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Pre-Extension Demonstration of Improved Field Pea Varieties in Selected Districts of Bale Highlands, Oromia, Ethiopia

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Abstract

*Pre-extension demonstration of improved field pea varieties was conducted in Goba, Sinana and Agarfa districts of Bale zone. The main objective of the study was to demonstrate and evaluate recently released field pea variety (Hortu) along with standard check. The demonstration was undertaken on adjacent plots of 10mx10m area for each variety with row planting, recommended seed rate of 75kg/ha and fertilizer rate of 100kg/ha 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 ranked using pair wise ranking methods. The demonstration result showed that Hortu variety gave gigher yield (*36.3*qt/ha) than the standard check; Harena variety which gave* 31.42qt*/ha. Hortu variety had* 15.53*% yield advantage over the standard check and preferred by by farmers. Thus, Hortu variety was recommended for further scaling up.*

Key words: *Demonstration, Farmers' preference, field pea, Hortu, Selection criteria*

Introduction

Field pea is the most important high land pulse which is mainly used for human consumption in Ethiopia. It is widely grown in the Highlands and performs well at an altitude of 1800 – 3000 meter above sea level. In addition, the crop also better adapted under low rainfall environments as compared to other pulses such as Faba bean, lentil, and chickpea. Field pea has moisture requirements similar to those of cereal grains. However, field peas have lower tolerance to saline and water-logged soil conditions than cereal grains (Mohammed et al., 2016). Among the pulse crops produced in Bale zone, 9,562.24 hectare of land was covered by field pea with average productivity of 20.15 quintal per hectare (CSA, 2017).

It contains high levels of amino acids, lysine and tryptophan, which are relatively low in cereals. It also contains approximately 21-25 % protein and rich in carbohydrates. Moreover, it plays a significant role in soil fertility restoration as a suitable rotation crop that fixes atmospheric nitrogen. It is used as source of protein and income for the poor farmers (Telaye *et al*., 1994). However, local varieties are becoming low yielding and less profitable to subsistence farmers. The reduction in yield is due to pests like pea weevil and pea aphid; diseases like Ascochyta blight and powdery mildew, poor management practices and climatic changes (Fikere, 2010).

By considering this prevailing problem, researchers from Sinana Agricultural Research Center had made significant efforts by releasing high yielding and disease tolerant variety namely Hortu with yield potential of 42.04 quintal per hectare. The yield advantage of Hortu over Urji (standard check) and local check is 26.28% and 43.1%, respectively. However, this variety was not evaluated by target beneficiaries, since it was released.

Participatory technology evaluation under farmers management condition may have many advantages, such as increased and stable crop productivity, faster release and adoption of varieties, better understanding farmers' criteria for variety selection, enhanced biodiversity, increased cost effectiveness, facilitated farmers learning and empowerment (Sperling et al, 2001).The two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process (Getachew et al, 2008). Hence, participatory on farm demonstration of these varieties under farmers' condition and enhancing farmers to select variety/ies of their interest to their locality is a vital task.

Objectives of the study

The specific objectives of the demonstration trial were:

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

Methodology

Description of the study area

The activity was conducted in Goba, Sinana and Agarfa 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

Pre extension demonstration of improved field pea varieties was conducted at Goba, Sinana and Agarfa districts of Bale zone. Purposive sampling methods were employed to select the districts based on the potential of the crop. Two PAs from Goba and Agarfa and three PAs from Sinana were selected based on accessibility or vicinity to the road. Similarly, one trial farmer from each PA was used to carry out the demonstration process considering each farmer's field as replication of the trial.

Materials used and Field design

Improved field pea variety (Hortu) was demonstrated and compared with standard check Harena. The demonstration was under taken on simple plot design of 10mx10m area for each variety. Full packages were applied in which row planting, recommended seed rate of 75kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. In addition, twice hand weeding was done on time (i.e. the first weeding one month after planting and the second weeding was done one month later after of the first weeding). SARC was the source of agricultural inputs (seed, fertilizers and chemicals in case needed). Hosting farmers provided their land. Land preparations were carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up and visit, harvesting, threshing were handled and managed by SARC.

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 of 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 Goba, Sinana and Agarfa 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.

Results and Discussions

Training

Training was given to farmers, DAs, and agricultural experts on field pea crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture development office, Zone and district level cooperative promotion offices, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training. In general, a toral of 61 farmers, 25 development agents and 33 subject matter specialists were participated on the training.

Table 1. Participants of training

SMS			**DAs**			**Farmers**				
Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Male (youth)	Female (youth)	Total
28	5	33	22	3	25	53	4	4	0	61

Yield performance of Demonstrated varieties

The overall mean yield of demonstrated varieties of field pea were summarized in the following table. The demonstration result revealed that, the new variety (Hortu) performed better than the standard check (Harena variety) all over the demonstration sites. It gave higher yield at all locations. The mean yield of Hortu variety was 30.98qt/ha, 40.53qt/ha, and 37qt/ha at Goba, Sinana and Agarfa, respectively with all over mean yield of 36.3qt/ha. Similarly, the mean yield of Harena variety was 24.82qt/ha, 33.9qt/ha and 35.5qt/ha Goba, Sinana and Agarfa, respectively with all over mean yield of 31.42qt/ha (table 2).

Table 2. Yield performance of the demonstrated varieties

District	**PA**	**Yield obtained (Qt/ha)**	
		Harena	**Hortu**
Goba	Aloshe	23.02	28.96
	Sinja	26.62	33
	Mean	24.82	30.98
Sinana	Selka	34.13	41.83
	Gamora	32.05	40.1
	N/Robe	35.53	39.67
	Mean	33.9	40.53

Agarfa	Ali	35.15	36.98
	Ilani	29.76	37.66
	Mean	35.5	37.4
Overall mean		31.42	36.3

Comparison of yield advantage of improved varieties

The yield advantage of Hortu over Harena was calculated using the formula shown below. The result showed that Hortu variety had 15.53% yield advantage over the Harena variety.

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

Yield Advantage of **Hortu** over Harena: $\frac{36.3-31.42}{31.42} \times 100\% =$ **15.53%**

Economic evaluation

As shown in the above table (table 3) the cost benefit ratio analysis showed that, the net return gained from Hortu and Harena varieties was 38790.00 birr and 31242.00 birr per hectare, respectively. Hortu variety had higher cost benefit ratio (2.01) than Harena variety (1.64). This means, Hortu variety is more profitable than Harena variety with the same cost expenditure for both varieties per unit area.

Table 3. Cost-Benefit Analysis of the Demonstrated varieties

Variables	**Varieties**	
	Hortu	**Harena**
Yield obtained (qt/ha)	36.3	31.42
Sale price (ETB/qt)	1600	1600
Gross Returns (Price X Qt) TR	58080	50272
Land preparation	4050	4050
Seed purchase	