improvement the demonstration of improved forage like Lablab (lablab purpureus) is essential.

Objectives of the Study

- To demonstrate Lablab varieties in midland areas of Guji Zone.
- To develop and promote Lablab varieties in midlands districts of Guji Zone, Oromia Region, Ethiopia.
- Assess farmers' feedbacks for further development of Lablab variety production

Materials and Methods

Description of study area

Adola Rede, Odo Shakiso and Wadera districts are located at about 470 KM, 490 KM and 530 KM to the south from Addis Abeba respectively. Districts are characterized by three agro climatic zones, namely Dega (high land), Weina dega (mid land) and Kola (low land) which are suitable for production of different crops and forages with different coverage. The mean annual rain fall and temperature of the districts are about 950 mm and 12-34 0 c respectively. Based on this condition two-time cropping season was commonly practiced i.e. Arfasa (main cropping season) which start from March to April especially for maize, haricot bean, wheat and barley. The second cropping season is called Gana (short cropping season) which was practiced as double cropping using small size cereal crops like tef, wheat and barley after harvesting the main cropping season crops. Mixed farming, mining and forest product production are the major livelihood of study area. Generally, in midland areas of Guji Zone, there are no areas used for the research-based forage production.

Site selection:

Pre-extension demonstration of lablab varieties were conducted in Adola Rede, Wadera and Odo Shakiso districts of East Guji Zone during 2018 and 2019 main cropping season. Purposively two Kebeles from each district were selected based on their livestock production potential.

Hosting farmer's selection:

Farmer's Research Group (FRG) approach was followed to select farmers and group under hosting farmers. A total of 6 FRGs were organized having 60 male and 30 female members. Among the FRG members, a total of thirteen (13) interested hosting farmers were selected. Having suitable and sufficient experimental land to accommodate the trials, initiatives to implement the activity in high quality, vicinity to the roads, having or have to invest on small dairy or beef farming and willingness to explain the technologies to others were the criteria used to select the hosting farmers.

Materials used and Field design

Two improved lablab varieties (Gabis and Baresa) were planted on selected hosting farmers land on 100 m^2 plot for each variety in the main cropping season. Full packages of technologies that include row planting at 50 cm inter- and 20 cm intra- row spacing, recommended seed rate of 20 kg per hectare and fertilizer rate of 121 kg of NPS per hectare were applied. In addition, twice hand weeding was done on time. Land was provided by hosting farmers. Land preparation was carried out by trial/hosting farmers, whereas land leveling, planting, follow up and visit, harvesting, threshing was handled and managed by BoARC Agricultural Extension Research Team

Data types and methods of data collection

Both qualitative and quantitative data were collected using direct field observation, measurements and face to face interview. The grain and biomass data were collected using data collection sheets. Feedbacks were collected using checklist by conducting face to face interviews.

Data analysis:

The collected agronomic data was analyzed using descriptive statistics. Farmers' perceptions to demonstrated varieties were also analyzed qualitatively.

Results and Discussions

Capacity Building on Lablab Production

In order to capacitate the farmers' knowledge on lablab production trainings were given for selected Farmers, Development Agents (DAs), and Subject Matter Specialists (SMSs). Exchange visit and field days were organized to enhance farmer to farmer learning on the production and management of lablab. Multidisciplinary research team; animal feed, extension and socio-economic research team and other stakeholders (Offices of Livestock and Fish development) actively participated by sharing their experience and knowledge during training and field day organized. Table 1 shows the number of farmers, development agents, SMSs and other participants who attended training, exchange visit and field day of lablab demonstration.

Table 1. Capacity building methods and number of participants for demonstration of lablab

Capacity building methods	Participants	Number of participant		
		Male	Female	Total
A. Training	Farmers	60	30	90
	DAs	10	3	13
	SMSs	9	3	12
B. Exchange Visit	Farmers	17	3	20
	DAs	3	1	4
	SMSs	3	1	4
	Others	4	1	5
C. Field day	Farmers	121	27	148
	DAs	13	6	19
	SMSs	9	2	11
	Others	38	7	45

DAs = development Agent, SMSs = subject matter specialist

Mean grain yield and biomass of Lablab Varieties

Grain yield performance of lablab

Variability was observed among demonstrated varieties for grain yield qt/ha which was ranged from 18 qt/ha to 30 qt/ha with the mean value of 24.96 qt/ha from Gabis variety and 19 qt/ha to 28 qt/ha with the mean value of 23.59 qt/ha from Baresa variety. Mean grain yield values of both varieties were almost comparable. The mean grain yield of lablab varieties was less than from previously conducted adaptation which were 29.3 qt/ha and 33 qt/ha from Gabis and Baresa variety respectively (Teshale *et al.*, 2017 unpublished report). This yield difference could be due to soil fertility and dissimilar management practice of hosting farmers. Table 2 show that the yield performance of demonstrated lablab varieties.

Table 2. Grain yield performance of lablab varieties demonstrated

Grain yield performance of lablab varieties in qt/ha					
Variety	N	Minimum	Maximum	Mean	Std. Deviation
Gabis	13	18.00	30.00	24.9615	4.03351
Baresa	13	19.00	28.00	23.5962	2.84227

Biomass performance of Lablab

Table 3 indicates that above-ground biomass of demonstrated lablab varieties were varied in ton/ha. Gabis variety gave higher biomass yield range from 4 ton/ha to 5.2 ton/ha with average mean value of 4.63 than Baresa variety which range from 3.5 ton/ha to 4.8 ton/ha with average mean value of 4.18 ton/ha. The mean biomass yield of Gabis variety was less than from previously conducted adaptation which were 6.54 ton/ha (Teshale *et al.*, 2017 unpublished report). This difference could be due to diverse management practice of hosting farmers.

Table 3. Biomass performance of lablab demonstrated

Biomass performance of lablab varieties in ton/ha					
Variety	N	Minimum	Maximum	Mean	Std. Deviation
Gabis	13	4.0.00	5.2.00	4.63846	4.07305
Baresa	13	3.5.00	4.8.00	4.18462	3.95487

Table 4. Result of independent sample t test

	Test for Equality of Variances		t-test for equality of Means				
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances Assumed	.096	.759	2.882	24	.008	4.53846	1.57458

Table 4 show that the equality of biomass performance of demonstrated lablab varieties were tested by independent sample t test. The significance value for equality of variance is ($p = .759 > .05$). This indicated that there is no statistically significant difference between the two means biomass yield of both varieties. Thus, farmers can produce one or both varieties based on available feed source.

Farmers' Preference on Lablab

Promotion of certain technologies should be based on farmers' perception which is important for sustainability and utilization of technology. For Lablab demonstration, farmers were ordered to reflect their own ideas on lablab variety production. According to farmers perception, both lablab varieties had good smell and palatable by cattle. Gabis variety had more pod/plant and number of branches than Baresa variety. The demonstrated lablab varieties were also tolerant to insect and disease. The flower of lablab was used for a source of food for bees. Thus, lablab production had multifunction for farmers as source of feed for bee and livestock. However, lablab was not early matured forage crop at the study area; its life span on the farm was 8 months. For that reason, it was not used for double cropping. Once it got moisture the crop would regenerate itself. But, in

the study area there is high population pressure and scarcity of land. Therefore, farmers of the study area were more interested to produce early mature crops and double cropping. Thus, farmers mentioned lablab should be planted as intercropping with cereal crops like maize.

Conclusions and Recommendations

Midland parts of Guji were well known by the livestock rearing (sheep, goats and cattle). But there were no research-based forage technologies. For that reason, livestock feed depends mainly on natural pastures and crop residues which are often limited in quantity and nutritional quality. Nutritionally, lablab was used for fattening of cattle when mixed with other feeds. Demonstration of lablab helped farmers to overcome feed shortage during dry season. Gabis variety had more pod/plant and number of branches than Baresa variety. However, the demonstrated lablab varieties were not early matured feed crop. It is not used for double cropping which is commonly known in the farming system of the study area. Many farmers gave attention to food rather than feed crops. Therefore, extension system should breakthrough in balancing of crop and forage production. Gabis and Baresa should be tested for lowland areas where there is shortage of rainfall. For the midland areas, early matured lablab varieties should be adapted and recommended for farmers. In addition, research activity should be done on intercropping of lablab with cereal crops mainly with maize for promotion of lablab varieties.

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Pre-extension demonstration of lentil technologies at highlands of Guji Zone, Southern Oromia, Ethiopia

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Abstract

The activity was conducted in 2019 at Bore and Ana Sora districts of East Guji zone, Oromia, Ethiopia with the objective of evaluating yield performance and profitability of improved lentil technologies under farmers' circumstances, assessing farmers' perception or preference and raising farmers' knowledge and skill on lentil production and management practices. Three Kebele per district were selected based on suitable of area to produce lentil and 15 farmers were selected from each Kebele as one FRGs member. Thus, a total of 6 FRGs comprising 90 farmers (60 male & 30 female) were established. Two improved lentil varieties (Alamaya and Derash) was demonstrated on plot size of 100 m^2 area per variety at 20 cm space between row and drilling seed in the row with recommended seed and fertilizer rates. Training, exchange visit and field day used to enhance farmer to farmer learning on lentil production. Observation, measurement and face to face interview were employed to collect the data and the collected data were analyzed by descriptive statistics and qualitative narration was used to analyze farmers' and other stakeholder feedback. The demonstration result revealed that Alamaya variety gave 10.02 qt/ha and 4.72 qt/ha was obtained from Derash variety. Even though both varieties susceptible to rust and pod borer during production year, Alemaya variety selected as first based on yield, farmers preference and economic returns. With support of agro chemicals that control rust and pod borer Alemaya variety was recommended for pre scaling up in highlands of guji zone and similar agro ecologies of the area.

Key Words: *Demonstration, lentil, Farmers' preference, FRGs.*

Introduction

Ethiopia is an agricultural nation experiencing remarkable growth amidst persistent food insecurity (Lunt *et al.*, 2018). The agronomic, economic, social, and environmental constraints to farming are very important across Ethiopia, as agricultural performance is a major determinant of food security (Motbainor, Worku, and Kumie 2016).

Many factors influence agricultural performance in Ethiopia, including access to technology and markets, agronomic and environmental conditions, pest and disease pressures, socio-economic status, and institutional and policy constraints (Lunt *et al.*, 2018).
Lentil is one of the high land crops widely grows in Ethiopia. In Ethiopia lentil production covers about 99753.97ha by 703274 numbers of holders and its productivity was 14.12qt/ha (CSA, 2019).

It is largely produced in the high land and semi-highland regions of the country mainly on clay soil (Yasin, 2015). Lentil plays an important role in human, animal and soil health improvement

occupying a unique position in cereal-based cropping systems. Its ability in nitrogen fixation and carbon sequestration improves soil nutrient status, which intern provides sustainability in crop production systems (Abraham, 2015; Yasin, 2015).

Lentil is an important dietary item in several – often poor – parts of developing countries, contributing to worn ding off malnutrition through a balanced diet. Clearly, the old adage that lentils are "poor man's meat" still remains firmly applied today. About 30% of calories from protein, lentil has the third highest levels of protein, by weight of any other legume or nut, after soybeans and hemp (Yasin, 2015).

Despite nutritional, economic and environmental advantages of lentil the production of this crop is not known in highland of Guji zone due to lack of improved varieties. Highland parts of Guji are a potential for wheat and barley. Most farmers also use their land year to year for these cereal crops. But, naturally, cereal crops have ability of depleting soil fertility over years as sown repeatedly on the same land. Unless legume crops like lentils are supplemented with cereal crop farming the fertility of soil is in risk. Thus, for further awareness creation and evaluate yield performance, the demonstration of lentil varieties was initiated to highland districts of Guji Zone.

Objectives of the study

- To evaluate yield performance and profitability of the improved lentil technologies under farmers' conditions
- To create knowledge and skills on lentil production in highland area
- Assess farmers' feedbacks for further development of lentil production

Materials and Methods

Description of study area

Bore district is placed at a distance of 385 km from Addis Abeba and 205 km from Negele, zonal city of Guji Zone. Geographically, it is at the Northern part of Guji Zone, Oromia regional state. While astronomically situated between 6°57'27" - 6°20'52"northing latitudes and 38°25'51" - 38°50'21" easting longitudes. Most of the earth surface of the district has an undulating land surface with an elevation ranging from 1400-2800 meters above sea level. The district is characterized by two agro climatic zone, namely humid which starts in early April up to October and sub humid which starts late November up to beginning of March. It has the annual rain fall of 1200-1400 mm and the annual temperature ranges from 11.1 up to $21c^{0}$. The major soils of Bore district are Nitosols (red basaltic soils) and Orthic Acrosols. The two soils are found on the highland areas, and they are red brown and black brown in colors and on sloping topography and their utilization are good under natural vegetation.

Ana Sora is situated at a distance of 410 km from Addis Abeba and 180 km from zonal capital city, Negele. Astronomically, the district is located between 6°20'30" - 5°57'30" northing latitudes and 38° 39' 30" - 38° 57' 30" easting longitudes. The district is characterized by two agro climatic zone, namely humid which starts in early April up to October and sub humid which

starts late November up to beginning of March. It is most humid and sub humid moisture condition, which has relatively longer growing season. It comprises the annual rain fall of 1750 mm and mean temperature of 15 up to 20 c^0. The major soils of the district are Nitosoils and Orthic Acro soils. These two soils are found on the highland areas of the district, and they are red brown and black brown in colors and on sloping topography and their agricultural utilization are good under natural vegetation.

Site selection

The trail was implemented in two highland districts of Guji Zone. Purposively, Bore and Ana Sora districts were selected. From each district, three representative *Kebeles* were selected based on their accessibility for follow up and suitable for production of the lentil. Accordingly, 15 (5 women) farmers were selected from each *Kebele*.

Experimental farmers' selection

Having suitable and sufficient land to accommodate the trials, willingness to contribute the land, initiatives to implement the activity in high-quality and willingness to explain the technologies to others were criteria used to select experimental farmers. Three (3) experimental farmers were selected per kebeles. Therefore, 18 experimental farmers were used for this activity. But three experimental farmers trial was not used for analysis due to eaten by animals.

Materials used and Field design

Two improved lentil varieties namely (Alamaya and Derash) were demonstrated on 100 m^2 plot size. Full packages were applied in which drilling seed in lines of 20 cm between rows, the recommended seed rate of 100 kg/ha and 80 kg/ha for Alamaya and Derash were applied respectively, 121kg/ha NPS fertilizer per hectare was applied and twice hand weeding was done.

Methods of data collection

Both qualitative and quantitative data were collected using direct field observation, measurements and face to face interview. The grain yield data were collected using data collection sheets while feedbacks were collected using checklist by conducting face to face interviews.

Methods of data analysis

The collected data were analyzed by descriptive statistics and qualitative narration was used to analyze farmers' and other stakeholder feedback. Net farm income (NFI) was used to analyze the profitability of demonstrated lentil varieties.

Results and Discussions

Capacity Building on Lentil Production

In order to capacitate the farmers' knowledge on lentil production trainings were given for selected Farmers Research Group members, Development Agents (DAs) and Subject Matter Specialists (SMSs). Exchange visit and field days were organized to enhance farmer to farmer learning and experience sharing on the production and management of lentil among and between

FRGs members and other concerning body. Multidisciplinary teams; pulse and oil, extension and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge during training and field day organized. Table 5 shows the number of farmers, development agents, district office of agriculture experts and other participants who attended training, exchange visit and field day of lentil demonstration.

Table 5. Capacity building methods and number of participant for demonstration of lentil

Capacity building methods	Participants	Number of participant		
		Male	Female	Total
A. Training	Farmers	60	30	90
	DAs	6	3	9
	SMSs	6	-	6
B. Exchange Visit	Farmers	8	2	10
	DAs	3	-	3
	SMSs	3	1	4
	Others	3	1	4
C. Field day	Farmers	48	22	70
	DAs	8	2	10
	SMSs	10	-	10
	Others	30	8	38

DAs = development Agent, SMSs = subject matter specialist

Yield performance of demonstrated varieties

Alemaya variety gave 10 qt/ha, which is greater than 4.7 qt/ha from Derash variety. Yield obtained from both varieties were lower than the previously conducted participatory variety selection (PVS) of lentil by Bore Agricultural Research Center (BOARC) Oil and Pulse research team which were 19.44 qt/ha and 13.24 qt/ha from Alamaya and Derash variety respectively (Afeta *et al.*, 2018). This yield gap was due to rust during flowering stage and infestation of pod borer during critical pod stage. Below table (table 6) shows that mean grain yield performance of lentil demonstrated varieties.

Table 6. Mean yield of lentil variety demonstrated qt/ha

Mean yield of lentil variety demonstrated qt/ha			
Varieties	N	Mean	Std. Deviation
Alemaya	15	10.0293	2.17393
Derash	15	4.7200	1.13701

Table 7. Result of independent sample t test

	Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances not assumed	6.351	.018	8.382	21.126	.001	5.30933	.63344

Table 7 show that the equality of yield performance of demonstrated lentil varieties were tested by independent sample t test. During lentil demonstration, the equal variances are assumed ($p = .018 < .05$). A significance value of .001 (less than .05) this indicates that there is statistically significant difference between the two means yield of both varieties which was 5.3 qt/ha of Alamaya variety over Derash variety.

Infestation of pod borer and rust

Cost benefit analysis

In terms of profitability, the cost benefit analysis result shows that an average profit of 29,202 ETB and 8515.46 ETB per hectare was obtained from Alamaya and Derash varieties respectively during production season. Alamaya variety were profitable than Derash at the study area. The farm get price during production season was 40 ETB for one kilogram of both varieties. Total revenue was calculated by multiplying the price by the yield obtained (TR= Y x P), growth marginal rate were calculated by subtracting total variable cost from total revenue (GM = TR-TVC) and the final profitability was calculated by subtracting total fixed cost from total Gross marginal rate (Profit= GM-TFC).

Table 8. Cost benefit analysis of lentil demonstrated varieties in ETB/ha

Parameters	**N**	**Mean**	**Std. Deviation**
Yield of Alamaya qt/ha	15	10.0293	2.17393
Yield of Derash qt/ha	15	4.7200	1.13701
Farm get price (P)	15	40	.00000
Total Fixed cost	15	2500.0000	.00000
Total variable costs	15	8415.3333	178.75229
Total cost	15	10915.3333	178.75229
Total revenue of Alamaya	15	40117.3333	8695.72593
Total revenue of Derash	15	18880.0000	4548.02940
Gross margin of Alamaya	15	31702.0000	8612.47501
Gross margin of Derash	15	11015.4667	6599.59862
Profitability of Alamaya	15	29202.0000	8612.47501
Profitability of Derash	15	8515.4667	6599.59862

Farmers' Feedback on Lentil Varieties

In participatory research activities like sowing on farmers' field the farmers feedback is important for further research activities. During the demonstration of lentil farmers provide constructive feedbacks, this feedback goes back to research agenda for further research on lentil

technologies for researchers. Even though both Alemaya and Derash lentil varieties were susceptible to rust and pod borer Alemaya variety tolerates both rust and pod borer than Derash variety and Alemaya variety gave higher yield and returns than Derash variety for farmers at the study area. Finally, farmers were preferred based on the tolerant to rust and pod borer, seed size, seed color, good crop stand and profitability of the varieties. Farmers preferred Alamaya variety as their first choice.

Conclusions and Recommendations

Pre-extension demonstration of lentil varieties was carried out on fifteen (15) representative trial farmer's fields. Two Improved variety Alamaya and Derash varieties were demonstrated under farmer condition. Tolerate to rust and pod borer, grain yield and net return (profitability) were the top three priority concern of the farmers to select from demonstrated lentil varieties. The demonstration result revealed that both varieties were not gave their maximum potential which was 10 qt/ha and 4.72 qt/ha from Alamaya and Derash varieties respectively. This is due to infestation of rust and pod borer during flowering and pod stage. However, profitability from Alamaya varieties was viable at the study area. Based on that tolerant to rust and pod borer, seed size, seed color, good crop stand Alamaya variety was selected by experimental farmers in the study area. In study area, most farmers use their land year to year for these cereal crops. But, naturally, cereal crops have ability of depleting soil fertility over years as sown repeatedly on the same land. Thus, lentil should be rotation for soil fertility restoration. Even though, both lentil variety cannot give their maximum potential Alamaya variety had economically profitable at study area. Therefore, the succeeding pre-scaling up of Alemaya variety should be carried out with agro chemical application.

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Pre-extension demonstration of maize-haricot bean intercropping practices in Midlands of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Maize-haricot bean intercropping is one of the commonly practiced agronomic practices in Ethiopia. Intercropping is the production of two or more crops simultaneously in both space and time. The activity was conducted in 2019 main rainy season at Adola Rede and Odo Shakiso districts of Guji zone, Oromia, Ethiopia with the objective of evaluating yield performance and cost-benefit ratio of maize-haricot bean intercropping practices under farmers' circumstances, assessing farmers' and others stakeholders preference, to create awareness on maize-haricot bean intercropping practices and raising farmers' knowledge and skill on maize-haricot bean intercropping practices. Two Kebeles per district were selected based on maize and haricot bean production potential and 15 farmers were selected from each Kebele and grouped as one FRGs. Thus, a total of 4 FRGs comprising 60 farmers (45 male & 15 female) were established. improved maize (BH-546) and Haricot bean (Haramaya) varieties were demonstrated with sole cropping of respective maize and haricot bean on plot size of 100 m^2 area per variety at 40 cm inter- and 10 cm and 75 cm inter- and 25 cm intra- row spacing for haricot bean and maize respectively, with recommended seed and fertilizer rates. Training, exchange visit, technology evaluation and field day used to enhance farmer to farmer learning on maize-haricot bean intercropping practices. Observation, measurement, face to face interview and LER were employed to collect the data and the collected data were analyzed by descriptive statistics and farmers preference was analyzed qualitatively. The demonstration results revealed that 27.46 + 23.23 qt/ha of maize and haricot bean respectively and net return with 28,007.67 ETB/ha. Based on grain yield per hectare, economic benefit and effective land use maize-haricot bean intercropping was very important for the small scale farmers in were land scarcity and moisture stress like midland of Guji and similar agro ecologies.

Key Words: *Demonstration, intercropping, Farmers' preference, LER.*

Introduction

World population is growing exponentially and it is expected to fulfill the food requirements by setting strategies' for increasing crop productivity per unit area of available land through growing by time and space combination (Seran and Brintha, 2010). Intercropping is considered as one of crop intensification strategies to increase agricultural productivity per unit area of land. This is an ancient practice still used in most of developing countries to maximize crop productivity, basically consists of cultivating two or more crops in the same area of land at the same time. The aim of this cropping system is to optimize factors and environmental resources usage, thus leading to an increased yield or output of the mixture (Liw., *et al*., 2005; Dwivedi *et al*., 2015). In addition result in improved soil nutrient and water use with reduced risk of crop failure while enabling healthier diets that if one crop fails another or the others may still be harvested (Elodie *et al*., 2010; Meighen and Marney, 2012).

Maize and haricot bean are the major staple food crops among cereals and pulses, respectively, in Ethiopia. Maize is an important cereal crop in the family meal ever. It is an important source of carbohydrate in human diet in the developing world and as animal feed worldwide (Undie *et al.*, 2012). As it is quick maturing and can be easily intercropped, haricot bean serves as a key component for intensifying production in smallholder farming systems. Its ability to fix nitrogen is much needed for longer term improvement of soil fertility (Buruchara *et al*., 2011). Intercropping offers greater financial stability than sole cropping and is easily practiced by labor-intensive smallholder farms (Lithourgidis *et al*., 2011).

The vigor of the crop production system of Ethiopia is governed by the size and distribution of rain. In the midland of Guji Zone, there were land scarcity and moisture stress which can directly affect crop production for household consumption. Land is a fixed resource that used to feed the increasing human population. Therefore, intensification of this fixed resource for improved productivity and farm return is the most strategy of intercropping. Now a day there is a shortage of land for different crop production. Even due to the recommendation for certain crop some parts of land is not intensively used.

Farmers' of study areas were practiced maize-haricot bean in traditional way (both crop on the same row) and produce cereal crop year to year without rotation. However, such practice can make low production and depletion of soil fertility. Thus, appropriate maize-haricot bean intercropping practice and bean-cereal rotation are important. Therefore, demonstration of maize-haricot bean intercropping in the midland of Guji zone is essential.

Objectives

- To evaluate yield performance of maize-haricot bean intercropping under farmer's condition.
- To analyze cost-benefit ratio of the demonstrated practices.
- To assess farmers' feedback.

Materials and Methods

Description of study areas

Adola Rede and Odo Shakiso districts are located at about 470 KM and 490 KM to the south from Addis Abeba respectively. Districts are characterized by three agro-climatic zones, namely Dega (high land), Weina dega (mid land) and Kola (low land) which are suitable for production of different crops with different coverage. The mean annual rain fall and temperature of the districts are about 1000 mm and 26 ^{0}c respectively. Based on this condition two time cropping season was commonly practiced i.e. Arfasa (main cropping season) which start from March to April especially for maize, haricot bean, wheat and barley. The second cropping season is called Gana (short cropping season) which was practiced as double cropping using small size cereal crops like tef, wheat and barley after harvesting the main cropping season crops. Mixed farming, mining and forest product production are the major livelihood of study area.

Site selection:

Pre-extension demonstration of maize-haricot bean intercropping practices was conducted in Adola Rede and Odo Shakiso districts of Guji Zone. Purposively two *Kebeles* from each district were selected based on their maize and haricot bean production potential. From each *kebele* 15 farmers were selected.

Hosting farmers' selection:

Farmer's research group (FRG) approach was followed to select farmers and group under hosting farmers'. A total of 4 FRGs were organized having 45 male and 15 female members. Among the FRG members, a total of twelve (12) interested hosting farmers and one FTC were selected. Having suitable and sufficient land to accommodate the trials, initiatives to implement the activity in high-quality, vicinity to the roads and willingness to explain the technologies to others were the criteria used to select the hosting farmers.

Materials used and Field design

Adaptable and recommended maize variety (BH-546) and haricot bean (Haramaya) variety were planted on selected hosting farmers land on 100 m^2 plot size for both treatments in the main cropping season. Respective sole cropping of maize and haricot bean variety was demonstrated as check treatment. Sole cropping of maize variety was demonstrated at 75 cm inters- and 25 cm intra-row spacing with seed rate of 25kg/ha for respective sole and intercropping plot. Whereas sole haricot bean demonstrated at 40 cm by 10 cm between row and plant respectively. While, the intercropping plots planted in single row between two rows of maize crop at 10 cm intra-row spacing with seed rate of 100 kg/ha for sole cropping and 50 kg/ha for intercropping plot.

At time of sowing, all plots of maize and sole haricot bean received 121 Kg/ha of NPS and 50 Kg/ha for intercropped haricot bean plots and 50 Kg/ha of urea only for maize by assuming the haricot bean would be benefited from nitrogen fixation. At knee height growth stage of maize, nitrogen in the form of urea was applied at the rate of 50 kg/ha to all plots. Simultaneous intercropping of haricot bean with maize was used, as the productivity and economic benefit were better than subsequent inter-seeding (Alemayehu *et al.*, 2018). Twice hand weeding was done on time.

Data types and methods of data collection

Both qualitative and quantitative data were collected using direct field observation, measurements and face to face interview. The grain and economic data were collected using data collection sheets. Feedbacks were collected using checklist by conducting face to face interviews. Land equivalent ratio which verifies the effectiveness of intercropping for using the resources of the environment compared to sole planting.

Data analysis methods:

The collected agronomic data was analyzed using descriptive statistics. Farmer's preferences to demonstrated practices were also analyzed qualitatively and profitability of each treatment was

also identified by using NFI (Net farm income). The LER values were computed using the following formula described by Willey (1979).

$$LER = \frac{Ymi}{Yms} + \frac{Yhbi}{Yhbs}$$

Where, Ymi = intercrop yield maize, Yhbi = Intercrop yield of haricot bean, Yms = Sole crop yield of maize and Yhbs = sole crop yield haricot bean.

Results and Discussions

Capacity building on maize-haricot bean intercropping practice

In order to capacitate the farmers' knowledge on the demonstration of maize-haricot bean intercropping practice trainings were given for selected Farmers Research Group members, Development Agents (DAs), and Subject Matter Specialists (SMSs). Exchange visit, mini field day and technology evaluation were organized to enhance farmer to farmer learning on the production and management of maize-haricot bean intercropping practice and farmers were evaluate the practice with sole cropping. Multidisciplinary teams; Cereal, Pulse and extension research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge during training, exchange visit, field day and technology evaluation organized. Table 9 shows the number of farmers, development agents, district office of agriculture experts and other participants who attended training, exchange visit, field day and technology evaluation of maize-haricot bean practice demonstration.

Table 9. Capacity building methods and number of participant for demonstration of maize-haricot bean intercropping practice

Capacity building methods	Participants	Number of participant		
		Male	Female	Total
A. Training	Farmers	45	15	60
	DAs	7	1	8
	SMSs	8	-	8
B. Exchange Visit	Farmers	20	-	20
	DAs	3	1	4
	SMSs	3	1	4
	Others	4	1	5
C. Mini field day	Farmers	24	6	30
	DAs	2	-	2
	SMSs	2	-	2
	Others	2	-	2

DAs = development Agent, SMSs = subject matter specialist

Role of farmers' and other stakeholders in technology demonstration

The role of the farmers, extension workers, researchers and other stockholder during the technology demonstration were indicated in the below table.

Table 10. Role of Farmers and other stakeholder's participation in demonstrated technology

Actors	**Roles**
FRG members	Involved in land preparation, sowing, management, yield evaluation and providing feedback.
Hosting farmers	Trail land provision, record keeping, facilitating of members involvement, field monitoring and reporting in the case of emergency and providing feedback.
Research teams	Provision of training for FRG members and other actors and providing input, agronomic data collection, field monitoring, social data collection and analysis, preparing extension materials.
Extension workers	Monitoring, feedback and information transfer, facilitating and organizing community.
Other stakeholders	input supply, technical backup, community facilitating, information dissemination, etc.

Yield performance of maize -haricot bean demonstrated

The result of demonstration of maize-haricot bean intercropping indicated that inter-cropping of haricot bean with maize is more advantageous than sole cropping of respective maize and haricot bean and increases crop production per unit area. Mean grain yield of intercropping plots revealed that 27.46 qt/ha for maize and 23.23 qt/ha haricot bean which is greater than respective sole cropped of 27.07 qt/ha and 33.46 qt/ha of maize and haricot bean respectively. Below table (table 11) indicates mean yield performance of maize-haricot bean demonstrated.

Table 11. Mean yield performance of maize and haricot bean (qt/ha)

Treatments	Mean yield of maize and haricot bean (qt/ha)		
	N	Mean	Std. Deviation
BH-546 Sole	13	27.0769	3.86138
Haramaya Sole	13	33.4615	10.72082
BH-546 Intercropped	13	27.4615	3.88620
Haramaya Intercropped	13	23.2308	6.08487

BH-546 = maize variety, Haramaya = haricot bean variety, Qt/ha = quintal/hectare

Land productivity

The productivity of this demonstration was evaluated by calculated total land equivalent ratio (ler). Land equivalent ratio is the amount of land required in sole cropping to obtain the same yield as in the intercrop. ler ranges from 1.65-1.75 and total land equivalent ratio of maize-haricot bean demonstration was 1.7. This result was greater than the report of lulie *et al.,* (2016) where ler of maize/common bean range from 1.29-1.69 in Ethiopia. Similarly, hirpa, (2013) reported the ler of 1.43-1.54 for maize/common bean intercropping.

Total Land Equivalent Ratio of 1.7 showed that land utilization of maize-haricot bean intercropping was more advantageous than for sole cropping. In other words, more lands will be required in the monoculture of either of the component crops to produce the same yield obtained from their intercropping.

Table 12. Total land equivalent ratio

Treatments	Grain yield qt/ha		Land equivalent ratio (LER)		Total LER
	Sole maize	Sole haricot bean	Maize	Haricot bean	
Sole maize	27.0769	-	-	-	
Sole haricot bean	-	33.4615	-	-	
Maize haricot bean intercropping	27.4615	23.2308	1.01	0.69	1.7

LER = Land Equivalent Ratio

Cost benefit analysis of maize-haricot bean intercropping

Production costs and returns of demonstration of maize-haricot bean inter-cropping were collected from experimental farmers. Production costs included were variable and fixed costs. Variables costs include cost of land preparation, cost of seeds, cost of fertilizers, planting, weeding, harvesting and cost of transport. Fixed cost was cost of land. During the production season fixed cost of the land for one season was 2500 ETB/ha at study area. Average farm gate price of maize and haricot bean during 2019 production season was 7 ETB/Kg and 8 ETB/Kg respectively. Haricot bean (Haramaya) variety was not high demand for market but demanding for the purpose of home consumption at the study area. Pre-extension demonstration of maize-haricot bean intercropping was profitable for farmers with return of 28,007.67 ETB/ha than respective sole of maize 11,453.84 ETB/ha and haricot bean 19,069.23 ETB/ha. Below table (table 13) shows that profitability of maize haricot bean intercropping

Table 13. Profitability analysis of maize-haricot bean intercropping demonstration in ETB/ha

Items	Treatments		
	Sole maize	Sole haricot bean	Maize-haricot bean intercropping
Total Fixed cost	2,500	2,500	2,500
Total variable costs	5,000	5,200	7,300
Total Cost (TFC + TVC)	7,500	7,700	9,800
Average Revenue (P x Q)	18,953.84	26,769.23	37,807.67
Average Gross margin (TR-TVC)	13,953.84	21,569.23	30,507.67
Net Profit (GM-TFC)	11,453.84	19,069.23	28,007.67

Farmers' and other stakeholders' feedback on maize-haricot bean intercropping practice

During the demonstration of maize-haricot bean intercropping practice farmers provide constructive feedback for further research on intercropping practice. Each farmer had his/her own feedback. During technology evaluation yield, early matured varieties, double cropping, economic benefit and effective land use were the traits preferred by farmers. To evaluate intercropping practices farmers compared the maize-haricot bean intercropping yield with respective sole crop of maize and haricot bean.

Inter-cropping of haricot bean with maize is more advantageous than sole cropping of maize and haricot bean and increases more crops production per unit area. In other words, more lands will be required in the monoculture of either of the component crops to produce the same yield

obtained from their intercropping. In addition, intercropping is important for farmers to recover from failure of one crop due to adverse climatic impact while they could harvest the rest crop.

Conclusions and Recommendations

In the study area farmers did not know crops to be intercropped, the time of sowing and intercropping system. They simply practiced in traditional way where there is less yield and return from the farm. Few farmers practice row intercropping (sowing of both crops on the same row) while, alternative row intercropping which has many advantage of reduced maize haricot bean competition for light, space and easy for management. Land scarcity and moisture stress problem is common at midland district of Guji zone. The result of demonstration of maize-haricot bean revealed that (27.46 qt/ha of maize + 23.23 qt/ha haricot bean) and generate 28,007.67 ETB/ha of return. More grain yield of maize was obtained when it intercropped with haricot bean than sole cropping. This result might be due to haricot bean added Nitrogen for soil fertility. However, the yield of haricot bean was higher when sown alone than intercropped with maize. This might be the shading effect of maize affect the haricot bean.

Based on yield, economic benefit and effective land use maize-haricot bean intercropping was recommended for the small scale farmers. Hence, intercropping of maize haricot bean is recommended to increase crop production and minimize the effect of moisture stress and scarcity of land on crop production in midland Guji and similar agro-ecologies.

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Pre-extension demonstration of teff technologies at midlands of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Midland area of Guji zone was potential for teff production. However, the productivity of the crop is low due to lack of improved varieties. To solve this problem demonstration of improved teff varieties were initiated to evaluate yield performance and profitability of the improved teff technologies and assess farmers' feedbacks for further development of teff production during 2018/19 and 2019/20 years. Three potential districts were selected based on teff their potential production. From each district two kebeles were selected. 32 experimental farmers were used for this demonstration. Dagim and Tesfa improved varieties were demonstrated with standard check (Tseday) on 10mx10m area. A seed rate of 10 kg/ha by a spacing of 20cm between rows, drilling of teff in the line of rows and 121 kg/ha of NPS fertilizer was used. Descriptive statistics, qualitative and cost benefit analysis used to analyze the data. Higher yield (19.06 qt/ha) was obtained from Dagim variety while Tesfa generated 14.09 qt/ha. Lower yield (8.9 qt/ha) was harvested from the standard check. The cost benefit analysis result shows that 38,042, 24,464 and 8,058 ETB/ha was obtained from Dagim, Tesfa and Tseday varieties respectively. Early mature, market demand and high yield teff variety was preferred by farmers in the study area. Farmers selected Tesfa and Tseday as they were slightly early mature crop than Dagim. Tesfa and Tseday varieties were lower yield than Dagim variety. Based on the preference of the farmers, grain yield obtained and returns both improved Dagim and Tesfa varieties were recommended for scaling up in the study area and similar agro-ecologies.

Key words: Guji, teff, Dagim variety, Demonstration

Introduction

Agriculture contributes 34.1% to the GDP, employs some 79% of the population, accounts for 79% of foreign earnings, and is the major sources of raw material and capital for investment and market (MOA, 2019).

Teff (*Eragrostis*teff) 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 Marcantonio, 2013).

Teff is a cereal crop comprehensively cultivated in Ethiopia with annual coverage of about 2.8 million hectares. This crop has special useful traits both for producers and consumers. For instance; i) teff is tolerant to extreme environmental conditions (teff is resisted to many biotic and abiotic stresses); ii) the seeds are not attacked by storage pests; iii) the seeds are gluten-free (safe for diabetics as well as sufferers of immune reactions to wheat gluten) and rich in minareals and protein (Fikadu *et al.*, 2019).

The most common utilization of teff in Ethiopia is the fermented flatbread called injera (Zhu, 2018). Other utilizations of teff include local alcoholic beverages called *tela* and *katikala*, and porridge (Abraham, 2015). Additionally, teff plant residues could be used as fodder for livestock, and often incorporated as construction materials (Cheng *et al.*, 2017). Teff is an economically superior commodity in Ethiopia. It often commands a market price two to three times higher than maize, the commodity with the largest production volume in the country (FAO, 2015), thus making teff an important cash crop for producers (Abraham, 2015). Nevertheless, the national yield per unit area (1.6 t ha^{-1}) still remains low, quite large proportions of tef producing farmers still use unimproved local cultivars, bottleneck problems like lodging have not been alleviated, and the demand for high-quality tef planting seed has become increasingly high (Solomon *et al.*,2017).

Teff 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. Teff could be produced in both seasons (*meher* and *belg*) hence the crop is used for double cropping purpose which increases farmers' production and income. Despite double cropping of teff in the area many farmers were not food secured and only few model farmers use teff 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 use of low yielder varieties and lack of climate smart varieties (drought tolerant and early mature varieties) which can produce surplus production. Therefore, demonstration of improved varieties such as Dagim and Tesfa which were drought tolerant, early mature and high yielder is important for farmers producing tef in midland areas of Guji zone.

Objectives of the activity

- To create awareness on the improved teff technologies in midland area
- To evaluate yield performance and profitability of the improved teff technologies under farmers' conditions
- Assess farmers' feedbacks for further development of teff production

Materials and Methods

Description of study areas

Adola Rede district is 468KM away from the Addis Ababa to the South. The district is bordered by Ana Sora district in the North, Wadera district in the South and Odo Shakiso in the West and Girja district in the East directions. The district has altitude range of 1350-2340 meter above sea level, annual mean of 1000mm rainfall and annual average of 28C° of temperature. Mixed farming, mining and forest product production are the major livelihood of Adola Rede farmers. Adola district has diverse agro-ecologies which are suitable for production of different crops. The rainfall pattern of the district is bimodal for lowland and midland areas and uni-modal for highland parts. Sandy, clay and silt are the major soils of Adola Rede district. The major crops produced in the area include maize, tef, haricot bean, chat, coffee and the others. Natural minerals are mainly found at Odo Shakiso. 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 engaged on extraction of different minerals.

Sites and farmers selection

With collaboration of District Agriculture and Natural Resource office two *kebeles* (sites) were selected from each district. In each district site for demonstration was selected based on teff producing potential and accessible for monitoring purpose. Farmers were selected based their interest to grow improved teff varieties and access to land. Accordingly, during both production of 2018/19 and 2019/20 32 farmers (9 women) were selected as experimental farmers for demonstration of teff.

Experimental design and treatments

Land was ploughed two to three times after maize is harvested from the land. Plantation was early September. Two improved teff varieties namely Dagim and Tesfa were demonstrated during 2018 and 2019 production seasons. For comparison standard check Tseday was sown along the improved varieties. A plot area of 10 m x 10 m was used for each treatment. The recommended seed rate of 10 kg/ha was sown by a spacing of 20cm between rows and drilling of teff in the line of rows. 121 kg/ha of NPS fertilizer was applied during sowing. Hand weeding was done by farmers. Harvesting and threshing was done manually by farmers with technical support of DAs and researchers.

Methods of data collection and analysis

Personal observation, measurements and interview were applied to collect yield data, costs of production, income generated, and farmers' feedback. Descriptive statistics and qualitative analysis of farmers' assessment/feedback was used to analyze the data. Cost benefit analysis was used to estimate economic returns on demonstrated varieties.

Results and Discussion

Capacity Building on Teff Production

In order to capacitate the farmers' knowledge on teff production trainings were given for selected Farmers, Development Agents (DAs), and Subject Matter Specialists (SMSs). Exchange visit were organized to enhance farmer to farmer learning on the production and management of teff. Cereal, Extension research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge during training and Exchange visit organized. Table 14 shows the number of farmers, development agents, SMSs and other participants who attended training and Exchange visit of teff demonstration.

Table 14. Capacity building methods and number of participants for demonstration of teff

Capacity building methods	Participants	Number of participant		
		Male	Female	Total
A. Training	Farmers	60	30	90
	DAs	6	2	8
	SMSs	5	1	6
B. Exchange visit	Farmers	15	5	20
	DAs	4	1	5
	SMSs	5	-	5
	Others	3	1	4

DAs = development Agent, SMSs = subject matter specialist

Yield performance of demonstrated teff varieties

Higher yield was obtained from Dagim variety (19.06 qt/ha) and Tesfa (14.09 qt/ha). Lower yield (8.9 qt/ha) was harvested from the standard check which was Tseday. Yield obtained from both improved varieties (Dagim and Tesfa) were greater than pre-scaling up of teff varieties at study area (13.2452 qt/ha and 13.037 qt/ha for Boset and Tseday respectively (Basha *et al.*,2019). Similarly, Yield obtained from Dagim Variety was greater than national average yield of teff 17.56 qt/ha (CSA, 2019). Below table (table 15) shows that mean grain yield performances of improved and standard check teff demonstrated varieties.

Table 15. Mean yield of teff variety demonstrated qt/ha

Varieties	N	Minimum	Maximum	Mean	Std. Deviation
Dagim	32	16.00	30.00	19.0625	2.71124
Tesfa	32	10.00	20.00	14.0937	2.55721
Tseday	32	6.00	12.00	8.9063	1.59352

Cost benefit analysis

In terms of profitability, the cost benefit analysis result shows that an average profit of 38,042, 24,464 and 8,058 ETB per hectare was obtained from Dagim, Tesfa and Tseday varieties respectively in both production seasons. Dagim variety was more profitable than both Tesfa and Tseday at the study area. The average farm get price for both production seasons was 27.5 ETB for one kilogram of both improved varieties and 25 ETB for standard check (Tseday) variety. Total revenue was calculated by multiplying price by yield obtained (TR= Y x P), gross marginal rate were calculated by subtracting total variable cost from total revenue (GM = TR-TVC) and the final profitability was calculating by subtracting total fixed cost from total growth marginal rate (Profit= GM-TFC).

Table 16. Cost benefit analysis of teff demonstrated varieties in ETB/ha

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Total Fixed cost	32	2500.00	3000.00	2750.0000	254.00025
Total variable costs	32	10613.00	13332.00	11629.3750	596.79454
Total cost	32	13113.00	16332.00	14410.6250	702.92191
Total Revenue of Dagim variety	32	40000.00	75000.00	52421.8750	8545.05080
Total Revenue of Tesfa variety	32	25000.00	60000.00	38765.6250	7880.13465
Total Revenue of Tseday variety	32	15000.00	33000.00	22437.5000	4321.27147
Gross margin of Dagim variety	32	28637.00	61687.00	40792.5000	8217.90706
Gross margin of Tesfa variety	32	13637.00	47968.00	27136.2500	7576.50366
Gross margin of Tseday variety	32	4337.00	19668.00	10808.1250	4060.67520
Profit of Dagim variety	32	26137.00	59187.00	38042.5000	8072.66572
Profit of Tesfa variety	32	11137.00	44968.00	24464.3750	7412.86170
Profit of Tseday variety	32	1837.00	16668.00	8058.1250	4006.29978

Farmers' preference on teff varieties

During pre-extension demonstration of teff technologies farmers give sound feedbacks regarding demonstrated varieties. Farmers at study area have an experience of teff production and they use teff as household consumption, income generation and use its straw as a feed for livestock and house construction. Both improved varieties used for demonstration were white in color which demands the market. Even though Tesfa and Tseday varieties were gave low grain yield compared to the Dagim variety they are early matured varieties with less rainfall than Dagim variety. Strong straw of Dagim variety can help the farmer for the purpose of house construction and the high grain yield and return can help farmers as income generation, food self-sufficient and increase their purchasing power of agricultural inputs.

Conclusions and Recommendations

The Pre extension demonstration of improved teff varieties were conducted in midland districts of Guji zone. Dagim and Tesfa were demonstrated along standard check (Tseday) variety. Both Dagim and Tesfa varieties gave higher yield and profitable than standard check. Based on their white color which is preferred for both household and market demand Dagim and Tesfa were selected by farmers. Midland districts of Guji zone is characterized with the shortage of rainfall. Therefore early mature teff variety was preferred by farmers. Farmers selected Tesfa and Tseday as they were slightly early mature crop than Dagim. Based on the preference of the farmers, grain yield obtained and returns both improved Dagim and Tesfa varieties were recommended for scaling up in the study area and similar agro-ecologies.

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Pre-Extension Demonstration of Improved Maize Technology at Midland Districts of Guji Zone, Southern Oromia, Ethiopia

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Abstract

Participatory demonstration of improved maize technologies was conducted in two potential mid land districts of Guji Zone in 2019. The main objective of the study was to popularize improved maize variety at midlands of Guji Zone. Two districts were selected based on their potential to grow maize and two kebele administrations from each district were selected based on their accessibility. 15 farmers of gender inclusive were established as Farmers Research Group (FRG) at each kebele administration. Three hosting farmers were nominated based on their consent to provide sufficient and suitable land for experiment. Trainings were given for farmers, development agents and subject matter specialists. An improved maize variety (BH-546) with one commercial variety was planted on selected farmers' land with a plot size of 10m x 10m. Recommended seed rate of 25 kg ha^{-1} with a spacing of 75 cm and 25 cm between rows and plants was used respectively. An inorganic fertilizer rate of 100 kg ha^{-1} NPS at planting time and 100kg ha^{-1} N with split application (50 kg at planting time while 50 kg at knee height stage). Development agents, subject matter specialists and different stakeholders were participated on organized field visit & joint monitoring and evaluation. Field day was organized on which different stakeholders participated and experience was shared. Quantitative data such as yield was collected and analyzed using independent t test whereas farmers' feedbacks were analyzed qualitatively. Knowledge change of the farmers was analyzed using dependent t test. Despite the shortage of rain fall, 3.023 tons ha^{-1} and 2.662 tons ha^{-1} for improved BH-546 and commercial maize variety respectively. Therefore, BH-546 variety was recommended for pre scaling up.

Keywords: *Demonstration; FRG; BH- 546*

Introduction

Maize (Zea mays L.) is one of the most important food crops grown world-wide. Among cereal crops, maize has the highest average yield per hectare and remains third after wheat and rice in total area and production in the world (FAOSTAT, 2012). It is grown in most parts of the world over a wide range of environmental conditions (Nigussie M. *et al*., 2002). It is one of the most essential cereal crops used in the human diet in most parts of the world and it is an imperative feed constituent for domestic animals. Maize widely cultivated and one of the most important staple food crops and a target of most food security programs in Ethiopia (CSA, 2018/19). Maize is one of the most important cereal crops cultivated in Ethiopia ranking second after teff in area coverage and first in total production. The post-harvest crop production survey of (CSA, 2018/19) indicated that out of the total land areas covered by grain crops, 80.71% is under cereals of which 16.79% covered by maize and about 8.396 million tons of grain yields. Maize is grown over a large area in many parts of the country, particularly in southern and southwestern Ethiopia (Nega A. *et al*.,2016) Despite the large area under maize, the national average yield of maize is about 3.944 tons ha^{-1} while that of the study areas is about 2.655 tons ha^{-1} (CSA, 2018/19). This is by far below the world's average yield, which is about 5.21 tons ha^{-1} (FAO,

2011). The low productivity of maize is attributed among other, to frequent occurrence of drought, declining of soil fertility, poor agronomic practice, limited use of input, and lack of credit facilities, poor seed quality, diseases, insect pests and weed (CIMMYT, 2004; Gezahegn B. *et al*. and Tewabech T. *et al*., 2012)

Midland districts of Guji Zone were potential for maize production. Maize is the main crop used for both household consumption and cash crop. It is an interesting crop in the study areas because the land used for maize is reused for other crop (like teff, haricot bean, chickpea and the like) production helping famers double cropping that enhance their food security and maintain their livelihood. Despite maize is used for human consumption and cash crop in Guji Zone, there is lack of farmers' knowledge on packages of maize and lack of improved, early mature and disease tolerant varieties. But in 2017 production season, different improved varieties were adapted and evaluated both at on farm and on station of Adola Rede sub site, mid land of Guji Zone. The result of adaptation study, unpublished data of cereal team of Bore agricultural research center, revealed that BH-546 variety was promising and recommended for demonstration based on high yield ha^{-1} (BH-546 gave 46.67 quintals ha^{-1}).Thus, it was depending on that recommendation that the demonstration of improved maize variety, BH-546 was initiated at midland districts of Guji Zone for further awareness creation, promotion of maize and reach more farmers with the main objective to popularize improved maize variety at midlands of Guji Zone

The specific objectives of the study were to:

- Evaluate yield performance of improved maize technologies under farmers' condition
- Create awareness on maize technologies in midland areas.
- Improve knowledge and skills of farmers on maize production and management
- Assess farmers' feedbacks for further development of maize
- Evaluate cost-benefit ratio (income of farmers)

Materials and Methods

Description of the Study Areas

Adola Rede District

The district is located in Southern part of Oromia, Ethiopia, at a distance of 468 km from Finfinne, the capital of Ethiopia. Astronomically the district is located between 5º44'10"- 6º12'38" latitudes and 38º45'10"- 39º12'37" longitudes. The district is characterized by three agro- climatic zones, namely humid, sub humid and dry arid zones. In terms of the agricultural calendar, the rain fall pattern of the district is bimodal for lowlands and midland areas and mono-modal for highland parts. The dry arid agro- climatic zones attributed to little rainfall while the humid agro- climatic zones receives extremely high rainfall. Rain-fed agriculture is a common practice for many farm households in this district. However, a semi- nomadic economic activity is also practiced as a means of livelihood by some of its dwellers. This district has 29 peasant associations and two urban centers. 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, wheat, maize and teff are the major crops cultivated by the farmers in this study areas. They also engaged in the production of coffee as means of livelihood.

Odo Shakiso District

Odo-Shakiso district is situated at a distance of 490 km south east from Finfinne and 139 km from the zone capital town, Negele. The district is classified in to 20 peasant associations. Astronomically, the district is located between $5^{o}2'29''$ - $5^{o}58'24''$ northing latitudes and $38^{o}35'0''$ - $39^{o}13'38''$ easting longitudes. It is boarded by Saba Boru in South and South West, Kercha in West, Adola Rede in the East and Uraga district in the North. The total area of the district is 133,677 ha or 1336.770 km^2. The district is characterized by three agro- climatic zones, namely Dega (20%), weina dega (65) and Kola (15) which starts in early November up to December, late June up to reaches beginning of November and March up to May respectively. The mean annual rain fall is about 900 mm and the annual temperature of the district is 22.5 c^0. Most of the earth surface of the district has an undulating land surface with an elevation ranging from 1500-2000 meters.

The major soils of the district are chromic eufric and calcic combisal with high spatial coverage of 70%. Camisole found mostly on slopes. Therefore, it has little agricultural potential other mostly developed on gentle slopes, Very good base saturation and fertility are the major important for agricultural production. The remaining portion 30% mostly covered by orthic acrisols, this soil is fertile and the relative humidity is also quiet suitable for the farm. 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, wheat, maize and teff are the major crops cultivated by the farmers in this study area. They also engaged in the production of coffee as means of livelihood.

Sites and Farmers Selection

Participatory demonstration of improved maize technology was conducted in two potential mid land districts of Guji Zone, Adola Rede and Odo Shakiso. Purposive sampling methods were employed to select two representative districts and two peasant associations from each district based on their potential for maize production and their accessibility.

Participatory approach using Farmers Research Groups (FRGs) were the main strategy used during demonstration of the technology. Selection of FRGs member farmers was based on farmers' consent to be held as member, accessibility for supervision of activities, good history of harmony with groups and genuineness and transparency to share innovations to other farmers. To this end, one FRG having 15 members with the arrangement of resource rich, medium and poor class of farmers including gender with proportion of 70% to 30% men and women respectively was established at each peasant associations. Three hosting farmers were nominated among FRGs member farmers based on their interest to provide sufficient and suitable land for experiment, vicinity to roads for the chance of being visited by many farmers, initiatives to implement the activity in high-quality, good in field management and willingness to explain the technology to other farmers and share knowledge, skill and experience for further promotion mechanism. Accordingly, three representative trial farmers were selected at each peasant

association from each FRG while the rest FRG member regrouped by their village cluster proportionally. One FTC at Odo Shakiso also selected.

Table l7. Number of FRG members established in each demonstration site

Districts(kebele administrations)	No of FRG	FRG member by gender		
		Male	Female	Total
Adola Rede (Kiltu Sorsa and Gobicha)	2	20	10	30
Odo Shakiso (Diba Bate and Korba)	2	20	10	30
Total	4	40	20	60

Materials Used and Field Design

An improved maize variety (BH-546) with one commercial variety was planted on selected farmers' land with plot of 10 m x 10 m in the main cropping season. The varieties were treated with full recommended maize production and management packages. The recommended seed rate of 25 kg ha^{-1} with a spacing of 75 cm and 25 cm between rows and plants respectively was used. The recommended inorganic fertilizer rate of 100 kg ha^{-1} NPS at planting time and 100 kg ha^{-1} UREA with split application (50 kg at planting time while 50 kg at knee height stage). All agronomic practices like land preparation-ploughing three to four times using oxen plough, planting, weeding, leveling, harvesting, threshing) were carried out by FRGs member farmers.

Technology Demonstration and Evaluation Methods

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

Training of Farmers and Development Agents

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

Training was given to farmers, Development Agents (DAs), and agricultural experts on maize production methods and management packages. Stakeholders such as district agriculture and natural resource office, cooperative experts were invited and participated during consultation meeting and training.

Field Day

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

Methods of Data Collection

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

Yield Advantage

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

$$\text{Yield advantage\% of HB- 546} = \frac{\text{Yield of new variety - commercial X 100}}{\text{Commercial}}$$

Variety preference ranking

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

.

Methods of Data Analysis

The collected agronomic data was organized, summarized and analyzed by statistical tools (T test) using Statistical Package for Social Science (SPSS) version 20. Independent T test was used to compare the mean yield of two independent varieties. The financial data was employed to analysis the costs incurred and the net benefit gained from the production of each variety and location used for the demonstration using excel and presented by table. The calculations were done by converting the parameters per hectare. The final selling price used was the farm gate selling price. Farmers' variety preference were also analyzed qualitatively. Knowledge level of the farmers about improved production practices of maize before and after the experiment was measured and compared by applying dependent t test. Two samples are said to be dependent on each other when the elements of one are related to those of the other in any significant or meaningful manner. In fact the two samples consists of observations made of the same objects, individuals or more generally, on the same selected population elements. It helps determine

whether the mean difference between paired observations is significant. The dependent t test is often used to compare ' before ' and ' after ' scores in experiments for the determination of the significant change that has occurred.

Results and Discussion

Yield Performance of Demonstrated Varieties

Table 18 below shows the result of yield performance of the varieties demonstrated. According to the results, a mean grain yield of 30.23 and 26.62 quintals ha^{-1} was obtained from BH-546 and commercial varieties, respectively.

Table 18. Comparison of mean yield of maize varieties demonstrated

Varieties	N	Mean yield of maize variety demonstrated (quintals ha^{-1})						
		Mean[Std. Deviation]	Std. Error difference	Calculated t value	Tabulated t value at v = 24	P-Value	95% confidence interval	
							Lower	Upper
BH-546	13	30.23[0.83]	0.96	3.68*	1.711	0.0436*	1.96	5.26
Commercial	13	26.62[0.66]						

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

As clearly shown in table above, information like the calculated t value (3.68) is greater than the tabulated t value (1.711), p- value (0.0436) less than alpha value (0.05) and the confidence interval does not contain zero which indicates that the mean difference in yield between the two varieties were significantly higher. However, the mean yield of pre-extension demonstration of improved maize variety (BH-546) were found to be less than the national average yield of maize, 39.92 quintals ha^{-1} (CSA, 2018/19). This yield difference could be associated with rainfall shortage occurred at the critical stage of the crop during production year, disparities in management practices and the fertility status of the soil. Yet the improved variety (BH- 546) still had an extra 13.56% yield advantage than the commercial check as indicated in table 3.

Table 19. Yield advantage of improved maize variety over the check.

Varieties	Yield	Yield advantage of improved BH- 546 over the check (%)
BH-546	30.23	13.56
Commercial	26.62	

Feedbacks and Farmers Preference

Farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria. During the demonstration of maize, farmers provide constructive feedback for further research on maize production. Accordingly, the participant farmers preferred improved BH- 546 variety as their first choice.

Table. 20. Direct Matrix ranking of demonstrated maize varieties by farmers preferences (N= 20)

Variety	**Rank**	**Preferred Traits**
BH 546	**1st**	Very good yield, white color, drought tolerant, disease tolerant, early mature, high weight, marketable,
Commercial	**2nd**	Good yield, white color, marketable, relatively less weight, susceptible to disease, medium mature

Capacity Development

Table 20 shows the number of farmers, Development Agents, district office of agriculture experts and other participants who attended training regarding to maize production and management before starting the activity. A total of 76 participants attended the training.

Table 21. Capacity building methods and participants

Capacity building methods	**Participants**	**Number of participants**		
		Male	Female	Total
A. Trainings	Farmers	45	15	60
	DAs	7	1	8
	SMSs	8	-	8
B. Exchange Visit	Farmers	20	-	20
	DAs	3	1	4
	SMSs	3	1	4
	Others	4	1	5
C. Field day	Farmers	24	6	30
	DAs	2	-	2
	SMSs	2	-	2
	Others	2	-	2

Monitoring and Evaluation

The activity was monitored majorly by researchers and agriculture and natural resource office of the districts which they represented by the DAs in the kebele administration. The development agents (DAs) see and monitor the activity day to day since they are near to the farmers' jurisdiction and also give technical assistant to the farmers. Joint exchange visit, monitoring and evaluation of the activities was conducted among the participating farmers of the districts based on the necessities and requirements. As a result, the group had offered advice based on the practical problem observed on the trial sites.

Mini Field Day

To show the performance of demonstrated varieties, mini field day was organized on which about 36 participants were participated on the event including FRG members to evaluate variety performance.

Economic Analysis of Maize Variety Demonstrated

Production costs and returns of demonstration of maize variety were collected from experimental farmers. Production costs included were variable and fixed costs. Variables costs include cost of land preparation, cost of seeds, cost of fertilizers, planting, weeding, harvesting and transaction cost. Fixed cost referred here was cost of land. This cost was included in this experiment as all the farmers could not owned enough farm land and contract some from their fellow farmers. So, this fixed cost parameter helps us to have insight about the profitability of this crop enterprise for rented farm land as well. During the production season the average fixed cost of the land for one season was 2500 ETB ha^{-1} at study area. Average farm gate price of both maize varieties at market during 2019 production season was 7 ETB Kg^{-1}. Pre-extension demonstration of maize was profitable with net return of 13325.61 ETB ha^{-1} and 11518.61 ETB ha^{-1} from BH-546 variety and commercial respectively.

Table 22. Financial analysis

Variable	Cost of cultivation	Growth return	Net return	Benefit cost ratio
BH- 546	7835.39	21161	13325.61	1.70
Commercial	7115.39	18634	11518.61	1.62
Additional in demonstration	720	2527	1807	2.51*

Incremental benefit cost ratio

Knowledge Level Before and After the Trial Period

Knowledge level of respondent farmers on various aspects of improved maize production technologies before conducting the demonstration and after implementation was measured and compared by applying dependent t test. A list of simple yes or no and open ended questions were

designed and administered to a total of 12 trial farmers to rate their knowledge level at both pre and post-trial period. The questions were asked during training period before starting the trial and during meeting conducted after the trial to assess farmers' feedback about varieties preference. It could be seen from the table 6 that farmers' mean difference in knowledge score after implementation of demonstration was 14.25. The mean difference in knowledge score of farmers was observed significantly higher. The computed value of t (33.405) was statistically significant at 5 % probability level. It means there was significant increase in knowledge level of the farmers due to demonstration. This shows positive impact of demonstration on knowledge of the farmers that have resulted in higher adoption of improved farm practices. The results so arrived might be due to the concentrated educational efforts made by the researchers.

Table 23. Comparison between knowledge levels of the respondent farmers about improved farming practices of maize (n=12)

Mean of the difference in knowledge scores	Standard deviation of the difference in knowledge scores	Calculated t value	Tabulated t value at v= 11
14.25	1.349	33.405*	1.796

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

Conclusions and Recommendations

The results indicated that the improved maize variety gave promising yield having a yield advantage of 13.56% over farmers' (commercial) variety. Furthermore, the improved variety was profitable with incremental benefit cost ratio of 2.51. In terms of farmers' preference, BH- 546 variety was selected as first choice by the participating farmers. Therefore, this variety is recommended for up scaling especially at the drought prone areas of the study zone, Guji.

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Pre scaling up of Bread Wheat variety in the Highlands of Guji Zone, Southern Oromia, Ethiopia

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Abstract

In Ethiopia wheat is the national strategic crop to solve food insecurity. Highland districts of Guji zone were potential producers of bread wheat varieties. The production of bread wheat on large area is limited by occurrence of rust and lack of improved bread wheat varieties. But the demand and supply of wheat is imbalance in the area. Sanate variety was used for pre scaling up with objectives of to popularize Sanate variety, improve farmers' income and improve farmers' knowledge and skills on bread wheat production. Four districts were selected based on wheat production potential. Farmers were selected based their interest to grow Sanate variety and ownership of land. 57.72 quintals of improved Sanate variety was distributed for four districts, 12 kebeles and 156 farmers were participated during 2018/2019 and 2019/2020 production seasons. 39 ha of land were covered by Sanate variety. The seed was sown 20cm between rows and drilling of 148 kg/ha seed rate in the rows. 121kg/ha of NPS fertilizer was applied at planting time. Hand weeding and 2-4-D was used to control weed. Yield data, costs of production, income from Sanate production and farmers' feedback were collected and analysed by descriptive statistics, qualitative and cost benefit analysis. Training, exchange visit and field day were used for the popularization of Sanate. 32.23 qt/ha was obtained from pre scaling up of Sanate. The cost benefit analysis shows that Sanate variety was profitable with 27,966.5 ETB/ha. Even though, Sanate gave high yield and profit at the study areas the variety was not highly demanded on the market due to its dark color. However, it was used for household consumption. The variety was also affected by rust at many farmers land. Therefore, the production of Sanate should be done with the support of fungicide in the highlands of Guji zone.

Key words: Sanate, Guji, Pre scaling up, Highland areas

Introduction

Agriculture contributes 34.1% to the GDP, employs some 79% of the population, accounts for 79% of foreign earnings, and is the major sources of raw material and capital for investment and market (MOA, 2019).

Wheat is one of the major cereals grown for use as food and industrial raw materials in Ethiopia. Bread wheat in Ethiopia is used in different forms such as bread, porridge, soup and roasted grain. In addition to the grain, the straw of bread wheat is used for animal feed, thatching roofs and bed decking (Bezabih, 2020; CSA, 2018). Wheat is also a strategic commodity which generates farm income and improves food security status (Amentae*et al.*, 2017)

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) (Adugnawand Dagninet, 2020; Goshu*et al.*, 2019; Tadesse*et al.*, 2018).

In Ethiopia, to improve the productivity of bread wheat in the country,89 bread wheat genotypes were released until 2017 (MOANR, 2019). However, the productivity of bread wheat is affected by factors such as genotypes, low use of agricultural inputs, environments, wheat rusts, management practices and their interactions (Gemechu*et al.*, 2019; Misganaw, 2017).

Despite releasing different improved wheat varieties 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). Furthermore, 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). This can be achieved through large scale demonstration and scaling up of released bread wheat varieties in their agro-ecologies.

Highland districts of Guji zone were potential producers of bread wheat varieties. Nine year ago, different varieties of bread wheat varieties namely Kakaba, Meraro, Digalu, Alidoro, Huluka, Sofumar, Shorima, Danda'a and the others were demonstrated and pre-scaled up to many farmers in highland parts of the zone. Starting from that time the demand on bread wheat varieties were created, good linkage with unions and community based seed producers were recognized. Currently these improved bread wheat varieties were out of production due to rust (both stem and leaf), and environmental hazards (frost, snow). At Guji highlands wheat is highly exposed to rust damage (Tolessa *et al*., 2013). The occurrence of rust and lack of improved bread wheat varieties made farmers reluctant to grow on large scale. Being the national strategic crop to solve food insecurity the land covered by wheat become smaller and smaller in the study areas. But the demand and supply of wheat for rural and urban household consumption is imbalance. To solve this problem participatory variety selection of bread wheat was conducted during 2017 production season. The result revealed that Sanate variety was tolerant and higher yield and recommended for further promotion in highland districts. Large scale production and scaling up of improved bread wheat varieties can fulfill the demand of wheat for rural and urban dwellers in Guji Zone. This is why pre scaling up of Sanate variety was important and disseminated to highland districts of Guji Zone.

Objectives of the activity

- To popularize Sanate variety and strengthen the stakeholders linkage
- To improve farmers' income
- To improve farmers' knowledge and skills on bread wheat production and management practices

Materials and Methods

Description of study areas

Bore, Ana Sora, Dama and Uraga were the most highland districts of Guji zone. Bore and Ana Sora was situated at a distance of 385 KM and 410 KM from Addis Ababa to the South respectively. Dama and Uraga districts are found alongside to the Southern direction of Addis Ababa. The districts have similar agro ecology where diverse crops such as bread wheat, food barley, horticultural crops (mostly potato, enset, garlic and head cabbage) and highland pulse crops (faba bean and field pea) were largely produced in each district. These districts are also known for rearing of livestock. Rural women sold of milk to near town to enhance their livelihood. White honey is produced each district from natural vegetation found in their district.

Sites and farmers selection

With collaboration of District Agriculture and Natural Resource two kebeles (sites) were selected from each district. In each district site for pre scaling up was selected based on wheat producing potential and accessible for monitoring purpose. Farmers were selected based their interest to grow Sanate variety and ownership of land. 57.72 qt of improved Sanate variety was distributed for four districts, 12 kebeles and 156 (30 women) farmers were participated during both 2018/2019 and 2019/2020 production seasons. Covering many districts and kebeles increased the popularity of Sanate and increased stakeholders' linkage. Based on farmer management practices, purchase and apply fertilizer 0.25 to 1 ha was used for this activity. Thus, 39 ha of land were covered by Sanate variety during pre-scaling up.

Agronomic practices

Land was prepared by farmers from May to August month. Plough was done by oxen. Sanate was sown from the early of June to late August. The seed was sown 20cm between rows and drilling of 148 kg/ha seed rate of Sanate in the rows. 121kg/ha of NPS fertilizer was applied at planting time. Hand weeding and 2-4-D was used to control weed. 3 Liters of Rex-duo fungicide was given freely for farmers where field day event was conducted. Other farmers intended to purchase and apply fungicide to minimize the effect rust on Sanate variety. The application of fungicide was done before occurrence of the symptom of rust. Harvesting and threshing was done manually by farmers with technical support of DAs and researchers.

Methods of data collection and analysis

Personal observation, measurements and interview were applied to collect yield data, costs of production and income generated from Sanate variety production and farmers' feedback. Descriptive statistics and qualitative analysis of farmers' assessment/feedback was used to analyze the data. Cost benefit analysis was used to estimate economic returns of Sanate variety.

Results and Discussion

Capacity building on Sanate Production and stakeholders linkage

Capacity building methods like training, exchange visit and field day were used in order to enhance the capacity of farmers, DAs, SMSs and other stake holders. Multipurpose research team and (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge during training, exchange visit and field day organized. Unions and cooperatives were participated during training and field days. Sanate variety did not popularized alone unless other recommended packages were delivered with it. Thus, Mea Boko union provides fertilizers, herbicides and fungicides for farmers ensuring linkage among key stakeholders. However, the cost of herbicide and fungicide is a key problem for farmers.

Table 24. Capacity building methods and number of participants on pre-scaling up of Sanate during both production seasons

Capacity building methods	Participants	Number of participant		
		Male	Female	Total
A. Training	Farmers	100	40	140
	DAs	20	4	24
	SMSs	16	2	18
B. Exchange Visit	Farmers	10	2	12
	DAs	4	1	5
	SMSs	3	1	4
	Others	3	1	4
C. Field day	Farmers	150	33	183
	DAs	14	2	16
	SMSs	12	2	14
	Others	80	39	119

DAs = development Agent, SMSs = subject matter specialist

Yield performance of Sanate

Average yield of both production seasons from the pre-scaling up of Sanate was 32.23 qt/ha. Mean yield obtained during both production year was greater than national average yield of wheat which is 27.64 qt/ha (CSA, 2019). The yield of pre scaling up of Sanate was lower than the yield (59qt/ha) obtained during PVS (Obsa and Yeared, 2017). The lower yield of pre scaling up is due to occurrence of leave rust during production.

Table 25. Yield performance of Sanate variety (qt/ha)

Variety	N	Mean	Std. Deviation
Sanate	156	32.2372	5.17670

Cost benefit analysis of Sanate Variety

GLEE (2014) stated that Benefit-cost analysis is a tool that is well suited for evaluating the profitability of scaling up options at the user level, or any level. Both fixed (cost of land) and variable costs (land preparation, fertilizer, sowing, weeding, harvesting, threshing, etc.) were calculated to consider the profitability of Sanate variety at study areas. On Average 1Kg of Sanate was sold at 12.43 ETB during harvesting time. Total revenue was calculated by multiplying farm gate price by yield obtained (TR= Y x P), growth marginal rate were calculated by subtracting total variable cost from total revenue (GM = TR-TVC) and the final profitability was calculating by subtracting total fixed cost from total growth marginal rate (Profit= GM-TFC). The cost benefit analysis shows that Sanate variety was profitable at the study area, which gave average profit of 27,966.5 ETB/ha.

Table 26. Net return obtained from pre-scaling up Sanate variety

Parameters	N	Mean	Std. Deviation
Yield of Sanate in qt/ha	156	32.2372	5.17670
Farm gate price of Sanate 1kg in ETB	156	12.4327	2.16950
Total Fixed Cost in ETB/ha	156	3461.5385	1220.17775
Total Variable Cost in ETB/ha	156	8806.4872	2138.83978
Total Cost in ETB/ha	156	12268.0256	3287.84820
Gross margin of Sanate in ETB/ha	156	31429.4167	8044.81796
Profitability of Sanate in ETB/ha	156	27966.5897	7340.99921

Farmers' perception

During both productions season farmers have their own feedbacks on the pre-scaling up of Sanate. Sanate variety was relatively tolerant to rust and adapted to the environment according to the farmers feedbacks. During the second year production Sanate variety was affected by leave rust at some place after milking stage. So the production of Sanate is affected based on the occurrence of rust and season. The recommended fungicides were not fully applied by farmers due to high expensive and not available on time. Being affected by leave rust the selected farmers' eager to produce Sanate due to more yield and net incomes obtained from the crop. Even though, Sanate gave high grain yield and profit at the study areas the variety was not highly demanded on the market due to its dark color. However, it was used for household consumption. Straw of Sanate variety helped the farmer for the house construction and feed for livestock. High grain yield and return can help farmers to improve their means of income.

Conclusions and Recommendations

Wheat is strategic crop to solve household food security in Ethiopia in general and Guji potential districts in particular. This household food security is maintained when large production is obtained as a result of pre scaling up and scaling out of improved bread wheat at potential areas. Sanate variety was used for pre scaling up purpose in four districts of Guji highlands. Though the color of Sanate is dark and not highly demanded at market the crop gave high yield per unit area and generates return for farmers. High grain yield and return helped the selected farmers to improve their livelihood through income generation, food self-sufficient and increase their purchasing power of agricultural inputs, etc. But the production of wheat in the highland districts of Guji zone is affected by the occurrence of rust (leave and stem). Fungicide was previously recommended for control of rust on wheat production in highlands of Guji zone. However, according to farmers' suggestion, affordability and accessibility of such fungicide is another problem for farmers to produce wheat in their area. Unions and agricultural cooperative should also provide fungicides for farmers on time. Therefore, the production of Sanate should be done with the support of fungicide in the highlands of Guji zone.

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On Farm Demonstration and Evaluation of Mung Bean Technology in Habro and Daro Lebu Districts of West Hararghe Zone, Oromia National Regional State, Ethiopia.

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Abstract

The experiment was carried out in Daro Lebu and Habro districts of West Hararghe Zone with the objectives of evaluating improved mung been varieties under farmers` field condition and to create awareness and improve skill of production and management of the improved mung been variety. Two kebeles were selected purposively based on mung been production potential; one kebele from each district. Eight farmers were included depending on their interest to the technology, managing the experiment, having appropriate land for the experiment and taking the risk in condition failure happens. NLV-1 and Rasa (N-26) improved varieties with standard check were demonstrated and evaluated. The experiment was demonstrated on 300m^2 demonstration plots. Both quantitative and qualitative data were collected through observation, farmers' feedback and data recorded. Descriptive statistics was used to analyze the collected quantitative data. While qualitative data were analysed in narration and summarization. Garret ranking method was used to rank farmers preference on mung bean selection criteria. The result of the study indicated that NLV-1 was ranked first in terms of high branch, high plant height, large pod size, high pod per plant, high yield (14.8 Qt/ha), drought tolerant and insect resistance. NLV-1 variety has more economic advantage than local variety at the study area. Thus, NLV-1 was recommended for further popularization and scaling up in study area and similar agro-ecology.

Key words: Mung bean, farmer preference, participation, NLV-1, Rasa

Introduction

Mung bean (*Vigna radiate*) is one of the most important pulse crops, grown from the tropical to sub-tropical areas around the world (Khan *et al*., 2012; Kumari *et al*., 2012). It is a warm season legume crop. It has a good ability of growing on dry and irrigated conditions (Rahim *et al*., 2010). It noted for its protein and lysine-rich grain, which supplements cereal-based diets (Minh, 2014).

Smallholder farmers in drier marginal environments of Ethiopia grow mung bean (Asfaw *et al*., 2012). Mung bean is being cultivated as a recently introduced crop in the country (Tensay, 2015). The optimum temperature range for its good production is 27-30°C (Asfaw *et al*., 2012). It is a quick crop, requiring 75–90 days to mature. It is a useful crop in drier areas and has a good potential for crop rotation and relay cropping with cereals using residual moisture (Gebre, 2015).

Mung bean is the most important cash crops in the world among pulse crops (Somta and Srinives, 2007; Pandey *et al*., 2011). It has multiple socio-economic values, including its use for food and fodder as well as soil fertility. It used as food and fodder, income generation and home consumption in the form of *nifro, kik woet* and soup (*shorba*) (Tensay, 2015). It is rich source of proteins, vitamins, and minerals where protein and micronutrient paucity are most its omnipresent. It play key role in various cropping systems and sustainable agriculture production due to nitrogen fixing ability and low water requirement (Itefa, 2016).

Moreover, there is huge demand for mung bean in the international market particularly in south-east Asia (Gebre, 2015). However, the improved varieties are not yet exposed to farmers in moisture stress areas particularly in West Hararghe. Thus, to overcome the problem adaptation trials were done by Mechara Agricultural Research Center on four improved mung bean varieties. The adapted varieties were Shawarobit (684.5kg/ha), NLV-1(703.2kg/ha), N-26 (Rasa) (610.5kg/ha) and Arkeba (379.3kg/ha). From the adapted and evaluated varieties; NLV-1 and Shewa robit were selected by their yield for further demonstration and evaluation under farmers' field condition. Hence, the study is initiated to evaluate and demonstrate NLV-1, N-26 (Rasa) and standard check varieties of mung bean in the study area.

Objectives

- To evaluate and demonstrate improved varieties of mung bean in the study area
- To create awareness on mung bean production, importance and management practices in the study area
- To identify farmers preferences towards improved mung bean technologies in the area

Literature Review

Origin of Mung Bean

The center of origin of cultivated mung bean is Asia. As Sangsiri *et al.* (2007, 2009) reported that mung bean originated in the India-Burma region of Asia because evidence provided by archae botanical findings and literary records showed that mung bean was domesticated in India where wild mung bean is widely distributed.

Distribution of Mung bean

Although native to India, mung bean is also widely cultivated in Africa, Asia and America. The wild mung bean (*Vigna radiata* var. *sublobata*) is widely distributed from tropical Africa and through west, south and Southeast Asia to Papua New Guinea and Australia (Sangiri, 2009).

Historical Perspectives of Mung bean in Ethiopia

According to ECXA (2014), mung bean is being cultivated as a recently introduced crop in Ethiopia. It is also grown in few areas of North Shewa and hence its consumption is no widespread like the other pulses. Farmers used mung bean in bordering areas to make soil fertile without providing fertilizer on the land. So, farmers regard mung bean as traditional crop. Mung bean in Ethiopia was landraces which are similar from one village to another and cultivated by traditional farming. The recently introduced mung bean is also grown in limited areas in smaller quantity.

Climate Requirements of Mung bean

Mung bean is an important food legume cultivated in many tropical and sub-tropical parts of the world (Iqbal, 2010). It is also cultivated in semi-arid condition of the tropical and warm regions of the world (Rahim *et al*., 2008; Sangsiri, 2009). It is a warm season crop requiring 90-120 days from sowing to maturity depends on variety of the crop. Adequate rainfall is required from flowering to late pod filling to achieve high grain yield (Zare *et al*., 2013). It is mostly grown during summer season when the temperature and light irradiance fluctuate frequently.

Cropping System of Mung bean

Mung bean is cultivated mostly in intercropping and sole cropping systems. Intercropping is a practice of growing two or more crops simultaneously in the same field in a particular growing season (Tensay, 2015). According to Onuh *et al*. (2011), intercropping mung bean with other crops confers advantages such as improved soil fertility through nitrogen fixation, shading of the soil surface and protection against erosion. It is also reduces the risk of damage due to biotic and abiotic factors.

Importance of Mung bean

Mung bean has ecological and socio-economic importance to those local consumers who are highly dependent on it (Tensay, 2015). Among pulses, mung bean is the most important cash crops in the world (Somta and Srinives, 2007; Pandey *et al*., 2011). It is a vital crop in developing countries where it is consumed as dry seeds, fresh green pods or leaves due to its high protein, vitamin and mineral content. It is also consumed as forage or green pods and seeds as vegetables (Tang *et al*., 2014; Das *et al*., 2014). Primarily, the purposes of this crop are for its protein rich edible seeds and fresh sprout. The seed of mung bean mainly used for making soups, bread and biscuits (Sehrawat *et al*., 2013).

Table1:Trend of Green mung beans export performance in Ethiopia.

Budget Year	Production (Mt)	Value (Usd)	Unit Price/Mt (Usd)
2005/06	2,310	1,732	749.9
2006/07	5,667	3,661	646
2007/08	2,873	1,754	610
2008/09	1,471	918	624
2009/10	44	24	550
2010/11	7,964	10,007	1,256
2011/12	10,570	10,867	1,028
s2012/13	17,396	16,712	961

Source: Kasahun, 2013

Constraints of mung bean

There are a number of biotic and abiotic factors that lead to decrease crop quality and productivity of mung bean. Abiotic factors include water stress, drought, temperature, salinity stress, while biotic factors include diseases, insect pests and weeds (Waniale *et al*., 2012; Das *et al*., 2014).

Strategy Development Approach of Agricultural Extension in Ethiopia

According to ATA (2014), the key principles identified for the development of the strategy documents and its further implementation are: (1) ensuring market-led production system, (2) developing location-specific and agro-ecology-based interventions, (3) development of competent and skilled human power, (4) specialization and diversification, (5) maximizing the available potential, (6) maximum use of rain fed and irrigated agriculture, (7) deploying participatory extension methods and approaches, (8) gender mainstreaming, (9) NRM & environment mainstreaming, (10) value chain based extension approach, (11) government-led pluralistic extension service provision, (12) promoting financial literacy and improved access to finance, and (13) scaling up of good practices.

Methodology

Description of the study area

On-farm demonstration of Mung bean technology in Daro Lebu and Habro districts of West Hararghe zone was conducted in 2018/2019 production season. The capital town of Daro Labu district which is Mechara town found at 434 km from Addis Ababa in South East. The district is situated between $7^{o}52^{'}10^{''}$and $8^{o}42^{'}30^{''}$ N and $4^{o}023^{'}57^{''}$ and $41^{o}9^{'}14^{''}$E. The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 up to 2450 m.a.s.l. The ambient temperature of the district ranges from 14 to 26^{0}C with average of 16^{0}C with annual average rainfall of 963 mm/year. The pattern of rainfall is bimodal: the short rainy season '*Belg*' lasts from mid-February to April whereas the long rainy season '*kiremt*' is from June to September. The rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular. Consequently most *kebeles* frequently face shortage of rain; hence moisture stress is one of major production constraints in the district (DLWADO, 2019).

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

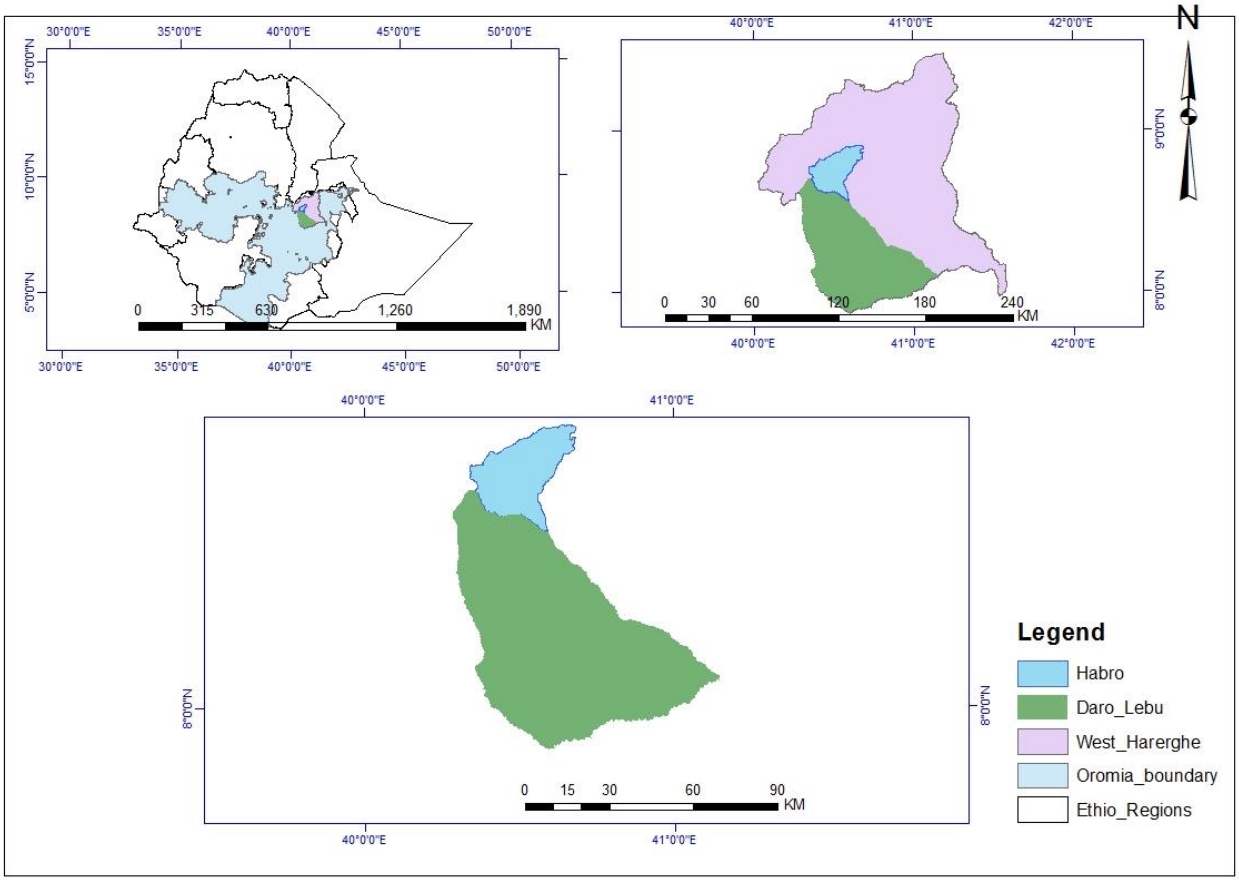


Figure 1: Map of the study area
Source: Own design from Arcgis data (2020)

Types of Data and Method of Data Collection

Data Types

Agronomic data were collected for this activity, like date of sowing, farmer's preference and yield per area were collected.

Method of Data Collection

Checklist and data collection sheet were developed prior to planting. Then, personal observation, field day, individual contact (listening to trial farmers) during site visit were used for data collection purpose. Close supervision and monitoring were undertaken through joint action of stakeholders. Finally, field days were organized for different stakeholders including farmers and DAs to get feedback from them.

Site and Farmer Selection

Two potential mung bean producer districts (Daro Lebu and Habro) were selected from West Hararghe zone. Two PAs were selected from the considered districts one from each and totally eight farmers and one FTC were selected for the accomplishment of the activity. Thus, six adult male, two adult female, and one FTC were selected for achievement of the experiment

Research design

Two improved mung bean varieties (N-26 and NLV-1) with Standard check were demonstrated on farmer's field. The experiment was demonstrated on 10m by 10m plot for each treatment. Row sowing and recommended seed and fertilizer rate were applied. The space between row and plant were 30cm and 10cm, respectively.

Method of data analysis

Quantitative data collected data were descriptively analyzed. While, qualitative data were analyzed and presented through narration, exploration and summarization. Garret ranking method was used to rank the three mung bean varieties (two improved and one standard check) based on the criteria used to select mung bean variety.

Technology Promotions and Capacity Building

Concerning awareness creation, training was organized for farmers, DAs and SMS for the selected stakeholders. In addition, field day was organized to promote the well performed technology and accepted by farmers.

Approach used

Training was organized for the selected experimental farmers and respective DAs concerning Mung bean production and management systems. Then, sowing was conducted jointly with researchers (extenstionists and pulse agronomist), farmers and extensions agents in each district. Close supervision and monitoring were undertaken through joint action of stakeholders. Finally, field days was organized for different stakeholders including farmers to create awareness, selection of performed varieties and boost the dissemination of the varieties through farmers to farmers. Different extension materials such as leaflet and manuals of training were delivered to the farmers during the field day and training for the available farmers, extension agents and agricultural office experts. Moreover, the outputs gained from the study were communicated on field day program, mass media and written materials.

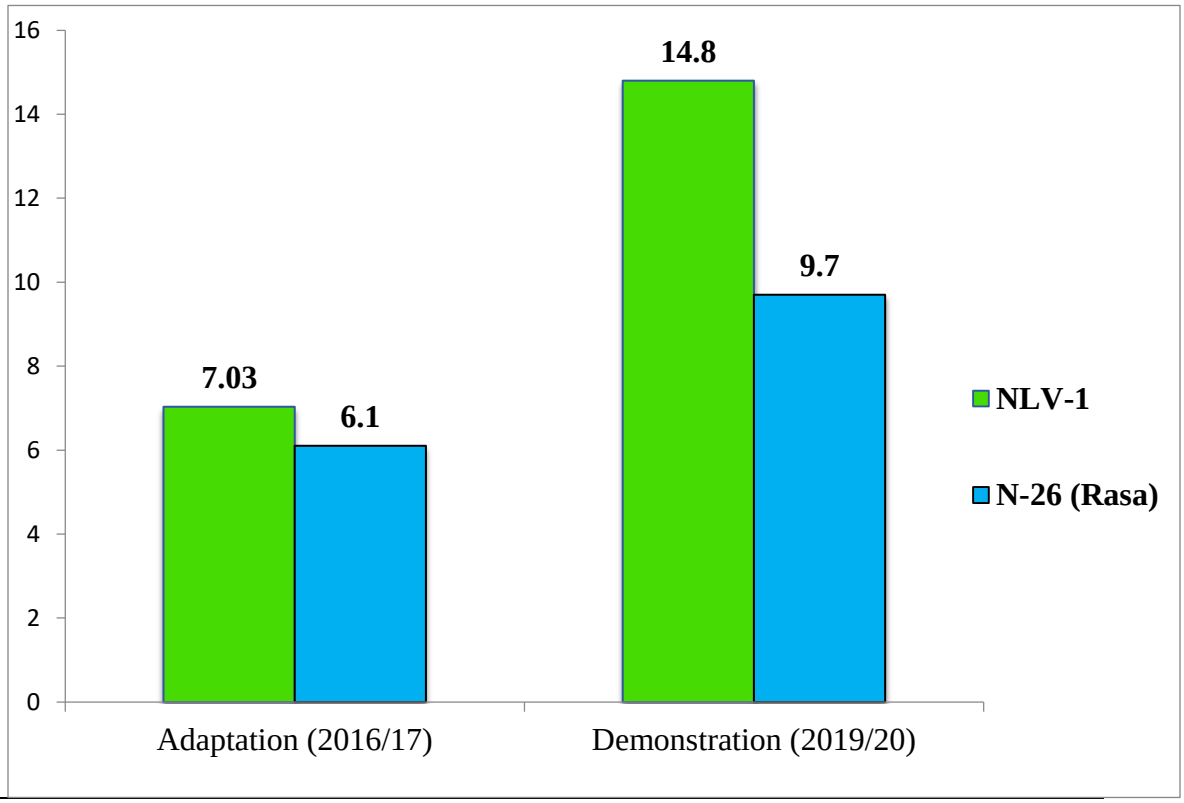
Result and Discussions

Descriptive analysis result

Yield gained

The yields data were harvested only from five farmers among the trial farmers in Habro and Daro Lebu districts. The result of Table 2 revealed that the average yield obtained from the improved Mung bean varieties accounted that 14.8 Qt/ha for NLV-1, 9.7 Qt/ha for N-26(Rasa) and 12 Qt/ha for Standard check. The highest yield recorded from NLV-1 and followed by Standard check and N-26 (Rasa) varieties. There was a high mean difference yield obtained between improved NLV-1 and N-26 (Rasa) variety.

Table 2: The mean yield of improved mung bean technologies and its yield advantage

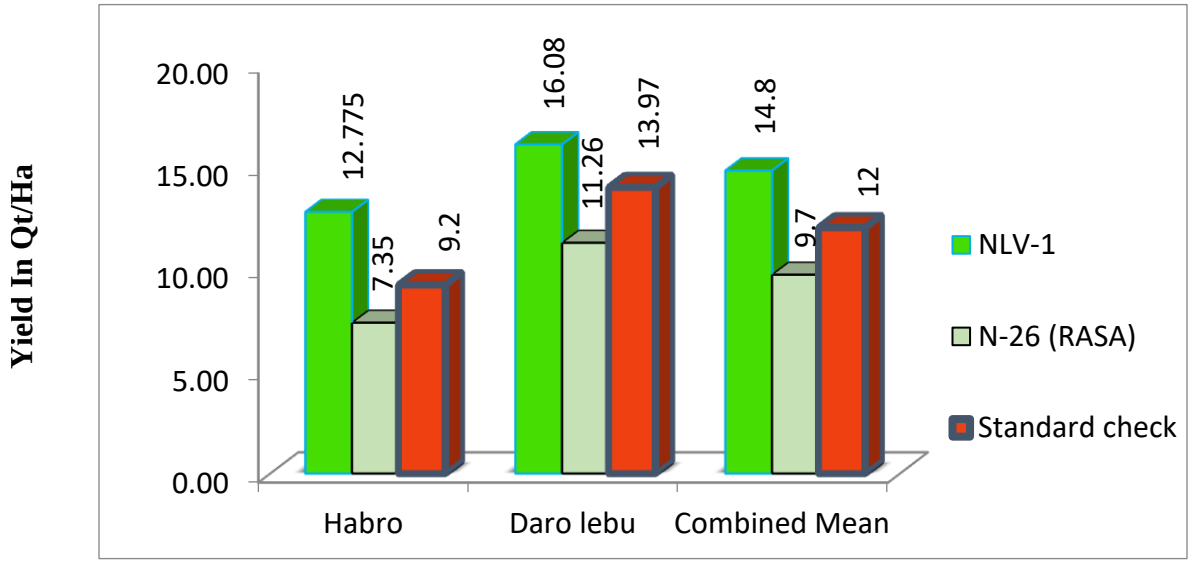


Varieties	Yield (Qt/ha) (N=5)				Mean difference over check (Qt/ha)	Yield advantage over check (%)
	Min.	Max.	Mean	Std. Dev.		
NLV-1	9	24	14.8	5.97	2.8	23.3%
N-26 (Rasa)	7.2	17	9.7	4.11	-2.3	-19.16%
Standard check	9.1	22	12	5.59	0	0

Source: Our results, 2020

Trial stage

Figre 2:- comprasion of mean yeild at adptation and demostration



Districts

Figure 3: Combined mean yield across varieties and Districts

Extension services

The concept of extension services has changed over time. While technological transfer is still important, more emphasis is being placed on expanding the skills and knowledge of farmers (i.e., human capital development), enhancing rural livelihoods, achieving food security, and creating more efficient farmer-based organizations (Swanson, 2008). Christoplos *et al*. (2010) defines agricultural extension services as "all the different activities that provide the information and advisory services that are needed and demanded by farmers and other actors in agri-food systems and rural development." It also includes, for instance, "facilitation, brokering and coaching of different actors to improve market access." According to Christoplos *et al*. (2012), agricultural extension services can be classified primarily into three areas, technology and information sharing, advice related to farm, organizational, and business management and facilitation and brokerage in rural development value chains. Accordingly, we were delivered the improved mung bean technologies, advisory services during site supervision, training and field day to experimental farmers in the study area.

Technologies demonstrated

The two improved mung bean varieties were demonstrated with their full package of technologies on the farmers' field. Mung bean NLV-1 , N-26 (Rasa) and standard check varieties were demonstrated on experimental farmers' field on 10m*10m plot size along the Standard check variety. The demonstration was includes the agronomic practices such as spacing (30cm and 10cm between rows and plants), seed rate (15kg/ha), management practices (weeding,

cultivating and others), land preparation, soil type and all other recommendations were followed. The 0.15kg amounts of the seed rate were demonstrated on one plot size for one variety. A total of 0.45kg of seed was used to demonstrate all varieties on each farmer field. The 1kg of DAP fertilizer rate on one plot size and a total of 3kg of DAP fertilizer were used to demonstrate on each farmers field in the two districts.

Training

Training is one of the extension services delivered for the farmers to improve their knowledge, skill and attitudes on mung bean technologies. The training is delivering to the farmers at different stages before, during and after the implementation of the research projects (Bedru *et al*., 2009). The training was given to the farmers and other relevant stakeholders before the implementation of the demonstration on farmers' field. The training given to the participants on mung bean production, pre-harvest and post-harvest management and extension methods for technology demonstration and communication for wider communities engaged on mung bean production.

Accordingly, 8 experimental farmers, 3 development agents and 2 agricultural experts were participated on the training given by pulse breeder and extensionist researchers at Mechara town for two days. Two ways communication methods were applied during training delivery period for sharing their knowledge and experiences. The reason behind was the farmers have a lot of enrich knowledge and experiences on mung bean production throughout their life. The National Ethiopian Agricultural Extension System (NEAES) (2014) indicated that participatory extension system is the focus through jointly integrate farmers into group, developments and agricultural profession through training farmers in different agricultural technologies. The training program helps the actors (farmers, extension agents, experts and researchers) of the agriculture to link each other and know the same information on the research demonstration trails.

Advisory services

In collaborative farmers' participatory research, the researchers and farmers jointly participated in the design, implementation and evaluation of the demonstration trail (Bedru *et al*., 2009). In the participatory research, researchers and development agents living in the area to serve the farmers were advising the experimental farmers during supervision of the Mung bean demonstration trial. The researchers were supervising the demonstration trail four times (germination, flowering, maturity and threshing) per cropping season in both locations. The farmers were obtained advisory services on weeding practices, management, harvestings and storage mechanisms of the crop. The farmers, extension agents and researchers were jointly sowing the crop on farmers' field. After training delivered, even there was a management gap observed among experimental farmers land.

Field day and awareness creation

Field day is a kind of meeting where by farmers, agri-business people and agricultural scientists and all stakeholders in agriculture discuss and interact fully with each other about agricultural practices (Akinsorotan, 2009). The importance of the field day is an opportunity for farmers to learn by seeing the performance of recommended practices adopted by other successful farmers. Farmers also discuss the pros and cons of the field day informally with their fellow farmers, extension workers and the subject matter specialists. Field day is an opportunity for the farmers to evaluate the technologies through their own criteria. It can be two or three times which the stages are at vegetative, flowering and maturity depending on crop type and nature produced (Bedru et al., 2009).

Accordingly, the field day was organized at maturity stage of the mung bean crop on Habro districts. A group of farmers, subject matter specialists, communication experts, researchers and other experts were involved on the program. There are 67 (58 Male, 9 Female) farmers, 3 (2 Male, 1 Female) extension agents and 12(8 Male, 4 Female) subject matter specialists were participated in the program (Table 3). Field visit through facilitator, on-field technology selection, group discussion and general discussion were the major methods used in the program. The Bedru *et al*. (2009) indicated that defining purpose, planning, implementation and evaluation of the program is important in conducting field day on the farmers' field. In the program, farmers were selecting the mung bean varieties based on different criteria for further production. Beside this, 120 leaflets on mung bean production were delivered for the participants of the field day program organized to create awareness on the improved mung bean technologies.

Table 3: Field day participants in Habro district by gender and profession

Locations	Participants of the field day								
	Farmers					DAs	SMS	Other	Total
	Adult M	Adult W	Youth M	Youth W	Total				
Bareda PA	58	9	0	0	67	9		7	16
Total	**58**	**9**		**0**	**67**	**9**		**7**	**83**

Note: M-stands for male, F-stands for Female and T-stands for total, DAs- stands for Development agents and SMS-stands for subject matter specialists.
Source: Our results, 2019

Farmers' preferences

Farmers' preferences are the most important type of data that cannot be missed in improved agricultural technologies demonstrations under farmers' circumstances. The rationale behind to use farmers preferences as part of demonstration is due to the fact that the objectives of researchers usually yield maximization may differ from objectives of farmers like market, quality, household utilization and results from conventional research process takes a long time to

reach to the farmers (Yalem, 2017). Accordingly, the farmers' preferences data on improved Mung bean technologies were collected at maturity stage of the crop through organizing field day. The data were collected at farmer's field at Bareda *kebele* in Habro district. Both women and men were participated on field day for technology evaluation and selection at farmer's field.

On the farmer's field, the mung bean variety selection criteria's were listed by the farmers and ranking was conducted in a group. Farmers' preferences were ranked in garret ranking method. The result of Garret ranking techniques depicted on Table 4 showed that number of pod per branch, number of seed per pod, seed size/shape, early mature, drought tolerant and disease resistant were the major criteria used by the farmers to evaluate mung bean varieties in the study area. Accordingly, NlV-1 variety was ranked first in most of criteria using garret ranking method of farmers' perception except disease resistant; while Standard check variety was the least preferred by farmers in all criteria.

Table 4: The result of Garret ranking techniques of mung bean varieties selection criteria

Variety	Ranked criteria											
	NPP		NSP		SS		EM		DT		DR	
	Garret score	Percentage	Garret score	Percentage	Garret score	Percentage	Garret score	Percentage	Garret score	Percentage	Garret score	Percentage
NlV-1	945	**9.45**	920	**9.20**	1005	**10.05**	920	**9.2**	630	**6.3**	860	**8.6**
N-26 (Rasa)	835	**8.35**	850	**8.50**	830	**8.30**	880	**8.8**	570	**5.7**	885	**8.85**
Standard check	770	**7.70**	770	**7.70**	700	**7**	705	**7.05**	460	**4.6**	760	**7.6**

Note: NPP = Number of pod per branch; NSP = Number of seed per pod; SS = Seed size/shape; EM = Early mature; DT = drought tolerant; DR = Disease resistant

Conclusions and Recommendations

Conclusions

NLV-1 and N-26 (Rasa) varieties of improved mung been were evaluated with standard check on eight experimental farmers land. From the evaluated treatments NLV-1 variety has more mean yield (14.8qt/ha), standard check (12qt/ha) and N-26 (Rasa) 9.7qt/ha). Even though the varieties did not record its potential yield due to insect problem, NLV-1 variety has more yield advantage than both varieties in the study area. Farmer has also selected NLV-1 variety in terms of high branch, high plant height, large pod size, high pod per plant, high yield, drought tolerant and insect resistance on the organized field day. Besides, observation and the experiment result the importance of the crop towards its market purpose and income motivated the farmer to accept the technology, expand and disseminate the seed further on its own land for the future.

Recommendation

Thus, based on its great importance of the crop and yield potential obtained from the result, NLV-1 variety was recommended for further scaling up to reach huge farmers and cover wide areas. Therefore, concerning bodies like research centers, district agricultural office, NGOs and other development institutions should have to be multiplied and disseminate the crop in study areas and similar agro-ecology.

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Pre Extension Demonstration of Food Barley Technologies in Chiro, Gemechis and Tullo Districts of West Hararghe Zone, Oromia National regional State, Ethiopia

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Abstract

The study was conducted in three districts where barely production is potential with objectives of evaluating & demonstrating improved varieties of food barley under farmer's condition in the study area. Three kebeles were selected purposively based on food barley production potential. Accordingly, Kuni segeria kebele from Gemechis, Arbarakate from Chiro district, and Gara Kufa kebele from Tulo district were selected. Twelve farmers were included to participated depending on their interest to the technology, managing the experiment, have appropriate land for the experiment and taking the risk of experiment. Two improved varieties namely BH1307 and Bentu with local variety were evaluated on simple design of 10mX10m land area for each variety. Both quantitative and qualitative data was collected through observation and directly from plot through data recording sheet. Descriptive statistics like mean and tabulation were used to analyze the crop performance concerning yield of the experiment. Improved varieties along with local variety were also analyzed through independent t-statistics. The study result revealed that Bentu variety gave slightly higher yielder (24.1 Qt/hec) with 3% yield advantage over the standard check while BH- 1307 showed only 1.7% yield advantage over the local check under farmer's condition. On the other hand, the result of independent sample t-test indicated that there was no significant difference between improved varieties (BH-1307 & Bentu) while significant difference was observed when both improved varieties compared with local check. *Hence, it recommended that both food barely varieties (BH1307 and Bentu) for further scaling up in similar agro-ecologies thereby government organizations, non-governmental organizations, and private sectors engaged in agriculture.*

Introduction

Barley (*Hordeum vulgare* L.) is one of the most important cereal crops in the world. It is widely grown fourth cereal and among top ten crop plants in the world. Barley was mainly cultivated and used for human food supply in the last century but nowadays it is significantly grown as animal feed, malt products and human food respectively (Taner *et al*., 2014).

Barley is an important grain crop in Ethiopia and has diverse ecologies being grown from1800 to 3400 m altitude in different seasons and production systems (Muluken, 2013) and makes Ethiopia being the second largest producer in Africa, next to Morocco, accounting for about 25% of the total barley production in the continent. Ethiopia is ranked 21th in the world in terms of barley production with a share of 1.2% of the world's total production and the second largest barley producer in Africa, next to Morocco and followed by Algeria, accounting about 25% of the total barley production in the continent (Abu and Teddy, 2014).

Barley is a major stable food and it takes the lion share in terms of the extent of production and food consumption in Ethiopia. There are two types of barley that farmers grow in Ethiopia namely food barley and malt barley. The majority of barley that farmers grow is food barley and it is the main ingredient for several staple dishes such as injera, porridge, and bread. Food barely is a cheaper cereal than maize, wheat, and teff and is often used as a substitute for lower income families (Samuel W., 2016). At the national level from the total area of cereals allocated in hectare, barley covered 951, 993.15 hectare with average yield of 21.57 Qt/ha. The total yield of barley harvested in this year was 20.5 million Qt in 2017/18 cropping season (CSA, 2018). Oromia, Amahara, Tigria, and SNNP regions are the most barley producing regions in Ethiopia.

Barley is the most important crop with total area coverage 451,279.26 hectares in which 10.9 Qt yield harvested with average of 24.12 Qt/ha in Oromia, and 6,737.49 ha in West Hararghe zone (CSA, 2018). West Hararghe zone is among some of the places in the region where food barley is grown as one of the major cereal food crops of highland and midland agro ecology. Most farmers of the zone produce food barley on hectares of land. However, their average productivity is low per hectare because of the existing cultivation is not supported with new and better technologies such as high yielding and adaptive varieties with improved cultivation practices.

Therefore, improving production and productivity of barley in West Hararghe is mandatory through availing new technology to contribute in to livelihood of farming communities. Hence, Mechara Agricultural Research Center has been conducted PVS of food barley varieties at Chiro, Gemechis and Tullo district in 2017/18 cropping season. The result of the trial revealed that HB1307 and Bentu varieties gives higher yield than others. The yield obtained from HB1307, Bentu and local check were 46.55 Qt/ha, 44.07 Qt/ha & 39.40 Qt/ha, respectively and improved varieties showed yield advantage than local check by 18.2% and 11.9%, respectively (Gebeyo *et al*, 2018).

Therefore, there is need to further evaluation and promotion of HB1307 and Bentu varieties under farmers' condition in the study area. So, this research was initiated with the objective of evaluating & demonstrating improved varieties of barley in the study area.

Methodology

Description of the study area

Chiro district is located in West Hararghe Zone of the Oromia National Regional state at about 324 km East of Finfine, the capital city of Oromia regional national state. The capital town of the district is Chiro, which is also the capital town of the Zone The district bordered with Miesso in the North, Gemmechis in the South, Guba-koricha in the West and Tulo in the East. Mixed farming, both crops and live stocks production, is the dominant practice in the district covering 98% and the rest is of pastoral production system with a share of 2%. The district is founded at an average altitude of 1800 m.a.s.l. From the total land area/topography of the district 45% is plain and 55% steep slope. The total number of population of the district is estimated to 184,705 out which 95,751 are male and 88,954 are female (Gosa *et. al*., 2016).

Gemechis district is one of the 14 districts in West Hararghe zone which is located at 343 km east of Addis Ababa and about 17 km south of Chiro, capital town of the zone. It shares borders with Chiro district in the west and north, Oda Bultum district in the south and Mesala district in the east. The district covers an area of 77,785 ha and it has 35 rural and one urban Peasant Association. The total population of the district is 184,032 of which 93,659 are males and 90,373 are females. The number of agricultural households in the district is estimated to 38,500 with 32,308 male headed and 6,192 female headed. The average family size is estimated to be 6 and 4 per household in rural and urban areas respectively (Aman *et.al*., 2014).

Tulo district has 45,670 hectares of land area and located 370km southeast of Addis Ababa. The altitude of the district is 1750 meters above sea level with mean annual rainfall of 1850ml and mean annual temperature of 23°C. It is found at the coordinate between 41^0 7’ 11.05’’E and 9^0 12’ 14.31’’ N. The production system is mixed type in which extensive husbandry management.

Site and Farmer Selection

The experiment was conducted for one year in Chiro, Gemechis & Tullo districts of West Hararghe zone. One Kebele from each district was selected purposively based on production potential of barley with collaboration of district agricultural office. Accordingly, from each kebeles **four (4)** farmers were selected, and then a total of **twelve (12**) farmers were participated on the experiment. Farmers were selected based on gender balance, willingness to provide land for the trial, promise to manage the field continuously, interest to provide labour without any support and willingness to communicate the result for fellow farmers.

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

Location/district	**Kebele**	**No. of trial farmers**	**Varieties used for the trial**
Gemechis	Kunisegaria	3	BH-1307, Bentu & local check
Chiro	Arbreket	2	
Tullo	Gara Qufa	2	
Total		**7**	

Source: Own result, 2019/20

Field Preparation and Trial Establishment

Two improved Barley varieties namely HB-1307 and Bentu were compared with local check under farmer`s condition of the study area. Simple plot size of 10mX10m was used for this activity for each variety on selected farmers. A spacing of 20cm between rows was applied and planting will be done by drilling seeds in rows with a seed rate of 100kg ha-^{1}. NPS fertilizer was applied at the rate of 100kg ha^{-1} at the time of planting and Urea will be applied at vegetative stage before booting at the rate of 50 kg ha^{-1}. Training was given for twelve (12) farmers and respective six (6) Developmental Agents concerning food barley variety production and management. Close supervision and monitoring was undertaken through joint action of stakeholders.

Data Types and Method of Collection

Quantitative data (gained yield) were collected from each demonstration plot or farmers field directly 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. Independent sample t-test was employed to identify the statistical difference of the yield among the varieties

Results and Discussion

Crop performance and yield advantage of improved variety on the farmer's field

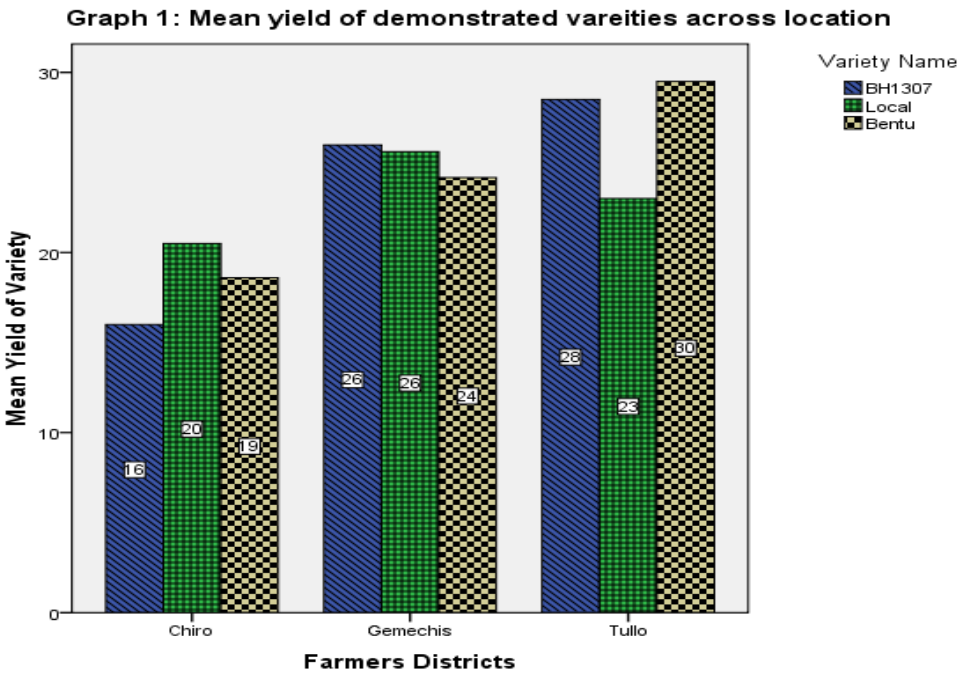
The mean yield of BH-1307 and Bentu varieties were 23.8 and 24.1 with standard deviation of 9.6 and 7.4, respectively while mean yield of the local variety was 23.4 with standard deviation of 4 in terms of Qt/hec. The result of the study was inconsistence with the result of (Gebeyo *et al,* 2018) in which BH-1307 variety give higher yield than Bentu variety. The percentage increase in the yield of both improved varieties over local check was observed during demonstration time even though it was not significant. Accordingly, Bentu variety gave slightly higher yielder (24.1 Qt/hec) with 3% yield advantage over the standard check while BH- 1307 showed only 1.7% yield advantage over the standard check under farmer's condition.

Table3: Yield Advantage of Improved Variety over local check across district (N=7).

Variety Name	Max.	Min	Mean	Std deviation	Mean difference over check(Qt/hec)	Yield advantage over local check (%)
Bentu	34	14	24.1	7.4	0.7	3
HB1307	40	15	23.8	9.6	0.4	1.7
Local	29.4	16	23.4	4	-	-

Source: own result, 2019/20

On the other hand, the result of the study indicated that both improved varieties of food barley gives higher yields at Tullo district while at Chiro district local check gives higher yield than both improved variety but not show statistically difference (graph 1).



Independent Sample t-test Result

The independent sample t-test was employed to identify the statistical difference of the yield among the varieties across study area. The independent sample t-test result indicated that there was no significant difference between improved varieties (BH-1307 & Bentu) while significant difference was observed when both improved varieties compared with 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 3: Independent t-test result on mean yield of improved food barely varieties

Combination of Varieties	Mean yield(Qt/hec)			t-value	Sign
	Mean	Std. deviation	Std. Error		
Bentu	24.1	7.4	2.8	0.059^{ns}	0.502
BH-1307	23.8	9.6	3.6		
Bentu	24.1	7.4	2.8	0.109**	0.069
Local	23.4	4.01	1.5		
BH-1307	23.8	9.6	3.6	0.022**	0.038
Local	23.4	4.01	1.5		

Note: * indicate significant at 10% and ** indicate significant at 5% level.
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Conclusion and Recommendation

The study showed that the improved food barley varieties (Bentu and BH-1307) had shown slight performance in grain yield than local check. Thus, production of food barley with improved varieties has been found more productive under farmer's condition. The independent sample t-test result indicated that there was no significant difference between improved varieties (BH-1307 & Bentu) while significant difference was observed when both improved varieties compared with 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.

Hence, the office of agriculture of the respective districts should further popularize to a large number of farmers in similar areas. Seed producer enterprise, cooperatives or organized seed producer farmers groups should continuously and consistently multiply and supply the seeds of those varieties to support sustainable seed supply food barley varieties in the area.

Referances

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Pre Extension Demonstration of Food Barley Technologies in Chiro, Gemechis and Tullo Districts of West Hararghe Zone, Oromia National regional State, Ethiopia

[1]Fekede Gemechu* and [1]Nimona Sime and [2]Gebeyo Chala

[1]Oromia Agricultural Research Institute, Mechara Agricultural Research Center, Mechara, Ethiopia, [2]Oromia Agricultural Research Institute, Bedele Agricultural Research Center, Bedele, Ethiopia.

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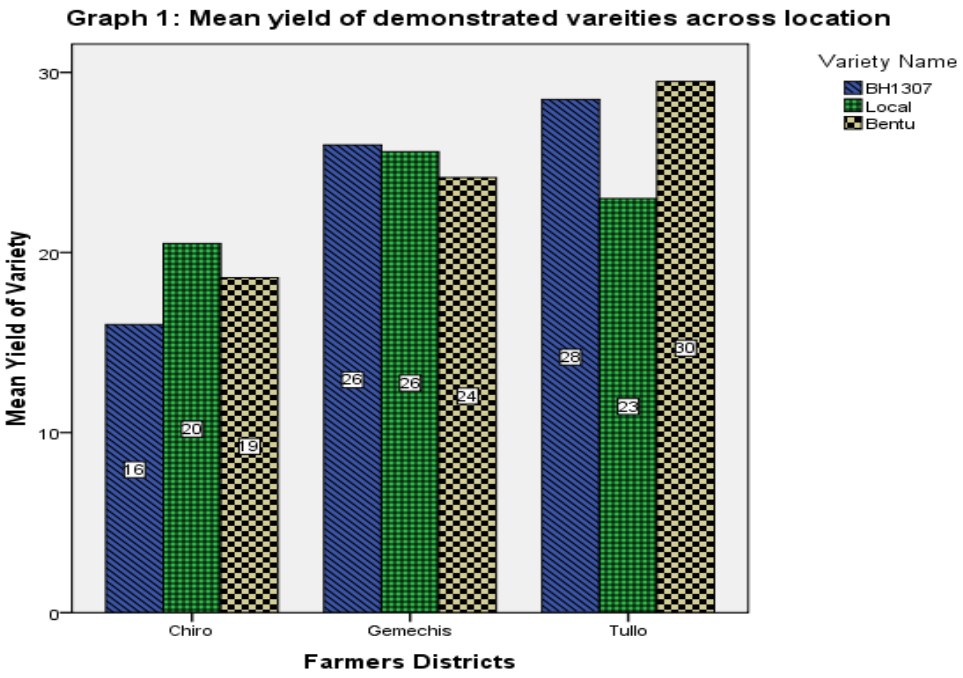

Independent Sample t-test Result

The independent sample t-test was employed to identify the statistical difference of the yield among the varieties across study area. The independent sample t-test result indicated that there was no significant difference between improved varieties (BH-1307 & Bentu) while significant difference was observed when both improved varieties compared with 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.

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Participatory Evaluation and Demonstration of Improved Haricot Bean Varieties in Daro Lebu & Habro Districts of West Hararghe Zone, Oromia National Regional State, Ethiopia

Fekede Gemechu and Nimoona Sime*
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Abstract

The activity was conducted in 2018/19 main cropping season at Daro Lebu and Habro districts of West Hararghe zone. Two improved Haricot bean varieties namely Awash-2 and Carcar were demonstrated with the objectives of to evaluate improved variety of Haricot bean under farmer's condition ***and*** *to enhance farmers' skill & knowledge on haricot bean production through participatory demonstration in the study area. Two kebeles (one kebele from each district) were selected purposively based on haricot bean production potential. A total of seven farmers; two from Daro Lebu and five 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, farmer's preferences were collected and analyzed by using simple rank analysis. Financial analysis was also used to analyze the economic benefit gained from the experiment. The result of the study revealed that improved varieties had yield advantage over the local check. The highest yield (1550 kg/ha) was recorded by Carcar variety with 25% yield advantage over the local check under farmers practices. On the other hand, Awash-2 Varity was ranked 1st then followed by Carcar as 2nd based on numbers of pod per plant, numbers seed per pod, seed size, early maturity, drought tolerant and disease resistance identified as selection criteria Therefore, Awash-2 & Carcar varieties were recommended for further scaling up to enhance haricot bean productivity under smallholder farmers.*

Key Words: *Improved variety, Farmers preference, Demonstration, Profitability and Farmers*

Introduction

Ethiopia is known as the homeland of several crop plants. It is ranked 13th among pulse producing countries in the world (FAO, 2015). The country produced about 2.8 million tons from total land of 1.5 million hectares in 2016/17 (CSA, 2017). Pulses play crucial economic, and food and nutrition security roles in Ethiopia. Recently, the production and supply of pulses, increased due to increased demand in both local and international markets, thus enhancing smallholders' income (Chilot et al., 2010). Haricot beans are among the most important grain legumes produced by small-scale farmers, both for subsistence and cash. They are usually intercropped with complementary crops such as maize, sorghum, and *enset* owing to increasing population pressure on agricultural land and paired nutrient needs in the soil. There are two main types of beans, red and white. Smallholder farmers typically grow the red bean types for household consumption, while white haricot beans are produced almost exclusively for the export market (Ferris and Kaganzi, 2008).

According to FAO (2015) haricot beans have a high nutritional value, are rich in calcium, phosphorus and iron, and are thus considered a key crop for improving food security. Beans in Ethiopia are traditionally seen as a ‘’poor man’s food’’ by the medium to high income urban and rural consumers, and thus urban demand is low. For instance, pulse retail in many major town centres do not want to keep haricot beans or others pulses (i.e. chickpeas, lentils, split peas, fava beans), implying that their customers were less interested in these low value products. Consumption of haricot beans are common for the rural poor in the major producing areas, however, with the food price spike and increasing awareness about its nutritional value, the perception of haricot beans is changing rapidly in urban centers.

Haricot bean (*Phaseolus vulgaris L.*) has been an export pulse crop for Ethiopia for more than 50 years and probably been grown as food crop for a much longer period in the low and mid land altitude areas of the country (Ferris and Kaganzi, 2008). There are a wide range of haricot bean types grown in Ethiopia, including red, white and black varieties. The leading white bean varieties are the Awash 1, Awash melka and Mexican 142 varieties. The pure red and pure white colored beans are the most common commercial varieties (Ferris et al., 2007). It is ranked as the second largest pulse crop in the country in terms of production with a share of 16.45 percent, next to Faba beans (CSA, 2017). The production obtained from faba beans, haricot beans (white) haricot beans (red) and chick peas was 3.02% (about 8,780,108.79 quintals), 0.43**%** (about 1,259,801.75 quintals), 1.23% (3,579,424.75 quintals) and 1.53% (4,441,459.26 quintals) of the grain production, respectively.

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). The crop is grown either as a sole crop and/or intercropped with either cereal or perennial crops (Rahmeto, 2007). From total production area of a country, oromia region covers around 116,696.94 hectares of land and obtained total yield of 1 million tones in 2016/17 cropping season. The average yield harvested from one hectare in the same year indicates about 1.7 tones which is low. West Hararghe zone also produce haricot bean for both food and marketing purpose. In 2016/17 cropping season a total of 5,178.41 hectar of land was covered with haricot bean (CSA, 2017/18).

The lack of improved varieties is one of the top problems for low yield of common bean in the country (Fekadu G. 2007). Similarly, shortage of improved variety was major problem which causes low productivity. Considering this problem Mechara Agricultural Research Center has been conducted adaptation trial of white haricot bean varieties at Daro Lebu, Habro and Meiso district in 2017/18 cropping season and the result of the trial revealed Awash-2 gives (2800 kg/hec) followed by Carcar (2530 kg/hec) & standard check (Awash-1) (2390 kg/hec) in which those varieties gives higher yield. Therefore, promotion of those improved varieties which are adapted to the study area should be needed to enhance agricultural productivity and improved nutrition of people living in the study areas especially smallholder farmers. The aim of this study was (i) to evaluate improved variety of Haricot bean under farmer’s condition and (ii) to enhance farmers’ skill & knowledge on haricot bean production through participatory demonstration in the study area.

Material 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- 32°C (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).

Farmer's selection and demonstration field establishment

The study was conducted in Daro Lebu and Habro districts of west Hararghe zone in 2018/2019 cropping season. Site and farmers selection was conducted with participation of respective district of Agricultural and natural resource Office based on haricot bean 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 (five farmers from Habro district of Bereda kebele & two farmers from Daro Lebu district of milkaye 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	Milkaye	2	Awash-2, Carcar & local check
Habro	Bareda	5	
Total		**7**	

Source: Demonstration result, 2019/20

Two improved varieties of haricot bean namely Awash-2 and Carcar were evaluated with local check under farmer's` field condition. The experiment was demonstrated on 100 m^2 demonstration plots for each varieties on each trial farmers and seed rate of 80 kg/ha was used with 100 kg/ha PSN at the time of sowing. A spacing of 40cm X 10cm between row & plant spacing was used, respectively during the demonstration. Before conducting the trial, farmers were trained about improved common bean 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. Profitability of the variety was analyzed through financial analysis method.

Farmer's preference were collected and analyzed by using simple ranking method in accordance with the given value (De Boef and Thijssen, 2007). The formula of ranking method used was specified as:

Rank = $\sum N/n$ **……1**

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

Result and Discussions

Yield performance of demonstrated variety on farmer's field

The mean yield gained from Awash-2, Carcar and local check was 1457, 1550 and 1275 kg/ha respectively from demonstration result as indicated on table 2. The mean yield of Carcar variety gives higher yield than others which indicated that using this variety enhance the yield harvest of farmers from their land. The study result also shown as 275 kg/ha and 182 kg/ha yield increment of Carcar & Awash-2, respectively over local check under farmers management condition. Similary study, conducted by Fistum *et al*., 2020 at Adami Tullu Jidu Kombolcha and Shalla districts of East Shawa indicated that using improved haricot bean maximize farmer`s profitability from their acre of land in which the result support the result of our study.

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

Variety Name	**Max.**	**Min**	**Mean**	**Std deviation**
Awash-2	2690	500	1457	699
Carcar	2825	625	1550	862.8
Local	2750	450	1275	743.5

Source: Our computation, 2019/20

Yield Advantage of Improved Variety over local check across location

The result of the study indicated in (Table 3) shows the recently released varieties of common bean have higher yield increment over the control across location/districts. The larger yield increment was gained from Daro Lebu district of Carcar variety with 550 kg/ha (25 %) increment and yield increment of 100 kg/ha (5 %) by Awash-2 variety over the control. Similar study conducted by Asfaw *et. al*., 2018, Fekede *et al*., 2018 and Fekede & Gosa, 2016 conclude that using improved variety was more advantages than local variety under farmers` condition.

On the other hand at Habro district, higher yield increment was gained from Awash-2 variety which is 210 kg/ha (23 %) and 160 kg/ha (17 %) from Carcar Variety over control. From table 3 below we also conclude that higher mean yield were recorded at Daro Labu than Habro district for all improved varieties as well as for local check which may be Daro Lebu district is more favorable for haricot bean production than Habro district.

Table 3: Yield gap and advantage of improved variety.

District	Variety	Max.	Min.	Mean	Std. Deviation	Yield increment in Kg/ha.	Yield advantage over control (%)
Habro	Awash-2	500	1600	1140	440	210	23
	Carcar	630	1500	1090	400	160	17
	Local	450	1400	930	350	-	-
Daro Lebu	Awash-2	2690	1820	2260	620	100	5
	Carcar	2830	2600	2710	160	550	25
	Local	2750	1520	2160	870	-	-

Source: Our computation, 2019/20

Financial Benefit

The result of study shown that highest total return and net benefits were gained from Carcar and Awash-2 varieties *under* farmers` condition as presented in Table 4. Application of improved varieties under on-farm demonstration with farmers practices records higher total returns for Carcar which was 24,375.75 birr/ha while total return for local check was 20,049.38 birr/ha within similar practices. Net benefit gained form Carcar & Awash-2 were 13,785.5& 12,321 birr/ha, respectively while for local check record 9,681 birr/ha. The result of this study supported with study of Fistum *et. al*., 2020, & Midegsa *et al*., 2018.

Table 4: Financial benefit gained from demonstration trial

Variety Name	**Cost & Benefit per ha. for demonstration varieties**			
	Total Cost	Total yield gain in kg/ha	Total return	Net benefit
Awash-2	10,590.25	1457	22,911.33	12,321
Carcar	10,590.25	1550	24,375.75	13,785.5
Local Check	10,368.25	1275	20,049.38	9,681

*Current price of haricot bean in 2019/20 =**1572.5** birr per kuntal
Source: Our computation, 2019/20

Awareness Creation and Farmers` Preference of the Technology

Mini field day was organized to collect farmers` preference and create awareness on improved variety for further application in the study area. Accordingly, a total of 83 (72 male & 11 female) participants consisting of farmers, extension agents, experts and researchers were participated on mini field day. Number of pod per branch, number of seed per pod, seed size/shape, early maturity, drought and disease tolerant were criteria's settled by participants of mini field for selection purpose among the varieties. The result of farmers` preference for improved variety was indicated below (Table 5).

Based on the selection criteria, farmers indicated that Awash-2 was preferred as 1st rank by trail farmers and participant farmers during field day organized on farmer`s field. The mean scores of farmers' selection criteria ranged from 4.8 (Improved variety) to 3.1 (local check). The highest score (4.8) recorded for number of pod per plant, number of seed per pod and early maturity for improved variety and 2.3 for local check against disease tolerance. However, Awash-2 variety gets highest score in terms of early maturity and drought tolerant than others varieties. From this farmers selection Carcar variety record highest score for number of pod per plant and number of seed per pod which support higher yield of this variety gained during demonstration of the trial on farmers field (Table 2).

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

Variety	**Selection criteria(Score 1-5)**						Total score	Mean score	Rank
	No. pod per plant	No. seed per pod	Seed size	Early maturity	Drought tolerant	Disease resistance			
Awash-2	4.7	4.3	4.5	4.8	4.6	4.2	27.1	4.5	1st
Carcar	4.8	4.8	4.3	4	4	4.2	26.1	4.3	2nd
Local check	3	3.3	3.2	3.3	3.4	2.6	18.8	3.1	3rd

Source: Our computation, 2019/20

Conclusion and Recommendation

Haricot bean is among pulse crops grown for food and market purpose in Ethiopia in general and west Hararghe zone specifically. Hence, this study conducted to evaluate yield performance of improved varieties of haricot bean under farmer's condition. Two improved varieties of haricot bean were evaluated with local check on under farmer's` field condition. The experiment was arranged on 100 m^2 single plots for each varieties on each trial farmers and seed rate of 80 kg/ha was used with 100 kg/ha PSN at the time of sowing. A spacing of 40cm X 10cm between row & plant spacing was used, respectively during the demonstration. Both qualitative and quantitative data were collected for the study and analyzed with descriptive statistics, simple ranking, summarization and financial analysis for the study.

The result of the study indicated that recently released varieties of Haricot bean have higher yield increment over the control check across location/districts. The study showed that the improved shown better performance in grain yield than the local check. The mean yield gained from Awash-2, Carcar and local check was 1457, 1550 and 1275 kg/ha respectively. Thus, the cultivation of haricot bean with improved varieties has been found more productive and the yield capacity can be enhanced by 25 percent. The result of study from financial analyses shown that application of improved varieties under farmers condition with farmers practices records higher total returns for Carcar which was 24,375.75 birr/ha while total return for local check was 20,049.38 birr/ha under similar practices

On the other hand, Mini field day was organized to collect farmers` preference and create awareness on improved variety for further application in the study area. Accordingly, a total of 83 participants consisting of farmers, extension agents, experts and researchers were participated on mini field day. Number of pod per branch, number of seed per pod, seed size/shape, early maturity, drought and disease tolerant were criteria's settled by participants of mini field for selection purpose among the varieties. Accordingly, participant famers had select Awash-2 as 1st rank followed by Carcar variety. Hence, Seed producer enterprise, cooperatives or organized seed producer farmers groups should continuously and consistently multiply and supply the seeds of this variety so that there is sustainable seed supply for Carcar and Awash-2 varieties in the area.

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Pre-extension demonstration of soil test crop response based NP-fertilizers recommendation for maize in Chora district of Buno Bedele zone, West Orormia.

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Abstract

Pre-extension demonstration of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate for maize was conducted in Chora district with the objective of participatory demonstration of soil test crop response based *nitrogen and phosphorus fertilizers* recommendation rate under farmers' condition *in 2019 cropping season. Two treatments used were (T_1) farmer practice/blanket recommendation and (T_2) soil test crop response based nitrogen and phosphorus fertilizers recommendation rate with improved maize (BH661) variety. The trial was conducted on eleven farmers' fields which were used as replications. The plot size per treatment was 16m x 32m with the spacing of 50cm and 80cm between seeds and rows respectively using seed rate of 25 kg ha^{-1} and the district recommended N-fertilizer rate of 92 kg ha^{-1}. In each PAs, one FREG unit comprising of 20 farmers were established to actively participate in the activity implementation. About 90 (66 male and 24 female) participants were take part on field visit based training held during physiological maturity of the crop. The average grain yield obtained with soil test crop response based nitrogen and phosphorus fertilizers recommendation rate was 59.64 qt ha^{-1} while farmer practice/blanket recommendation was 44.59 qt ha^{-1} with yield advantage of 34% in the study area. Likewise, economic analysis result show that the net benefit of* 31539.84 and 23811.00 *ETB ha^{-1} were gained from soil test crop response based nitrogen and phosphorus fertilizers recommendation rate and farmer practice respectively. Therefore, soil test crop response based nitrogen and phosphorus fertilizers recommendation rate should further scale up/out to in reach more maize producer farmers in the study area.*

Key Words: *Pre-extension, soil test, fertilizer recommendation, maize, farmer practice, FREG.*

Introduction

Maize is one of the most important cereals broadly adapted worldwide (Christian et al., 2012). It is largely produced in Western, Central, Southern and Eastern parts of Ethiopia. In Ethiopia, its total annual production and productivity exceeds all other cereals (23.24% of 267,789,764.02 qt), and second after teff (*Eragrostis tef*) in area coverage (16.12% of the 10,232,582.23 ha) and mostly grown in the highlands at an altitude ranging from 1,700 to 2,400 masl. In 2017/2018, cropping season 2,128,948.91 hectares of land was covered by maize with an estimated production not less than 83,958,872.44 quintals (CSA, 2017/2018).

In Ethiopia, maize is produced for food, especially, in major maize producing regions; mainly for low-income groups, it is also used as staple food. Maize is consumed as "Injera," Porridge, Bread and "Nefro." It is also consumed roasted or boiled as vegetables at green stage. In addition to the above, it is used to prepare "Tella" and "Arekie." The leaf and stalk are used for animal feed and dried stalk & cob are used for fuel. It is also used as industrial raw material for oil & glucose production (MARD, 2014).

However, low soil fertility is one among the major factors limiting maize production and productivity in western Oromia, Ethiopia (Wakene *et al*., 2005). 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). In western Oromia; particularly in Buno Bedele zone smallholder farmers use traditional practice which is 'Dayi or Mooraa Loonii' in Afaan Oromo as an option to sustain soil fertility and increase crop production and productivity which is not common for all smallholder farmers. Dou to this problem; smallholder farmers relied upon blended inorganic fertilizer recommendation to improve crop yields and maintain soil fertility without consideration of optimum plant nutrient requirement to realize full yield potential of the crop.

To overcome this maize limiting factors; the recommended doses of fertilizer application is very imperative that take into consideration the nutrient status of the individual fields. Thus, site-specific soil test based fertilizer recommendation rate ensures balanced nutrition to crops and affordability of fertilizers for smallholder farmers. Thus, the study was initiated to undertake participatory demonstration of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate for maize under farmers' condition.

Objectives of the study:

- To evaluate yield performance and economic analysis of the recommended NP-fertilizers rate under farmers' condition.
- To create awareness on the importance of site specific crop response based NP-fertilizers recommendation rate.
- To collect feedback on the yield of soil test crop response based and farmers condition NP-fertilizers recommendation rate for maize.

Research Methodology

Description of the study area

Chora district is located at 519 km from the capital city of Ethiopia, Addis Ababa and 36 km from Buno Bedele zonal capital town, Bedele. The district 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 longtude. It is characterized by warm climate with a mean annual maximum temperature of 25.5°C and a mean annual minimum temperature of 12.5°C. The annual rainfall ranges from 1000-1500mm. The district is dominated by Nitisols. The economy of the area is based on mixed cropping system and livestock raring agricultural production system among which dominant crops are maize, teff, sorghum and wheat. Chora has 33 kebeles among which 3 kebeles were used for this study.

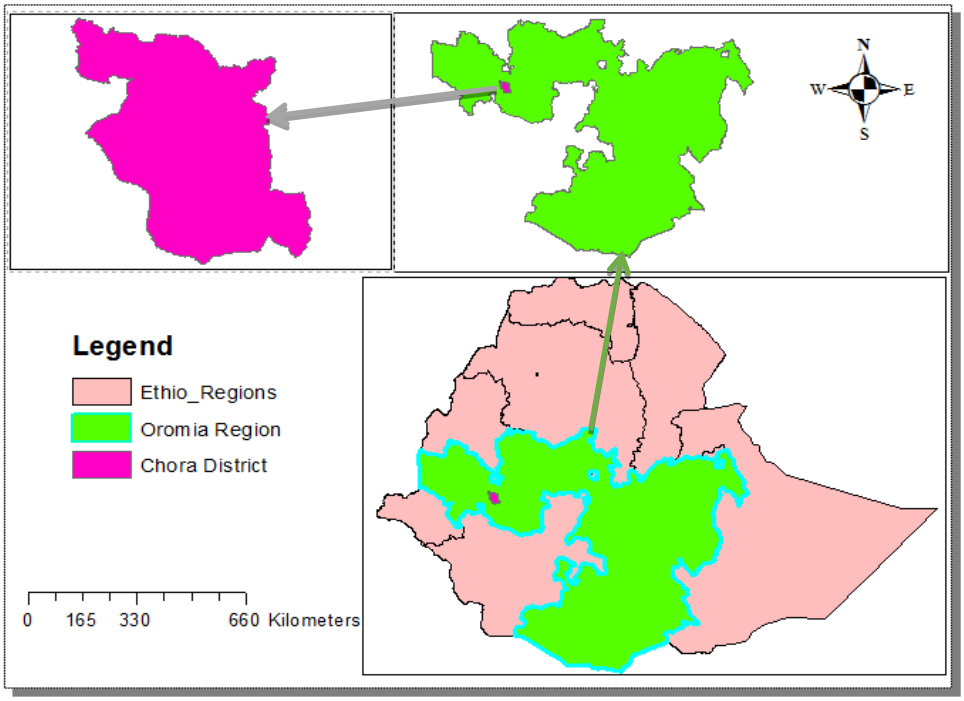


Fig. 1: Map of chora district

Site Selection

Pre-extension demonstration of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate for maize (BH661) variety was carried out in Chora district of Buno Bedele zone. Purposive sampling method was employed to select the district based on the potential for maize production and completed calibration study. Similarly, from the district three representative kebeles were selected based on their road accessibility and production potential of the crop.

Farmer selection

FRG approach was followed in order to simplify the demonstration process and enhance active participation of FRG/FREG members and concerned stakeholders during the implementation of the activity. Accordingly, in each kebeles one FRG/FREG unit was established which consists of 20 members by taking into account all categories of farmers and the concept of gender disaggregation. During FRG members selection; farmers' willingness to be held as member, good history of compatibility with groups, proximity and commitment to share innovations to other farmers were considered. From the established FRG/FREG members in each kebeles, four representative hosting farmers were selected in collaboration with community leaders, SMS, DAs and the members themselves. Accordingly, it was laid out the demonstration trial on 11 (as one host farmer live out the membership duo to security problem) farmers' field by considering each farmer field as replication of the trial.

Field design and materials

The demonstration plot size of 16m x 32m were allotted per soil test crop response based nitrogen and phosphorus fertilizers recommendation rate (T2) and farmer practice (T1) for maize treatments replicated per 11 farmers field by using the recommended spacing of 80 and 50 cm between rows and seed (two seed per hole) respectively using the seed rate of 25 kg ha^{-1}.
The slop of trial field, crop rotation and road accessibility was considered and one composite soil sample per trail field was collected at the depth of 0-20 cm to analyze available phosphorus in the soil with standard laboratory procedures. Depending on initial phosphorus status in the soil, rate of fertilizer applied was calculated with P (kg ha^{-1}) = (Pc-Po)*Pf formula. Where: Pc = Critical P value and Pf = P requirement factor which are 8.5 ppm and 6.64 respectively of the district and Po = Initial P values for the trial field. The recommended nitrogen fertilizer rate for the district is 92 kg ha^{-1} and applied at 30 days after planting with the necessary agronomic and management practices. Farm operations (land preparation) was carried out by hosting farmers; whereas activities such as planting, first and second weeding, harvesting, threshing were handled by FRG/FREG members with the facilitation of the researchers.

Technology demonstration approaches

FRGs members and other follower farmers were encouraged to participate on different extension events organized at well representative site. These are the mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings and field visits/tours. Field visit based training was provided for farmers and experts (DAs and SMS) on best performed (well variability between the treatments) host farmers trail field. The training was provided by BeARC researchers on the concept and principles of FRG, the role and responsibility of the FRG members in managing the trial, method of soil sampling and importance of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate to build the knowledge and skills of the participants toward the technology. The field visit based training conducted during crop maturity stage was strengthens the linkage among researchers-development agents and farmers in the study area.

Method of communication

In extension, there are no one-size-fits-all solutions. Hence, appropriate extension approaches (participatory) and all extension-teaching methods (individual, group and mass contact methods) were employed alone or in a judicious combination according to the situations during the implementation of the demonstration activity.

Data collected and Method of analysis

The grain yield, cost incurred, profit gained, number of farmers and other stakeholders participated on field visit based training data were recorded. Simple descriptive statistics were used to analyze the quantitative data while the economic related data was analyzed using cost-benefit analysis.

Results and Discussions

Participatory field visit based training for participants

Participatory field visit based training was given to participants on the concept and principles of FRG, the role and responsibility of the FRG members while managing the trial, method of soil sampling and importance of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate and at the end of the training; participants visit the trial field as all FRG members practice on their own field and while others share the experience. A total of 90 participants among which 62 farmers (44 male and 18 female), 6 DAs (6 male and 0 female) and 22 other concerned stakeholders (16 male and 6 female) were participated on field visit based training.

Table 1: Gender disaggregated stakeholders participated on field visit based training events

District	Participant	Male	Female	Total
Chora	Farmers	44	18	62
	DAs	6	-	6
	Other stakeholders	16	6	22
	Total	66	24	90

Source: Own Data, 2019

The recommended phosphorus and nitrogen fertilizers per demonstration site

As Dagne et al., (2017) reported during calibration study; P- critical was 8.5 ppm, Pf P-requirement factor was 6.64 and N-fertilizer was 92 kg ha^{-1} in the study area. Based on the critical phosphorus concentration, P- requirement factor and Po = Initial P values for specific demonstration site; rate of phosphorus fertilizer applied was determined. As a result, soil test crop response based Phosphorus fertilizer recommendation treatment was implemented using calibration recommendation whereas farmer practice/blanket recommendation treatment was implemented using 100kg ha^{-1} of NPS and Urea recommended by the Ministry of Agriculture and Rural Development.

Table 2: The NP fertilizers recommendation per demonstration sites.

Sites	***P_o (initial p values)(ppm)***	***P_c (P critical level) (ppm)***	***Pf (Requirement factor)***	***Rate of P-fertilizer applied Kg/plot***		***Rate of N-fertilizer applied Kg/plot***	
				Fp	***STCRBFR***	***Fp***	***STCRBFR***
site 1	1.019	8.5	6.64	***5.1***	***15.3***	***5.1***	***10***
site 2	1.533	8.5	6.64	***5.1***	***14.3***	***5.1***	***10***
site 3	0.698	8.5	6.64	***5.1***	***16.0***	***5.1***	***10***
site 4	5.067	8.5	6.64	***5.1***	***7.0***	***5.1***	***10***
site 5	1.644	8.5	6.64	***5.1***	***14.0***	***5.1***	***10***
site 6	0.296	8.5	6.64	***5.1***	***16.8***	***5.1***	***10***
site 7	4.211	8.5	6.64	***5.1***	***8.8***	***5.1***	***10***
site 8	0.822	8.5	6.64	***5.1***	***15.7***	***5.1***	***10***
site 9	1.073	8.5	6.64	***5.1***	***15.2***	***5.1***	***10***
site 10	2.046	8.5	6.64	***5.1***	***13.2***	***5.1***	***10***
site 11	1.157	8.5	6.64	***5.1***	***15.0***	***5.1***	***10***
Average	***1.78***	***8.5***	***6.64***	***5.1***	***13.75***	***5.1***	***10***

Note: Fp = farmers practice; STCRBFR=soil test crop response based fertilizer recommendation.
Source: Own Computing Data, 2019

The result presented on Table 2 indicate that the available phosphorus level within the demonstration sites were inconsistent. The highest the available p of the demonstration site (**5.067** ppm) the lowest it required the recommended p-fertilizer rate(***7.0*** kg/plot) and the lowest the available p of the demonstration site (**0.296** ppm) the highest it required the recommended p-fertilizer rate (***16.8*** kg/plot). The inconsistency of available p entire the farmers' field was due to inherently low P content, high P fixation capacity, crop harvest and soil erosion of Ethiopian agricultural soils particularly the Nitisols and acid soils (Yihenew, 2002).

Yield performance of the Demonstration Site

The result of the trial conducted at Chora district shows that maize grain yield was higher with application of 92 kg ha^{-1} N and site-specific p-fertilizer recommendation. As indicated by Dagne et al., (2017) with extra use of NP fertilizers recommendation, the maize grain yield and economic profitability was not added in the study area. The application of 92 kg ha^{-1} N and site specific p-fertilizer recommendation rate increased maize grain yield from 31 qt ha^{-1}(farmer practice) to 71 qt ha^{-1} (soil test crop response based NP-fertilizers recommendation rate) with 34% grain yield advantage.

Yield Advantage was calculated using

$$\frac{A-B}{B} \times 100 \quad \text{formula.}$$

Where, A=Yield of soil test crop response NP-fertilizers recommendation rate

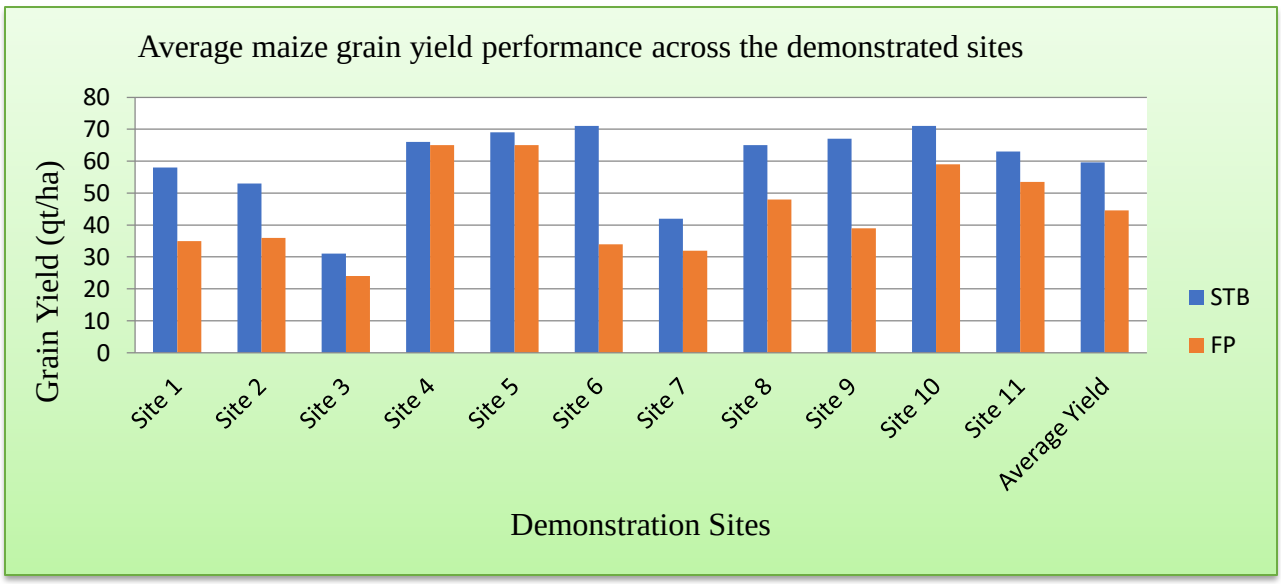
B = Yield of farmer practice

Table 3: Average maize grain yield per treatments.

Treatments	**Grain yield (qt ha^{-1})**		**Average**	**% increment**
	Minimum	Maximum		
Farmer practice	24	31	44.59	**34%** yield increment over the blanket type for grain yield
STCRBFR	65	71	59.64	

Note: STCRBFR = soil test crop response based p-fertilizer recommendation

Source: Own Computing Data, 2019



Graph 1: Average maize grain yield across the demonstration sites

Source: Own Sketch, 2019

Economic analysis

Economic analysis was done using the prevailing market prices for inputs at planting and for outputs at the time the crop was harvested. The varied cost that incurred during the implementation of the activity was recorded. All costs and benefits were calculated on hectare basis in Ethiopian birr (ETB ha-1). Accordingly, the market price of inputs like seed, NPS and N-fertilizers were 5280, 1549 and 1394 ETB qt-1, respectively during planting time whereas maize grain yield (output) was 600 ETB qt-1 at field price. The economic analysis result show that; the net benefit of 31539.84 and 23811.00 ETB ha^{-1} were gained from soil test crop response based NP-fertilizers recommendation rate and farmer practice respectively in the study area.

District	Treatments	Yield (Y) obtained (qt ha^{-1})	Unit Price (ETB qt^{-1})	Gross Return (Price x Qt)	Total variable costs (ETB ha^{-1})	Net Return (GR-TVC)
Chora	Farmer practice	44.59	600.00	26754	2943.00	23811.00
	STBCFR	59.64	600.00	35784	4244.16	31539.84

Note: STCRBFR = soil test crop response based P-fertilizer recommendation, ETB = Ethiopian Birr
Source: Own computing Data, 2019

Conclusion and Recommendations

In spite of the inevitable variability in performance between and even within the demonstration sites, yield performance of soil test crop response based NP-fertilizers recommendation rate was still promising over farmer practice/blanket recommendation. The variability in yield performance might have stemmed from difference in the status of soil fertility and managements. Despite this fact, the average yield obtained from soil test crop response based NP-fertilizers recommendation rate was higher than that of farmer practice. Likewise, the average benefit gained from soil test crop response based NP-fertilizers recommendation rate was more profitable than that of farmer practice/blanket recommendation. Therefore, the scaling up/out of soil test crop response based NP-fertilizers recommendation rate for maize should be carried out in the coming main cropping season in the study area.

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Pre-extension demonstration of soil test crop response based Np-fertilizers recommendation for maize in Dabo Hana district of Buno Bedele zone, West Orormia

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Abstract

Pre-extension demonstration of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate for maize was conducted in Dabo Hana district with the objective of participatory demonstration of soil test crop response based *nitrogen and phosphorus fertilizers* recommendation rate under farmers' condition *in 2019 cropping season. Two treatments used were (T_1) farmer practice/blanket recommendation and (T_2) soil test crop response based nitrogen and phosphorus fertilizers recommendation rate with improved maize (BH661) variety. The trial was conducted on twelve farmers' fields which were used as replications. The plot size per treatment was 16m x 32m with the spacing of 50cm and 80cm between seeds and rows respectively using seed rate of 25 kg ha^{-1} and the district recommended N-fertilizer rate of 138 kg ha^{-1}. In each PAs, one FREG unit comprising of 20 farmers were established to actively participate in the activity implementation. About 101 (86 male and 15 female) participants were take part on field visit based training held during physiological maturity of the crop. The average grain yield obtained with soil test crop response based nitrogen and phosphorus fertilizers recommendation rate was 74.87 qt ha^{-1} while farmer practice/blanket recommendation was 49.60 qt ha^{-1} with yield advantage of 51% in the study area. Likewise, economic analysis result show that the net benefit of 39642.52 and 26817ETB ha^{-1} were gained from soil test crop response based nitrogen and phosphorus fertilizers recommendation rate and farmer practice respectively. Therefore, soil test crop response based nitrogen and phosphorus fertilizers recommendation rate should further scale up/out to in reach more maize producer farmers in the study area.*

Key Words: *Pre-extension, soil test, fertilizer recommendation, maize, farmer practice, FREG.*

Introduction

Maize is one of the most important cereals broadly adapted worldwide (Christian et al., 2012). It is largely produced in Western, Central, Southern and Eastern parts of Ethiopia. In Ethiopia, its total annual production and productivity exceeds all other cereals (23.24% of 267,789,764.02 qt), and second after teff (*Eragrostis tef*) in area coverage (16.12% of the 10,232,582.23 ha) and mostly grown in the highlands at an altitude ranging from 1,700 to 2,400 masl. In 2017/2018, cropping season 2,128,948.91 hectares of land was covered by maize with an estimated production not less than 83,958,872.44 quintals (CSA, 2017/2018).

In Ethiopia, maize is produced for food, especially, in major maize producing regions; mainly for low-income groups, it is also used as staple food. Maize is consumed as "Injera," Porridge, Bread and "Nefro." It is also consumed roasted or boiled as vegetables at green stage. In addition to the above, it is used to prepare "Tella" and "Arekie." The leaf and stalk are used for animal feed and dried stalk & cob are used for fuel. It is also used as industrial raw material for oil & glucose production (MARD, 2014).

However, low soil fertility is one among the major factors limiting maize production and productivity in western Oromia, Ethiopia (Wakene *et al*., 2005). 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). In western Oromia; particularly in Buno Bedele zone smallholder farmers use traditional practice which is 'Dayi or Mooraa Loonii' in Afaan Oromo as an option to sustain soil fertility and increase crop production and productivity which is not common for all smallholder farmers. Dou to this problem; smallholder farmers relied upon blended inorganic fertilizer recommendation to improve crop yields and maintain soil fertility without consideration of optimum plant nutrient requirement to realize full yield potential of the crop.

To overcome this maize limiting factors; the recommended doses of fertilizer application is very imperative that take into consideration the nutrient status of the individual fields. Thus, site-specific soil test based fertilizer recommendation rate ensures balanced nutrition to crops and affordability of fertilizers for smallholder farmers. Thus, the study was initiated to undertake participatory demonstration of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate for maize under farmers' condition.

Objectives of the study:

- To evaluate yield performance and economic analysis of the recommended NP-fertilizers rate under farmers' condition.
- To create awareness on the importance of site specific crop response based NP-fertilizers recommendation rate.
- To collect feedback on the yield of soil test crop response based and farmers condition NP-fertilizers recommendation rate for maize.

Research Methodology

Description of the study area

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 masl and located between 8°55'26.423" to 8°30'044"N latitude and 36°5'32.953" to 36°26'23.781"E longitude. The mean annual temperature of the district ranged from 15 C° to 31 C° whereas mean annual rainfall ranges from 1000-1500mm. 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, teff, sorghum and wheat. Dabo Hana has 17 kebeles among which 4 kebeles were used for this study.

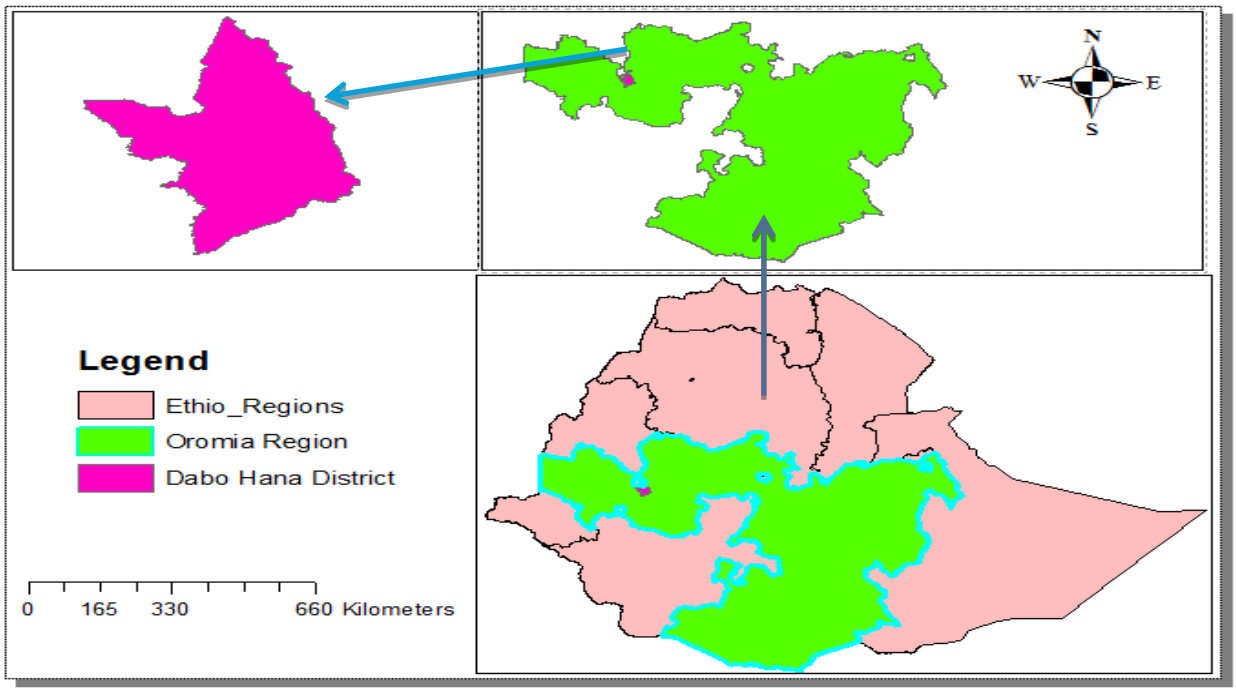


Fig. 1: Map of Dabo Hana district

Site Selection

Pre-extension demonstration of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate for maize (BH661) variety was carried out in Dabo Hana district of Buno Bedele zone. Purposive sampling method was employed to select the district based on the potential for maize production and completed calibration study. Similarly, from the district four representative kebeles were selected based on their road accessibility and production potential of the crop.

Farmer selection

FRG approach was followed in order to simplify the demonstration process and enhance active participation of FRG/FREG members and concerned stakeholders during the implementation of the activity. Accordingly, in each kebeles one FRG/FREG unit was established which consists of 20 members by taking into account all categories of farmers and the concept of gender disaggregation. During FRG members selection; farmers' willingness to be held as member, good history of compatibility with groups, proximity and commitment to share innovations to other farmers were considered. From the established FRG/FREG members in each kebeles, three representative hosting farmers were selected in collaboration with community leaders, SMS, DAs and the members themselves. Accordingly, it was laid out the demonstration trial on 12 farmers' field by considering each farmer field as replication of the trial.

Field design and materials

The demonstration plot size of 16m x 32m were allotted per soil test crop response based nitrogen and phosphorus fertilizers recommendation rate (T_2) and farmer practice (T_1) for maize treatments replicated per 12 farmers field by using the recommended spacing of 80 and 50 cm between rows and seed (two seed per hole) respectively using the seed rate of 25 kg ha^{-1}.
The slop of trial field, crop rotation and road accessibility was considered and one composite soil sample per trail field was collected at the depth of 0-20 cm to analyze available phosphorus in the soil with standard laboratory procedures. Depending on initial phosphorus status in the soil, rate of fertilizer applied was calculated with P (kg ha^{-1}) = (Pc-Po)*Pf formula. Where: Pc = Critical P value and Pf = P requirement factor which are 11.0ppm and 10.01respectively for the district and Po = Initial P values for the trial field. The recommended nitrogen fertilizer rate for the district is 138 kg ha^{-1} and was applied at 30 days after planting with the necessary agronomic and management practices. Farm operations (land preparation) was carried out by hosting farmers; whereas activities such as planting, first and second weeding, harvesting, threshing were handled by FRG/FREG members with the facilitation of the researchers.

Technology demonstration approaches

FRGs members and other follower farmers were encouraged to participate on different extension events organized at well representative site. These are the mechanisms used to enhance farmer-to-farmer learning and information exchange such as trainings and field visits/tours. Field visit based training was provided for farmers and experts (DAs and SMS) on best performed (well variability between the treatments) host farmers trail field. The training was provided by BeARC researchers on the concept and principles of FRG, the role and responsibility of the FRG members in managing the trial, method of soil sampling and importance of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate to build the knowledge and skills of the participants toward the technology. The field visit based training conducted during crop maturity stage was strengthens the linkage among researchers-development agents and farmers in the study area.

Method of communication

In extension, there are no one-size-fits-all solutions. Hence, appropriate extension approaches (participatory) and all extension-teaching methods (individual, group and mass contact methods) were employed alone or in a judicious combination according to the situations during the implementation of the demonstration activity.

Data collected and Method of analysis

The grain yield, cost incurred, profit gained, number of farmers and other stakeholders participated on field visit based training data were recorded. Simple descriptive statistics were used to analyze the quantitative data while the economic related data was analyzed using cost-benefit analysis.

Result and Discussions

Participatory field visit based training for participants

Participatory field visit based training was given to participants on the concept and principles of FRG, the role and responsibility of the FRG members while managing the trial, method of soil sampling and importance of soil test crop response based nitrogen and phosphorus fertilizers recommendation rate and at the end of the training; participants visit the trial field as all FRG members practice on their own field and while others share the experience. A total of **101** participants among which 66 farmers (59 male and 7 female), 9 DAs (7 male and 2 female) and 26 other concerned stakeholders (20 male and 6 female) were participated on field visit based training.

Table 1: Gender disaggregated stakeholders participated on field visit based training events

District	Participant	Male	Female	Total
Dabo Hana	Farmers	59	7	66
	DAs	7	2	9
	Other stakeholders	20	6	26
Total		86	15	101

Source: Own Data, 2019

The recommended phosphorus and nitrogen fertilizers per demonstration site

As Dagne et al., (2017) reported during calibration study; P- critical was 11.0 ppm, P-requirement factor was 10.01 and N-fertilizer was 138 kg ha^{-1} in the study area. Based on the critical phosphorus concentration, P- requirement factor and Po = Initial P values for specific demonstration site; rate of phosphorus fertilizer applied was determined. As a result, soil test crop response based Phosphorus fertilizer recommendation treatment was implemented using calibration recommendation whereas farmer practice/blanket recommendation treatment was implemented using 100kg ha^{-1} of NPS and urea recommended by the Ministry of Agriculture and Rural Development.

Table2: The recommended P and N (urea) fertilizers rate per farmer's entire field of the experiment.

Sites	***P_o (initial p values)(ppm)***	***P_c (P critical level) (ppm)***	***Pf (Requirement factor)***	***Rate of P-fertilizer applied Kg/plot***		***Rate of N-fertilizer (urea)applied Kg/plot***	
				Fp	***STCRBFR***	***Fp***	***STCRBFR***
site 1	0.697	11.0	10.01	***5.1***	***31.8***	***5.1***	***15***
site 2	1.001	11.0	10.01	***5.1***	***30.8***	***5.1***	***15***
site 3	0.966	11.0	10.01	***5.1***	***31.0***	***5.1***	***15***
site 4	1.025	11.0	10.01	***5.1***	***30.8***	***5.1***	***15***
site 5	0.201	11.0	10.01	***5.1***	***33.4***	***5.1***	***15***
site 6	2.746	11.0	10.01	***5.1***	***25.5***	***5.1***	***15***
site 7	0.994	11.0	10.01	***5.1***	***30.9***	***5.1***	***15***
site 8	0.861	11.0	10.01	***5.1***	***31.3***	***5.1***	***15***
site 9	1.122	11.0	10.01	***5.1***	***30.5***	***5.1***	***15***
site 10	0.793	11.0	10.01	***5.1***	***31.5***	***5.1***	***15***
site 11	0.749	11.0	10.01	***5.1***	***31.7***	***5.1***	***15***
site 12	0.591	11.0	10.01	***5.1***	***32.1***	***5.1***	***15***
Average	***1.0***	***11***	***10.0***	***5.1***	***30.9***	***5.1***	***15.0***

Note: Fp = farmers practice; STCRBFR= soil test crop response based fertilizer recommendation.
Source: Own Computing Data, 2019

The result presented on table 2 indicates that the available phosphorus level within the demonstration sites were inconsistent. The highest the available p of the demonstration site (**2.746** ppm) the lowest it required the recommended p-fertilizer rate(**25.5** kg/plot) and the lowest the available p of the demonstration site (**0.201** ppm) the highest it required the recommended p-fertilizer rate (**33.4** kg/plot). The inconsistency of available p entire the farmers' field was due to inherently low P content, high P fixation capacity, crop harvest and soil erosion of Ethiopian agricultural soils particularly the Nitisols and acid soils (Yihenew, 2002).

Yield performance of the demonstration sites

The result of the trial conducted at Dabo Hana district shows that maize grain yield was higher with application of 138 kg ha^{-1} N and site-specific p-fertilizer recommendation. As indicated by Dagne et al., (2017) with extra use of NP fertilizers recommendation, the maize grain yield and economic profitability was not added in the study area. The application of 138 kg ha^{-1} N and site specific p-fertilizer recommendation rate increased maize grain yield from 65 qt ha^{-1}(farmer practice) to 92 qt ha^{-1} (soil test crop response based NP-fertilizers recommendation rate) with 51% grain yield advantage.

Yield Advantage was calculated using

$$\frac{A-B}{B} \times 100$$ formula.

Where, A=Yield of soil test crop response NP-fertilizers recommendation rate

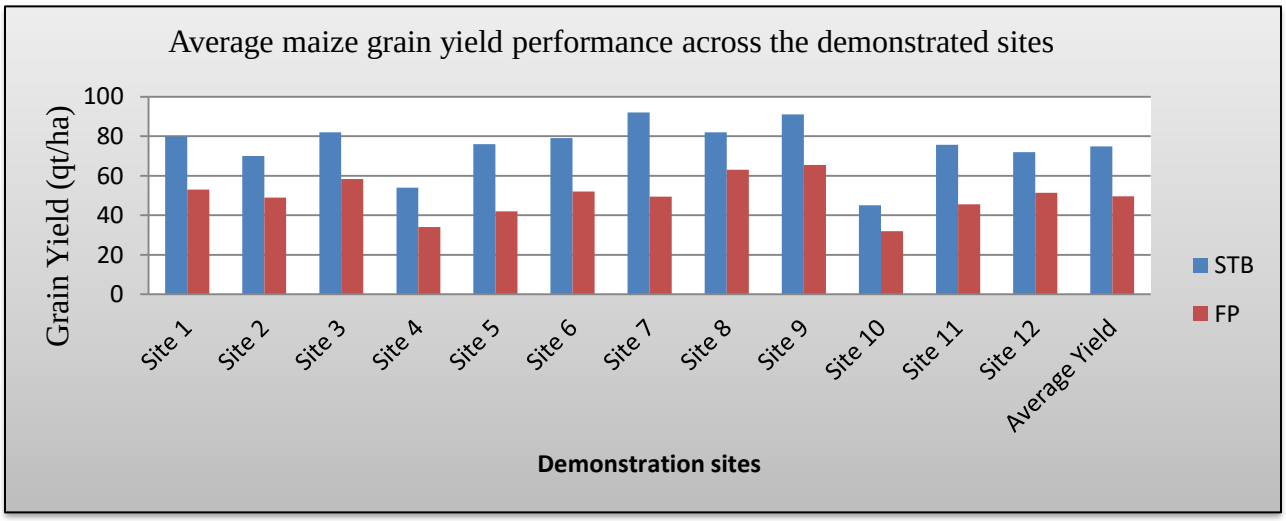
B = Yield of farmer practice

Table 3: Average maize grain yield per treatments.

Treatments	Grain yield (qt ha^{-1})		Average	% increment
	Minimum	Maximum		
Farmer practice	32	65	49.60	51% yield increment over the blanket type for grain yield
STCRBFR	45	92	74.90	

Note: STCRBFR = soil test crop response based p-fertilizer recommendation

Source: Own Computing Data, 2019



Graph 1: Average maize grain yield across the demonstration sites

Source: Own Sketch, 2019

Economic analysis

Economic analysis was done using the prevailing market prices for inputs at planting and for outputs at the time the crop was harvested. The varied cost that incurred during the implementation of the activity was recorded. All costs and benefits were calculated on hectare basis in Ethiopian birr (ETB ha^{-1}). Accordingly, the market price of inputs like seed, NPS and N-fertilizers were 5280, 1549 and 1394 ETB qt^{-1}, respectively during planting time whereas maize grain yield (output) was 600 ETB qt^{-1} at field price. The economic analysis result show that; the net benefit of 39642.52 and 26817 ETB ha^{-1} were gained from soil test crop response based NP-fertilizers recommendation rate and farmer practice respectively in the study area.

District	Treatments	Yield (Y) obtained (qt ha^{-1})	Unit Price (ETB qt^{-1})	Gross Return (Price x Qt)	Total variable costs (ETB ha^{-1})	Net Return (GR-TVC)
Dabo Hana	Farmer practice	49.60	600.00	29760.00	2943.00	26817
	STBFR	74.90	600.00	44940.00	5297.48	39642.52

Note: STCRBFR = soil test crop response based P-fertilizer recommendation, ETB = Ethiopian Birr
Source: Own computing Data, 2019

Conclusion and Recommendations

In spite of the inevitable variability in performance between and even within the demonstration sites, yield performance of soil test crop response based NP-fertilizers recommendation rate was still promising over farmer practice/blanket recommendation. The variability in yield performance might have stemmed from difference in the status of soil fertility and managements. Despite this fact, the average yield obtained from soil test crop response based NP-fertilizers recommendation rate was higher than that of farmer practice. Likewise, the average benefit gained from soil test crop response based NP-fertilizers recommendation rate was more profitable than that of farmer practice/blanket recommendation. Therefore, the scaling up/out of soil test crop response based NP-fertilizers recommendation rate for maize should be carried out in the coming main cropping season in the study area.

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Demonstration and Evaluation of Double Cropping Practice (Legume followed by Sorghum crop) in Fedis District

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Abstract

Climate smart technology intervention in production and productivity enhancement of agriculture sector for small holder farmers' livelihood improvement is indispensable options. Taking this in consideration the double cropping practice research activity was undertaken with objectives of evaluate the productivity and profitability of double cropping practice technology under farmers condition, build farmers' knowledge and skill of different crop combination production and management practice and strengthen stakeholders linkages and collaboration among stakeholders. A total of fifteen (10) trial and follower farmers were selected and organized as form of FRGs. Improved varieties of common bean (KATB-1 and Batu) and sorghum (Melkam and Local) were replicated on the plot of 10mx10m. The yield performance of the improved varieties (Batu, KATB-1, Melkam and Local sorghum) were 13, 14.50, 35.50 and 29.00 qt/ha at Fadis Ballina Arba Kebele. The double cropping practices preferred as it diversify the crop, more yield obtained, and shorter crop cycle, better to cope up the dry spell, efficient use of land, reduce risks of striga and reduce risk of bird infestation. Moreover, based on the obtained result, Batu, KATB-1 and Melkam combination preferred by farmers since they could able to harvest twice within single season. Therefore, it is batter to be promoted and scale-up on wider area and reach large number of farmers.

Key words: *Demonstration, Double cropping, FRG*

Introduction

Rain-fed agricultural areas of East Africa are often food insecure due to rainfall variability and ongoing soil degradation that negatively impacts crop yields. Agricultural activities and consequently the livelihoods of people reliant on agriculture will be affected by changes in temperature and precipitation conditions in large parts of Sub-Saharan Africa (Muller et al., 2011). Under climate change, many areas in Sub-Saharan Africa are likely to experience a decrease in the length of the growing season, while in some highland areas rainfall changes may lead to a prolongation of the growing season (Thornton et al., 2006).

What so ever, mono-cropping of sorghum whether it is long or early maturing is their usual practice which aggravates the infestation of *striga* in case of susceptible varieties and has risk of crop failure in most cases due to erratic and unreliable rainfall(Samuel et. al., 2013). Basically, the farming system should be revised in the cropping areas of Fedis, and similar dry lowlands of Hararghe. Since eight-month-cycle sorghum being rain-fed, is simply late maturing and too vulnerable to pests and dependent on rainfall patterns. A reorientation towards shorter cycle crops like early maturing sorghum, pulses and oil crops would help farmer's better cope with the climatic hazards of the area (Ibid, 2013).

The degree of climate change impacts on agricultural production differs among crops and agricultural systems (Thornton et al., 2011). Therefore, the farmers' choice of an adequate cropping system and crop cultivar, especially in precipitation-limited areas, might be an important adaptation strategy to changing climate conditions. However, farmers in Fedis area are accustomed to sow the local varieties from end of March to the middle of April though they know the advantage of using improved sorghum varieties reduce risk of striga and yield. This is because farmers do not want to leave their land idle when the rain starts early in March/April until the right planting time of the early maturing striga resistant sorghum varieties. Whereas, these improved varieties are sown after the local varieties from middle of June to the beginning of July and farmers who are adopting improved sorghum varieties are forced to leave their land idle to synchronize its maturity with long maturing sorghum varieties to reduce the high bird infestation prevailing in the area (Fuad et al., 2017a).

To alleviate this problem experiment have been done at Fedis on evaluation of suitable double cropping combination and mungbean, haricot bean and cowpea were found to be economically and ecologically convenient in the area as preceding crops followed by early maturing sorghum in the area (Fuad et al., 2017a). Therefore, farmers' participation in technology promotion is very important to be acceptance by the whole community of the areas. Therefore, this activity is proposed to demonstrate and evaluate suitable double cropping sequence under the farmer condition through FRG approach in Fedis area. The preceding and succeeding crops that conducted on station under the control of the researchers during 'Belg' and 'Meher' season at Fedis in 2015 respectively.

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One kebele Balina Arba was selected. While farmers were selected 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. 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.

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The evaluation and demonstration of the trials were conducted on farmers' fields to create awareness about the double cropping practices. 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.

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Land preparation was done by tractor-powered and animal traction systems. The land was ploughed and smoothened to bring the soil to fine tilth and tie ridge was made in order to conserve moisture. The plots was laid out as per plan and plots was bunded lightly to prevent the entry of runoff water. Seeds of sorghum were drilled in the row of 75 cm between rows and 15-20 cm between plants and the spacing was the same for sorghum during second sowing they were thinned to one plant per hill at spacing of 15-20 cm.

Haricot bean was sown 40cm x 10 cm between rows and plants, respectively and for KATB-1 the spacing was 40 cm x 5 cm between rows and plants, respectively. At first sowing, all plots were received a basal application of Di Ammonium Phosphate at the rate of 100 kg/ha. Four weeks after emergence for sorghum and KATB-1 N in the form of urea (46 kg N) was applied at the rate of 100 kg/ha and for Haricot beans 23 kg N was applied at the rate of 50 kg/ha when the soil moisture was enough. At the end of June the preceding crops was harvested and threshed after it is sun dried for one weak except the control since it takes 7 to 8 months to mature and grain yield per plot was recorded.

The succeeding crop and the control all sorghum were harvested on maturity. The stalks from net plot was cut close to ground level and later ear was separated. The ear were sun-dried, threshed and grain yield per plot was recorded after 7 days of sun drying.

Data Collection

Qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and. Quantitative data were data collected by data sheet tools.

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Quantitative data was analyzed using simple descriptive statistics (Mean, Frequency and Percentage) while the qualitative data were analyzed using narrative explanation.

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Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for publicity of the work done, Development agents, experts and farmers were participated on the training given on double cropping practices and management, post-harvest handling and marketing information.

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1	Farmers	22	8	30
2	DAs	3	-	3
3	District experts	2	1	3
4	Journalists	3	0	3
	Total	30	9	39

Source: Own computation 2018/19

Among the training participant stakeholders, 76.9% were farmers. From those farmers, 26.6% were female farmers' participants.

Table 3: number of participants on the field day

		Ballina Arba		
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For those individuals, 70 leaflets and 40 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. Most farmers showed high interest towards improved double cropping technology production because of better yield and earned income by selling it for different stakeholders (neighbors' farmers and Non-Government Organizations). Generally, all farmers were very interested to have the technology for their future production.

Agronomic and yield performance

The following table describes the yield performances of the demonstrated Batu, KATB-1, Melkam and Local sorghum varieties across the study site. The yield performance of the improved varieties (Batu, KATB-1, Melkam and Local sorghum) were 13, 14.50, 35.50 and 29.00 qt/ha at Fadis Ballina Arba Kebele.

Table 3. Yield performance of improved varieties across districts

PA	**Crop**	**Varieties**	Std. Deviation	**Mean (qt/ha)**	**Maximum**	**Minimum**
B/Arba	Common Bean	Batu	1.086	13.00	13.10	11.00
		KATB-1	0.940	14.50	14.40	12.00
	Sorghum	Melkam	2.949	35.50	35.50	27.60
		Local Sorghum	1.812	29.00	29.00	24.10

The average yield performance of Melkam is higher than local sorghum at Ballina arba even though double harvest were obtained from the plot of Melkam but single harvest from the plot of local sorghum variety.

Economic Analysis

Table: Financial analysis for sorghum and common bean varieties across the districts

Financial analysis				
Location: Ballina Arba				
Parameters	Varieties			
	Batu	KATB-1	Melkam	local
Yield qt/ha(Y)	13	14.50	35.50	29
Price(P) per quintal	2000	2000	1000	1000
Total Revenue (TR)=TR=Y*P	26,000	29,000	35,500	29000
Variable costs				
Seed cost	250	250	100	100
Fertilizer cost	283	283	1701	1701
Labor cost	2,100	2,100	3000	3000
Total Variable costs(TVC)	2,633	2,633	4,801	4,801
Fixed costs				
Cost of land	2000	2000	2000	2000
Total fixed costs (TFC)	2000	2000	2000	2000
Total cost (TC) =TVC+TFC	4,633	4,633	6,801	6,801
Gross Margin (GM) = TR - TVC	23,367	26,367	30,699	24,199
Profit=GM-TFC	21,367	24,367	28,699	22,199

Farmers' Opinion/Perception

Farmers in the study area selected the best performing double cropping practices 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 diversify the crop, more yield obtained, shorter crop cycle, better to cope up the dry spell, efficient use of land, reduce risks of striga and reduce risk of bird infestation.

Table 5: Ranks of the varieties based on farmers' selection criteria**.**

Cropping system	**Farmers rank**	**Reasons**
Double Cropping	1st	Diversify the crop ,more yield obtained ,shorter crop cycle, better to cope up the dry spell, efficient use of land ,reduce risks of striga and reduce risk of bird infestation
Single Cropping	2nd	Mono cropping ,less yield obtained ,longer crop cycle, vulnerable to erratic rain fall, leave the land idle ,maximize the risks of striga and maximize the risk of bird infestation

Summary of Matrix Ranking of Farmers' Selection Criteria

S.no	Traits	Frequency	Percentage (%)	Rank
1	Diversify the Crop	3	15	4th
2	Yield	4	20	2nd
3	Efficient use of Land	6	30	1st
4	Crop cycle	1	5	6th
5	Cope up the dry spell	4	20	3rd
6	Reduce the striga infestation	2	10	5th
7	Reduce bird infestation	0	0	7th
	Total	**20**	**100**	

Table: Direct Matrix Ranking

S.no	Traits	Double cropping	Single cropping	Total	Rank
1	Diversify the Crop	2	0	2	4
2	Yield	2	1	3	2
3	Efficient use of Land	2	2	4	1
4	Crop cycle	1	0	1	6
5	Cope up the dry spell	2	1	3	3
6	Reduce the striga infestation	1	0	1	7
7	Reduce bird infestation	1	1	2	5
	Total	1	2		

Discussion

The trial farmers in the two locations are aware of the physical characteristics and field performance of all varieties used in the double cropping practices. The major variety selection criteria of farmers in the two locations were almost similar.

Conclusion and Recommendation

Farmers in Fadis District have been practicing mono cropping of sorghum for a long period of time. The average land holding is fragmented and rainfall distribution is erratic. Such mono cropping does not ensure the production of adequate food for the family. This local sorghum variety is also susceptible to striga and affected by drought. Low yielder than improved sorghum varieties when the season is not good. It requires different planting season. Though some farmers are adopting improved sorghum varieties, still most of them are hesitating to delay planting even if the rain fall in March or April is good and it is better to use double cropping practices for further scaling up to large number of farmers.

References

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Demonstration and Evaluation of Double Cropping Practice (Legume followed by Sorghum crop) in Fedis District

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P.O. Box 904, Harar, Ethiopia
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Abstract

Climate smart technology intervention in production and productivity enhancement of agriculture sector for small holder farmers' livelihood improvement is indispensable options. Taking this in consideration the double cropping practice research activity was undertaken with objectives of evaluate the productivity and profitability of double cropping practice technology under farmers condition, build farmers' knowledge and skill of different crop combination production and management practice and strengthen stakeholders linkages and collaboration among stakeholders. A total of fifteen (10) trial and follower farmers were selected and organized as form of FRGs. Improved varieties of common bean (KATB-1 and Batu) and sorghum (Melkam and Local) were replicated on the plot of 10mx10m. The yield performance of the improved varieties (Batu, KATB-1, Melkam and Local sorghum) were 13, 14.50, 35.50 and 29.00 qt/ha at Fadis Ballina Arba Kebele. The double cropping practices preferred as it diversify the crop, more yield obtained, and shorter crop cycle, better to cope up the dry spell, efficient use of land, reduce risks of striga and reduce risk of bird infestation. Moreover, based on the obtained result, Batu, KATB-1 and Melkam combination preferred by farmers since they could able to harvest twice within single season. Therefore, it is batter to be promoted and scale-up on wider area and reach large number of farmers.

Key words: *Demonstration, Double cropping, FRG*

Introduction

Rain-fed agricultural areas of East Africa are often food insecure due to rainfall variability and ongoing soil degradation that negatively impacts crop yields. Agricultural activities and consequently the livelihoods of people reliant on agriculture will be affected by changes in temperature and precipitation conditions in large parts of Sub-Saharan Africa (Muller et al., 2011). Under climate change, many areas in Sub-Saharan Africa are likely to experience a decrease in the length of the growing season, while in some highland areas rainfall changes may lead to a prolongation of the growing season (Thornton et al., 2006).

What so ever, mono-cropping of sorghum whether it is long or early maturing is their usual practice which aggravates the infestation of *striga* in case of susceptible varieties and has risk of crop failure in most cases due to erratic and unreliable rainfall(Samuel et. al., 2013). Basically, the farming system should be revised in the cropping areas of Fedis, and similar dry lowlands of Hararghe. Since eight-month-cycle sorghum being rain-fed, is simply late maturing and too vulnerable to pests and dependent on rainfall patterns. A reorientation towards shorter cycle crops like early maturing sorghum, pulses and oil crops would help farmer's better cope with the climatic hazards of the area (Ibid, 2013).

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Source: Own computation 2018/19

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5	Cope up the dry spell	4	20	3rd
6	Reduce the striga infestation	2	10	5th
7	Reduce bird infestation	0	0	7th
	Total	**20**	**100**	

Table: Direct Matrix Ranking

S.no	Traits	Double cropping	Single cropping	Total	Rank
1	Diversify the Crop	2	0	2	4
2	Yield	2	1	3	2
3	Efficient use of Land	2	2	4	1
4	Crop cycle	1	0	1	6
5	Cope up the dry spell	2	1	3	3
6	Reduce the striga infestation	1	0	1	7
7	Reduce bird infestation	1	1	2	5
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Discussion

The trial farmers in the two locations are aware of the physical characteristics and field performance of all varieties used in the double cropping practices. The major variety selection criteria of farmers in the two locations were almost similar.

Conclusion and Recommendation

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Pre-Scaling *up* of Drought Tolerant and Early Maturing Food Barley Varieties in Eastern Hararghe Zone

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Abstract

The study was conducted at Fedis District of East Hararghe Zone with areas of major food insecure due to influence by shortage and evenly distribution of rainfall pattern area. Pre-scaling up of drought tolerate crops are an option to reduce this food insecurity problem. The objectives of this activity were to scale-up and increase the productivity of drought tolerant and early maturing food barley variety. The activity was undertaken for the consecutive two years (2011-2012) of main cropping season. A total of 40 farmers was involved in the pre-scaling up of drought tolerant and early maturing food barley variety. One improved lowland food barley aquila variety was used on plot size of 0.125ha of land. The result indicated that improved food barley variety aquila recorded the higher grain yield (23.9 qt/ha and 24.7 qt/ha) in 2011 and 2012 respectively. The result obtained from was very encouraging. Moreover, the varieties were identified and ranked based on the criteria set by farmers (early maturity, yield, disease tolerance, seed color, seed size, tillering effect, performance throughout growing stage and biomass). As a result, aquila variety was recommended for more promotion in the area and other similar agro-ecological situation to reduce the problem of food insecurity.

Key Words: Food Barley, Improved Varieties, Pre-scaling up, Aquila

Introduction

Barley is the fourth most important cereal crop in the world after wheat, maize, and rice, and is among the top ten crop plants in the world (Akar et al. 2004). Globally, European Union, Russian Federation, Ukrian,Turkey and Canada are the top five largest world Barley producers where, European union produce the greatest quantities of barley with an estimated production of nearly 60 million tons followed by Russian federations with a production of about 20 million tons according to United state of Agricultural institute estimate in 2014. On the African continent, Morocco Ethiopia ,Algeria, Tunisia and south Africa were the top five largest barley producers for the year 2014 with estimated production of approximately 2.1 million tones,1.7 million tones,1.3 million tones,0.9 million tones and 0.307 million tons respectively. Barley is cultivated from 1400 to over 4000 m above sea level, and its importance increases in drought-prone areas and at higher elevations (above 2800m), where poor soil fertility, frost, water logging, and soil acidity and degradation are the major yield limiting factors (Asfaw, 2000). The major barley producing regions in Ethiopia are Oromia, Amhara and Tigray Regional States, which account for about 87% of the national barley production (CSA, 2000).

Barley is an important grain crop in Ethiopia and has diverse ecologies being grown from1800 to 3400m altitude in different seasons and production systems (Muluken, 2013)and makes Ethiopia being the second largest producer in Africa, next to Morocco, accounting for about25% of the total barley production in the continent (FAO, 2014) and recognized as one of the world's most

ancient food crop, which is believed to have first domesticated about 10,000 years ago from its wild relatives in the Fertile Crescent of the Near East and center of diversity in Ethiopia.. There are two types of barley that farmers grow in Ethiopia: food barley and malt barley. Food barely is a cheaper cereal than maize, wheat, and teff and is often used as a substitute for lower income families. Traditionally barley is used for making local recipes and drinks such as Injera, Bread, Roast, Porridge, 'Baso',Borde' and other types of food. Its straw is a good source of animal feed (Yosef et al., 2011).The objective of this study is to disseminate improved food barley variety selected Fadis district. This project aimed at alleviating the problems of low quality food barley and ensures the benefits to be obtained from these improved food barley variety

Objectives

- To increase production and productivity of improved food barley varieties in selected districts
- To improve income of the farmers in selected districts
- To strengthen stakeholders linkages and collaboration in selected districts

Methodology

Description of the study area

Fedis district has latitude between 8°22' and 9°14' north and longitude between 42°02' and 42°19' east, in middle and low land areas: altitude range is from 1200 – 1600m.a.s.l meters, with a prevalence of low lands. The area receives average annual rain fall of 400 - 804 mm. The minimum and maximum temperature of the area is 20 – 25°C and 30 – 35°C, respectively. The population's livelihood mainly consists of agriculture, husbandry and small-scale trade. The farm units are small family holdings with an average agricultural land area of less than one hectare. Agriculture is mainly rain-fed. The cropping system is classified as intensive with cereal mono-cropping mainly sorghum and maize etc.

Materials and Methods

Farmers' Selection

Farmers were selected based on their interest, innovation he/she has, land provision for this pre-scaling up, interest in cost-sharing, willingness to share experiences for other farmers. Farmers' selection was under taken in collaboration with DA's, Woreda experts (SME) and multidisciplinary Researchers. 40 Farmers were selected for pre-scaling up of improved food barley varieties aquila variety purposively.

Site Selection

PAs were selected purposively based on the potentiality, appropriateness of the area by considering access to road, suit for (clustering, repeatable monitoring and evaluation in progress of sowing to harvesting). One potential peasant associations per district were selected purposively based on the demonstration result and crop performance. The land holding size in Hararghe ranges from 0.5 ha to 2ha in average at least we need 0.125 ha of land from individual farmer. Therefore, 10 ha (40* 0.125) of land was covered with this technology Aquila.

Implementation/Experimental/ Research Design

One improved treatments aquila variety was sown on 40 farmers land. 0.125ha of land from individual trial farmer, Spacing: 30cm between rows, Seeding rate: 85 kg/ha, Shallow planting depth: 2-4cm Fertilizer rate of NPS 85kg/ha and Urea 85 kg/ha will be applied with NPS at sowing and Urea half at sowing and half at stem elongation stage respectively

Information sharing and ways of communication

Training, field and exchange visit field day, preparing pamphlet, brochures, manuals, and posters, and proceedings, and publications on international journals.

Methods of Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FRG, yield performance, economic analysis and number of stakeholders participated on the training. While qualitative data were farmers' perceptions towards 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 or PRA (Participatory Rural Appraisal) tools and argument. Finally, data from different sources was triangulated to get reliable information.

Result and Discussion

Training provided for stakeholders

Multidisciplinary Fadis agricultural research center researchers were participated in training delivering. The team members involved in the training deliver was research-extension, socio-economic and crop agronomics. The training was given on improved Food barley production, market information and experience sharing and technology transfer approaches.

Table 2: Type of profession and number of participants on the training at Fadis

		Fadis (B/Aarba)		
No.	Participants	Male	Female	Total
1	Farmers	22	8	30
2	DAs	3	1	4
3	District experts	3	2	5
	Total	28	11	39

Source: Own computation 2018/19

Among the training participant stakeholders, 76.9% were farmers. This showed that most of the training participants were farmers. From those farmers, 36.3% are female farmers' participant.

Agronomic and Yield performance

Cropping Season	Location	Hosting farmers	Total Seed distributed (kg)	Total area covered (ha)	Yield qt/ha
2011	Fadis	20	210	2.5	23.9
2012	Fadis	20	210	2.5	24.7

The yield performances of the demonstrated varieties across the year 2011 and 2012.The grain yield performance of the improved food barley variety (Aquila) was 23.9qt/ha,24.7 qt/ha at Balina Arba in the year 2011 and 2012 respectively.

Conclusion and Recommendation

Food barley is one of the important small cereal crops in the East Hararghe Zone. However, its productivity is low as compare to released improved varieties. To address this low productivity pre-scaling up of improved aquila variety was undertaken. In the process, a mutual learning among farmers, as well as among researchers and Development agents has been enhanced. The result indicated that pre-scaling up improved food barley variety grain yield (23.9 qt/ha and 24.7 qt/ha) in 2011 and 2012 respectively. Aquila variety are well appreciated and recommended to more reach out for more farmers in the areas.

Exit strategy

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

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Pre-extension Demonstration of Animal Feed Chopper in selected districts of West Arsi and East-Shoa zones

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Abstract

The research activity was carried out in two purposively selected districts namely Negele Arsi from west Arsi and Adami Tulu Jido Kombolcha from east Shoa zone with the objectives of demonstrating *and evaluating the profitability of the animal feed chopper under farmers' management, creating awareness on the importance of the technology enhancing farmers' knowledge and use of the technology. Four kebeles were purposively selected based on their accessibility and four framers research extension groups composed of members representing male, female and youth were organized to undertake the demonstration. On organized training a total of 92 participants of which 80.4% was male and 19.6% female from two districts participated on both theoretical and practical training. Among the farmer interviewed 18.75, 37.5 and 43.75% had responded that it was very simple, simple and medium to operate the livestock feed chopper. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; (41.7%) of farmers responded that maintenance of technology was simple, (22.5%), 21.25 and (11.25%) responded that as it was difficult, medium and very simple to maintain technology respectively. On price to afford technology; about 33.75%, 35% and 31.25 of respondent farmer responded that the cost of technology was low, medium and high to afford the technology. Thus, animal feed chopper was recommended for further scaling.*

Key words: *Demonstration, Animal feed chopper, training.*

Introduction

Ethiopia has the largest livestock population in Africa (Hussen et al. 2008; Solomon et al. 2003).The livestock subsector comprised 11 percent of national GDP and 24 percent of agricultural GDP between the years of 1995/96 and 2005/06, and is a source of revenue for 60–70 percent of the population (NBE 2005/06;Halderman 2004). Livestock plays a central role in the natural resource-based livelihood of the vast majority of the population living in developing countries. Between 2005 and 2008, livestock population (in terms of cattle, sheep, and goats) in Ethiopia grew at 22 percent. In 2007/08, Oromia region produced the largest share, 38 percent of livestock within Ethiopia, while Amhara and Southern Nations, Nationalities, and Peoples (SNNP) regions produced 26 and 16 percent of livestock shares, respectively according Central Statistical Agency (CSA). 2012/13(2005 E.C). However, most of these regions face the problem of acute shortage of feed resources. The pastures are degraded and poorly managed and the area under green forage crops is shrinking due to increase in human population and urbanization. As a result, the bulk of feeds available for livestock in these regions are the crop residues.

Livestock feed preparation is a great problem nowadays. Earlier time there is grazing area. But now the quest to increase the agricultural production in all facets, have intensified crop

production by way of increasing cultivated areas thereby reducing the grazing areas. Livestock farmers especially in the sector of goats, sheep and cattle are constantly faced with problem of feed shortage during the dry season. The herd constantly relies on crop residue, but these are usually in short time.

The unavailability of sufficient feed during the dry season in the Ethiopia is a major problem in livestock production. During this period, grazing livestock lose weight and in extreme cases some deaths do occur.

Livestock production, productivity and its sustained development depend on the advancement of science and technology that will enhance production, processing, handling, storing of livestock feed. In this regard, concerted efforts are underway to modernize the livestock feeding chopper.

To solve these problems Asella Agricultural Engineering research center adapted animal feed chopper machine that has a chopping capacity of 4.5 quintal/hr and 5.14 quintal/hr of Maize stalk and Sorghum stalk respectively.

Therefore this study initiated with the objective of demonstrating animal feed chopper technology in selected districts of west Arsi and east Shoa zones.

Objectives

- To demonstrate and evaluate the profitability of the animal feed chopper under farmers' management
- To create awareness on the importance of the technology
- To enhance farmers' knowledge and use of the technology

Materials and Method

Materials

Materials such as:

- Feed chopper
- Stopwatch
- Balance
- knife
- Maize and sorghum
- Other necessary materials were used.

Method

Site and farmers selection

Based on crop residue potential and their representativeness Adami Tulu from East-Shoa and Negele Arsi from West-Arsi was purposively selected. Then experimental site and representative farmers was selected based on location, suitability for more farmers to visit the demonstration site with DA and district expert for the experiment under taken.

Technology evaluation and demonstration method/techniques

Demonstration of Animal feed chopper was conducted in the two select districts of East-shoa and West Arsi zone in the presence of farmers and different stakeholders. It was tested and compared with traditional way of animal feed chopping material at selected PA station. Both method and result demonstration was followed. Mechanisms used to enhance farmer to farmer learning and information exchange was mini-field day. The experiment was done on two treatments one was improved practice and the other one was local practices and it was replicated on two experimental sites.

Data type and method of data collection

Both qualitative and quantitative data from primary data sources was used. Primary data such as; Time reduced because of using this machine, labor reduced, eeconomic return/profitability, total number of farmers participated in training and field visits and field days by gender. Method that used for data collection was observation, household/participant interview, focus group discussion.

Method of data analysis

Data was analyzed using descriptive statics such as percentages, mean values and frequencies for data analysis. Economic data on livestock feed chopper was analyzed using partial budget analysis.

Result and Discussion

On organized training a total of 92 participants of which 80.4% was male and 19.6% female from two districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology. Multidisciplinary team consists of Engineers`, Extensionist and Socio-economist were organized to deliver the training on capacity building and facilitating extension efforts on technology.

Table 1. Training to stakeholders on animal feed chopper

Disticts	Description of participants	Male	Female	Total
Negele Arsi	Farmers	30	10	40
	Agricultural Experts	2	1	3
	Development agents	2	1	3
	Supervisor	1	-	1
Adami Tulu Jido kombolcha	Farmers	35	5	15
	Agricultural Experts	2	-	2
	Development agents	2	1	3
	Supervisor	-	-	-
Grand total		**74**	**18**	**92**

Farmer perception

Likert scale method was used to measure respondent's opinion/views towards new technology. Among the farmer interviewed 18.75, 37.5 and 43.75% had responded that it was very simple, simple and medium to operate the livestock feed chopper. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; (41.7%) of farmers responded that maintenance of technology was simple, (22.5%), 21.25 and (11.25%) responded that as it was difficult, medium and very simple to maintain technology respectively. On price to afford technology; about 33.75%, 35% and 31.25 of respondent farmer responded that the cost of technology was low, medium and high to afford the technology. As far as portability of technology concerned; about 37.5%, 32.5% and 30% of respondent farmers responded that the demonstrated technology simple, very simple and medium to transport technology from place to place.

Table 2 .Farmer's response towards the technology

N^{o}	Criteria	Attributes	N^{o} of respondent	Percentage (%)
1	Ease of operation	Very simple	15	18.75
		Simple	30	37.5
		Medium	35	43.75
		Difficult	0	0
		Very difficult	0	0
2	Maintenance	Very simple	9	11.25
		Simple	36	45
		Medium	17	21.25
		Difficult	18	22.5
		Very difficult	0	0
3	Price to afford technology	Very low	0	0
		Low	27	33.75
		Medium	28	35
		High	25	31.25
		Very High	0	0
4	Portability of technology	Very simple	26	32.5
		Simple	30	37.5
		Medium	24	30
		Difficult	0	0
		Very difficult	0	0

Framers` feedback and reaction

In the process of demonstrating animal feed chopper mini-field day was organized. In the course of field day different stakeholders and researcher were participated and reacted on what they observed during operation. Criteria's were availability of feed and cost of feed in relation to their feed shortage and feedback were collected and analyzed. Because of above stated quality animal feed chopper has many advantages. As a result, all participant farmers and stakeholders liked and accepted animal feed chopper technology.

Conclusion and Recommendation

Demonstration of Animal feed chopper was conducted in the two select districts of East-shoa and West Arsi zone in the presence of farmers and different stakeholders with the objectives of To

demonstrate and evaluate the profitability of the animal feed chopper under farmers' management, creating awareness on the importance of the technology and enhancing farmers' knowledge and use of the technology. Among the farmer interviewed 18.75, 37.5 and 43.75% had responded that it was very simple, simple and medium to operate the livestock feed chopper. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; (41.7%) of farmers responded that maintenance of technology was simple, (22.5%), 21.25 and (11.25%) responded that as it was difficult, medium and very simple to maintain technology respectively. On price to afford technology; about 33.75%, 35% and 31.25 of respondent farmer responded that the cost of technology was low, medium and high to afford the technology. As far as portability of technology concerned; about 37.5%, 32.5% and 30% of respondent farmers responded that the demonstrated technology simple, very simple and medium to transport technology from place to place. In the course of field day different stakeholders and researcher were participated and reacted on what they observed during operation. Criteria's were availability of feed and cost of feed in relation to their feed shortage and feedback were collected and analyzed. Because of above stated quality animal feed chopper has many advantages. As a result, all participant farmers and stakeholders liked and accepted animal feed chopper technology. Therefore, animal feed chopper technology was recommended for further scaling up for wider utilization.

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Pre-extension Demonstration of manually operated wet Coffee pulpier in selected district of Arsi zone

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Abstract

The research activity was carried out in one purposively selected district namely Gololcha district of Arsi zone with the objectives of demonstrating *and evaluating the profitability of the manually operated wet coffee pulper under farmers' management, creating awareness on the importance of the technology enhancing farmers' knowledge and use of the technology. Two kebeles were purposively selected based on their accessibility and two framers research extension groups composed of members representing male, female and youth were organized to undertake the demonstration. On organized training a total of 37 participants of which 31(83.8%) was male and 6(16.2%) female from selected district were participated on both theoretical and practical training. Among the farmer interviewed 33.3, 50 and 16.7% had responded that it was very simple, simple and medium to operate the manually operated wet coffee pulpier. Maintenance of the technology was also considered as one criterion to see the simplicity of technology.*

Regarding to the simplicity of maintenance of technology; 30, 53.3 and 16.7% of farmers responded that maintenance of technology was very simple, simple and medium to maintain technology. As far as price of the technology concerned 43.3, 36.7 and 20% of the respondent responded that the price the technology was low, medium and high respectively to buy it. Profitability analyses of manually operated wet coffee pulpier were calculated using partial budget analysis. The result of this finding depicted that coffee producer obtained net benefit of five thousand seven hundred forty birr. Thus, manually operated wet coffee pulper technology was recommended for further scaling up.

Key words: *Demonstration, Wet coffee pulper, profitability, training.*

Introduction

Coffee *(Coffee Arabica L.*) is a non-alcoholic stimulant beverage crop that belongs to the family *Rubiaceae* and genus *Coffee.* Among 100 *Coffee* species in the genus *Coffee*; *C. Arabica* is the only species naturally occurring in Ethiopia (Anthony *et al*., 2001; Yigzaw, 2005). Ethiopia is the only center of origin and diversity of Arabica coffee (*C. Arabica*) (Anthony *et al*., 2001).

Coffee is the major source of foreign currency for Ethiopia and contributes more than 35% of the total export earnings (FAO/WFP, 2008). Thus, it is a cornerstone in the export economy of the country and it supports directly or indirectly the livelihood of some 15 million people (EEA, 2001). In Ethiopia, coffee is produced in four production systems, namely: forest, semi-forest, garden and plantation coffee in the Western, Southern, and Southwestern parts of the country (CFC, 2004).

Arsi Zone is one of the Oromia region's zones which has potential of coffee production. In 2015/16 Meher season, 6,476.56 ha of land was allocated and 40,248.25 quintal was produced with average yield of 6.21quintal/ha (CSA, 2016). Coffee plantation enterprise is also found in Gololcha district which is one of the districts in the Arsi Zone. Gololcha district is 14th from top 25 coffee producing districts in Ethiopia and 7th from top 18 coffee producing districts in Oromia (James et al., 2015).

Coffee is either processed by the wet or dry methods, which vary in complexity and expected quality of the coffee (Wrigley, 1988). Both sun-drying as well as wet-processing methods are operated in Ethiopia, which accounts for 70% and 30% of coffee produced in the country, respectively. Despite the favorable climatic conditions, variety of local coffee types for quality improvement and long history of its productions, still there are gaps like lack of improved small scale wet coffee pulpier to enhance wet coffee process to improve coffee quality problems in west Arsi zone and lack of adequate information on the effects of post-harvest processing and handling techniques on coffee quality.

Jima Agricultural Engineering Research Center adapted and evaluated manually operated wet coffee pulpier with the pulping capacity of 176.06 kg/hr, cleaning efficiency of 95.5% and breakage of 9.5%.

Therefore, this study initiated with the objective of demonstrating and popularizing small scale manually operated wet coffee pulpier to minimize problems of coffee growers and processors for quality coffee produce in Gololcha district of Arsi Zone.

Objectives

- To enhance farmers awareness on the importance and use of the machine
- To evaluate the performance of the machine under farmers condition
- To collect farmers feedback on wet coffee pulpier
- To evaluate the economic analysis/ cost-benefit gain of the machine

Materials and method

Materials

The study was made use of necessary materials such as wet coffee pulpier, stopwatch and other necessary materials were used.

Method

Site selection, Technology evaluation and demonstration methods/techniques

Demonstration of wet coffee pulpier was held in Gololcha district that purposively selected based on their crop potential. The study also conducted in two PAs and in each kebeles one farmer’s research groups (FRG) established that has different category of farmers like male, female and youth. The technology tested and compared with traditional way of wet coffee pulping at selected kebeles hosting farmer. To do this both result and method demonstration

method and techniques was followed. In the demonstration process the mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day. The experiment was done on two treatments which were improved practice and the other one was local practices and it was replicated on two experimental sites.

Method of data collection

This study was employed both qualitative and quantitative data from primary data sources. Primary data such as time reduced because of using this machine, labor reduced, economic return/profitability, total number of farmers participated in training, field visits and field days by gender, numbers of farmers become aware of the relative advantage of the technology by gender, role of farmers and other stakeholders in technology demonstration, farmers' opinion was collected using different appropriate data collection method/technique such as field observation, household/participant interview, focus group discussion.

Method of data analysis

The study was analyzed using descriptive statics as percentages, mean values and frequencies for data analysis. Economic data on wet coffee pulpier was analyzed using partial budget analysis.

Result and Discussion

Training of farmers and stakeholders

On organized training a total of 37 participants of which 31(83.8%) was male and 6(16.2%) female from selected district were participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology. Multidisciplinary team consists of Engineers`, Extensionist and Socio-economist were organized to deliver the training on capacity building and facilitating extension efforts on technology. The training was mainly focused on how to operate technology, relative advantage of technology over local practice.

Table 1. Training to stakeholders on manually operated wet coffee pulper.

District	Description of participants	Male	Female	Total
Gololcha	Farmers	25	5	30
	Agricultural Experts	3	-	3
	Development agents	2	1	3
	Supervisor	1	-	1
Grand total		31	6	37

Farmer perception

Among the farmer interviewed 33.3, 50 and 16.7% had responded that it was very simple, simple and medium to operate the manually operated wet coffee pulpier. Maintenance of the technology was also considered as one criterion to see the simplicity of technology.

Regarding to the simplicity of maintenance of technology; 30, 53.3 and 16.7% of farmers responded that maintenance of technology was very simple, simple and medium to maintain

technology. As far as price of the technology concerned 43.3, 36.7 and 20% of the respondent responded that the price the technology was low, medium and high respectively to buy it.

Table 2 .Farmer's response towards the technology

N^{o}	Criteria	Attributes	N^{o} of respondent	Percentage (%)
1	Ease of operation	Very simple	10	33.3
		Simple	15	50
		Medium	0	0
		Difficult	0	0
		Very difficult	0	0
2	Maintenance	Very simple	9	30
		Simple	16	53.3
		Medium	5	16.7
		Difficult	0	0
		Very difficult	0	0
3	Price to afford technology	Very low	0	0
		Low	13	43.3
		Medium	11	36.7
		High	6	20
		Very High	0	0

Profitability analysis of the technology

The Profitability analyses of manually operated wet coffee pulpier were calculated using partial budget analysis. As result shown in the following table net return obtained from deduction of increased income from increased cost due to introduction of the technology. Thus, coffee producer obtained net benefit of five thousand seven hundred forty birr.

Table 3. Profitability analysis of machine

Column 1	**Column 2**
Increased income due to change:	**Increased costs due to change:**
Income increased due to increased:	Cost increased due to purchase of machine: 7,000 Birr
Subtotal = 0 Birr	Subtotal = 7,000 Birr
Reduced costs due to change:	Reduced income due to change:
Reduced wage: 100 person X 130 Birr= 1300 Birr	**Reduced wage: 2person X 130=260 Birr**
Change in income: **(subtotal from Column 1 minus subtotal Column 2)** **13,000 – 7260= (5,740 birr)**	

Conclusion and Recommendation

Demonstration of manually operated wet coffee pulpier was conducted in Arsi zone with the objectives of demonstrating, evaluating the profitability technology under farmers' management, creating awareness on the importance of the technology and enhancing farmer's skill. The technology tested and compared with traditional way of wet coffee pulping at selected kebeles hosting farmer. Both result and method demonstration method and techniques was followed. The Profitability analyses of manually operated wet coffee pulpier were calculated using partial budget analysis. Coffee producer obtained net benefit of five thousand seven hundred forty birr (5740). Among the farmer interviewed 33.3, 50 and 16.7% had responded that it was very simple, simple and medium to operate the manually operated wet coffee pulpier. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 30, 53.3 and 16.7% of farmers responded that maintenance of technology was very simple, simple and medium to maintain technology. As far as price of the technology concerned 43.3, 36.7 and 20% of the respondent responded that the price the technology was low, medium and high respectively to buy it. As a result, all participant farmers and stakeholders liked and accepted manually operated wet coffee pulpier technology. As a result, all participant farmers and stakeholders liked and accepted manually operated wet coffee pulpier technology. Therefore, manually operated wet coffee pulpier technology was recommended for further scaling up.

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Pre-Scaling up of Replaceable Drum-Beater Multi-Crop Thresher in Jimma and Buno-Bedele zones

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Abstract

The study was conducted in Jimma and Buno Bedele Zones of Oromia Regional State, Ethiopia. The objective of the study was to scale up the Drum Replaceable Multi-Crop Thresher machine at the farmer's condition. Fourteen hosting households were selected for the study as hosting households residing in two zones at different districts (Nada, Dedo, Limu Seka, Shebe, Tiro-afeta, Gechi and Bedele). The result showed that the multi-crop thresher machine operates with minimum force requirement for feeding for the duration of threshing and or shelling activities. It has threshing capacity 2,526.31, 386.98, 237.2, 780.68 and 221.62 kg/h with threshing/Shelling efficiency of 99.39, 97.33, 98.97, 98.63 and 96.45 for maize, wheat, teff, sorghum and barley respectively. The theoretical and practical trainings were given to 214 participants out of who were 162 farmers 33 Development Agents (DAs), and 19 Subject Matter Specialists (SMS) on general aspects of operation and maintenance of the machine to improve awareness, attitude and adoption behavior of the farmers. A total of 296 participants attended the field demonstration conducted at five sites where thresher scaling up has made involving 241 farmers, 12SMS, 15 DAs and 28 stakeholders. Participants from agricultural offices of the two zones and technical micro enterprises were also invited and participated during consultation meeting and training.

Key words*: *Multi-crop, thresher, Sheller, Drum, Replaceable, Capacity, Efficiency scaling up

Introduction

Agriculture is the foundation of Ethiopia's economy and it provides all the necessary dietary foods, raw materials for food industries and quality products for export market. The country's agricultural potential for food production is known to be immense and over 90% of its export earnings come from this sector. Available sources indicate that a total of 11.6 million tones of cereals, 1.3 million tone of pulses and 0.5 million ton of oil crops were estimated produced annually (CSA, 2007). Despite the large production, the country has never relieved itself from shortage of food. Estimates suggest that the magnitude of post-harvest loss in Ethiopia is remarkable ranging from 5% to 19% for maize and 5% to 26% for other cereals and pulses (Dereje, 2000).

As to the African Postharvest Losses Information System (APHLIS) postharvest losses in 2012 for teff were estimated at 12.3%, for sorghum at 11.6%, for wheat at 9.9% and for maize at 16.8%. All these figures represent a marginal decline from the year before. Other data sources put that postharvest losses for pulses at 19.6% due to insects and molds alone. Furthermore, a recent study conducted by Addis Ababa University and the Swiss Agency for Development and Cooperation (SDC) in two communities in the East Gojam zone of the Amhara National Regional State showed that, in at least some locations, postharvest losses can be as high as 30% to 50%. The 2010 national grain balance estimated by United Nations Food and Agriculture Organization/World Food Program Crop and Food Security Assessment Mission estimates total postharvest losses at 2.04 million tons of grain whereas the cereal import requirement was roughly 1.16 million tones.

In order to help small scale agriculture increase its contribution in ensuring food security in the country, all aspects of production including harvest, threshing and post harvest handling of the produce need equal and proper attention (Husen A. and Dubale B, 2015) .
Ethiopian farmers are totally engaged in farm works the whole year which includes land preparation, sowing, cultivating, harvesting, transporting, shelling/threshing and storing activities which are tedious process. Threshing or shelling is the process of separating the grain from the seed heads, panicles, cobs or pods. It is important to minimize the damage done to grain during threshing as damaged grain is much more prone to attack by insects and fungi.

Consequently, techniques usually employed by most farmers that crush and damage grains such as beating with sticks or trampling by cattle are not recommended (Hodges and Stathers, 2012). Traditional threshing of crops like wheat, barley and sorghum is one of the most times consuming laborious and maximum loss of grain (worku et al., 1996)

To solve this problem a number of appreciable works have been done by different bodies; Bako maize sheller and Asella wheat barley thresher are the prominent one since long. But the high cost of these machines and their engines together with their heaviness limits its adoption rate.

In addition to the above problems, the undulating topography of south-western Ethiopia and small and fragmented land ownership of the farmer of this area plays a great role in limiting the adoption rate of the mentioned technologies. Maize, teff, sorghum, wheat and barley are among crops produced in south western Ethiopia. So, farmers are obliged to have single machine that can serve for maize shelling and threshing teff, sorghum, wheat and barley. In order to have both machines they need to spend an initial capital of more than 250, 000 Et. Birr which is very big amount compared to the capacity of most farmers in the area. To solve the above shelling and threshing problems of the farmers of the study area, the Jimma Agricultural Engineering Research Centre (JAERC) have manufactured a machine which is affordable, portable, combine the work of two machines in to one and that can use engine power (10HP diesel) available in the market at reasonable price having mean output capacities of 2526.31 kg/hr, 386.98 kg/hr, 237.2 kg/hr, 780.68 kg/hr and 121.62 kg/hr for average grain-straw (cob) ratios of 1:0.36, 1:2.22, 1:2.56, 1:0.21 and 1:1.29 were recorded for maize, wheat, teff, sorghum and barley crops respectively was demonstrated that had got good acceptance by the participant farmers for shelling and threshing the above mentioned crops and thus accordingly scaled up to farmers of the study area with advantages of being smaller size for transportation with 2-4 persons

comfortably, can thresh teff, wheat, barley and sorghum using only cylindrical drum and can shell maize using replaceable triangular drum interchangeably, use engine powers (10HP) that available on market at reasonable prices (currently at about 30,000 to 35,000 Et. Birr) & can be manufactured at small scale manufacturer level.

Objective:

- To popularize multi-crop thresher at wider areas for awareness creation on the technology
- To improve research-extension linkage for farther dispersion
- To collect feedback on farmers perception

Materials and Methods:

Materials

- Nine prototypes of Replaceable Drum-Beater Multi-Crop Thresher were manufactured in JAERC workshop as per its design for the scaling up purposes.
- Engines of 10 hp were used
- Five Replaceable Drum-Beater Multi-Crop Thresher with engine were provided to the land less young farmers organized in groups at five sites for the scaling up purposes

Methods

Description of the study area

The study was conducted in two zones of Jimma namely Nada, Dedo, Limu Seka, Shebe and Tiro-afeta districts including Buno-Bedele zone namely Gechi and Bedele districts.

Approach followed

Participatory and multidisciplinary approach was used involving team consisting of researchers from post harvest, technology production workshops and agricultural extensions established at Jimma Agricultural Engineering Research Centre (JAERC) for the implementation of activity. In addition, ensuring efficiency, effectiveness, integration and cooperation were institutional tools used for the realization of the strategy. Moreover, the approach followed included the followings:-

- Joint planning: establishment of task force at district and Kebele and establishment of FRGs at each site were done
- Capacity building training on operation and maintenance: training the participant farmers, DAs, SMS and local microenterprises members
- Inputs supply for technology production and distribution: The JAERC produced and supplied the technology for use in group
- FREG members and other follower farmers were encouraged to participate in physical activities at all stages (from start to the end) of the crop thresher pre-scaling up activities.
- Joint monitoring and evaluation: field visit and supervision were made regularly by extension agents at different study sites where the thresher popularization made. Mini-field day organized at three sites namely Nada, Tiroafeta, Shebe, Gechi & Dedo districts.
- Discussion session and result communication forum were also organized.

- Technology supply & maintenance mechanism: sustainable technology delivery and maintenance system was designed. Persistent follow up and frequent maintenance were made for the threshers by the JAERC technicians. Members from micro and small enterprises and private manufacturers at district level were invited on mini-field day visit and information of potential technology manufacturers were provided to the farmers for future technology supply and maintenance.

Stakeholder Analysis (SA)

The research center was closely working and has made frequent consultation with the respective stakeholder in promotion of Drum-Beater Replaceable Multi-Crop Thresher. The joint stakeholder analysis was made to identify potential stakeholders, the type, role, duties and responsibilities of each actor in activity implementation since the pre-scaling up activities need different actors in partnership. The stakeholders were mainly district Office of Agriculture, Improved Seed Enterprises, Micro Enterprises, farmers and private investors identified as our stakeholders.

Communication method used

Primarily individual, group, and other mass contacts of extension teaching methods were used in line with the situations during the machine pre-scaling up activity implementation.

Data collection

In this research activity, both qualitative and quantities data were collected about users' perceptions, ease of operation, advantage and limitation of technology using appropriated data collection methods such us field observation, interview and focused group discussion. The collected data analyzed through descriptive statistics as well as quantitatively.

Results and Discussion

Performance of multi-crop thresher under the farmers' management

Threshing and shelling involves removal or separation of grain from chaff stock or corncob. The thresher can be adjusted as per the crop variety using the replaceable drum-beater. The performance of the multi-crop thresher was calculated under the farmers' management during the demonstration as follows:

Table 1: Factors and optimum performance of machine for different crops under farmers' management

Description of Factors	Optimum Performance for the Crop Varieties				
	Maize	Wheat	Teff	Sorghum	Barley
Threshing capacity (kg/hr)	2,526.31	386.98	237.2	780.68	221.62
Threshing/Shelling efficiency (%)	99.39	97.33	98.97	98.63	96.45
Breakage percentage	0.35	2.2	0	1.12	0.1
Grain loss (%)	5.5	4.4	2.87	3.97	0.1

The multi-crop thresher machine operates with minimum force requirement for feeding for the duration of threshing and or shelling activities. It has good threshing capacity 2,526.31, 386.98, 237.2, 780.68 and 221.62 kg/hr for maize, wheat, teff, sorghum and barley respectively. As far as its threshing/Shelling efficiency is concerned, it was obtained that 99.39, 97.33, 98.97, 98.63 and 96.45 for the respective crops maize, wheat, teff, sorghum and barley.

Training

Both theoretical and practical trainings were given to 214 participants out of whom 162 were farmers 33 were Development Agents (DAs), and 19 were district Subject Matter Specialists (SMS). The training topics were on general aspects of operation and maintenance of the multi-crop threshing and shelling technology with aim to improve the users' awareness, attitude and adoption behavior of the people. Participants from agricultural offices of the two zones and technical micro enterprises were also invited and participated during consultation meeting and training.

Table2. Training given to farmers, DAs & SMS

No	**Location**			**Training Participants**				
				Farmers		**Others**		**Total**
	Zone	**District**	**Kebele**	**Adult**	**Youth**	**DAs**	**SMS**	
1	Jimma	Nada	Doyo	0	10	3	2	15
			Soya Adami	2	10	3	1	16
		Dedo	Calte	0	10	3	0	13
			Sito	0	10	2	2	14
		Shebe	Kishe	10	3	2	1	16
			Gasara	6	4	2	1	13
		Tiro-afeta	Biodru	8	3	2	2	15
			Qanani	7	5	2	2	16
			DachaNadhi	7	3	2	2	14
		Limu Seka	Yedo	0	10	2	2	14
2	Buno Bedele	Bedele	Mute	11	4	2	1	18
			Urgesa	10	2	2	0	14
		Gechi	Chara	10	3	3	1	17
			Muche	11	3	3	2	19
	Total			82	80	33	19	214

Mini-Field days

A total of 296 participants attended the field demonstration that conducted at different sites where the drum replicable multi-crop thresher scaling up has made involving 241 farmers at the five hosting farmers' farm sites. The twelve district level agricultural workers or subject matter specialists, fifteen development agents and twenty-eight stakeholders were participated in mini-field day demonstration as stated in the table below

Table3. Participants on mini field days

No	Location			Participants of field day					
				Farmers		workers		Stake holder	Total
	District	Kebele	Sites	Adult	Youth	DAs	SMS		
1	Nada	Doyo	1	29	25	3	4	6	67
2	Dedo	Calte	1	27	30	3	3	7	70
3	Shebe	Gasara	1	26	29	2	1	8	66
4	Tiroafeta	Qanani	1	20	17	5	2	5	49
5	Gechi	Chara	1	26	12	2	2	2	44
6	**Total**		**5**	**128**	**113**	**15**	**12**	**28**	**296**

Farmers' perception on the technology attributes

Evaluation was made to know how farmer perceived the technology. The response showed that the machine was liked by farmers for threshing and shelling different types of crops rather than using animal or human labor. About 83.08% had responded it is simple to use the machine for threshing and shelling purposes compared to the tedious local methods mainly human or animal labor. While only 16.92 % of the respondents stated that it requires some technical knowledge to use and maintain when it damages. Normally the multi-crop thresher machine was practically easy to operate with minimum labor requirement.

Table4. Farmers response on the drum replaceable multi-crop thresher machine (no= 65)

No	Districts	Response level	No. of respondents	Percentage (%)
1	Ease of operation	Simple Not Simple	54 11	83.08 16.92
2	Maintenance	Easy Difficult	44 21	67.69 32.31
3	Affordability (for model farmers or farmers group)	High Medium Low	12 40 13	18.46 61.54 20.00

About 67.69 % of the respondent farmers also indicate that it is possible to repair and maintain by local technicians or by themselves when the machine damages. As far as its affordability is concerned, 61.54 % of the farmers responded that the machine price is medium that can be affordable by the average farmers and mainly easy for the model farmers.

Success factors: The center had provided drum replaceable multi-crop thresher machine for the five groups of unemployed youth farmers after the necessary training has given. Accordingly, after working on the machine for a year, the groups has got profit from the machine service and some groups could required for purchase of additional machines after a year and they planned to step up their work in other activities like contracting farm land, fattening and other pity business activities.

Alliance between different teams, active participation and good linkage among stakeholders and cooperative workshop technicians and researchers were some of the conditions that favored the scaling-up process

Challenges encountered:

Shortage of time was what reflected to satisfy the demand of farmers when required for threshing and sheering service during the scaling up process and demanding for frequent follow-up to provide services when the machine or the engine damages especially for those machines provided in groups.

Using the machine in group by itself is challenging as it needs continuous awareness creation to reconcile different interests of the group members and maintain their proper functioning.

Exiting strategy

Since the role of the research centre in technology supplying is very much limited, the wider scale dissemination of the technology is to be undertaken by the bureau of agriculture in collaboration with manufacturer enterprises. Thus information was provided to the respective districts and zonal bureau of agriculture.

Conclusion and Recommendation

Conclusion

The multi-crop thresher machine operates with minimum force requirement for feeding for the duration of threshing and or shelling activities. It has threshing capacity 2,526.31, 386.98, 237.2, 780.68 and 221.62 kg/h with threshing/Shelling efficiency of 99.39, 97.33, 98.97, 98.63 and 96.45 for maize, wheat, teff, sorghum and barley respectively.
The theoretical and practical trainings given to participants on general machine operation and maintenance had enhanced the farmers' awareness, attitude and adoption behavior aided by field demonstration conducted at five sites where thresher scaling up has made. Participants from agricultural offices of the two zones and technical micro enterprises were also invited and well informed about the way out through consultation meeting.

Recommendation

Even though the drum-biter replaceable multi-crop thresher machine was efficient and has got acceptance by the famers, it was remained challenge to have sustainable supplying mechanism that need creation of smooth linkage between the district and zonal agricultural bureau with the respective technical manufacturer microenterprises.
Since the machine use the engine for energy source, the necessary training need be provided for the operators so that they can be able to repair and maintain when the machine and or the engine damages

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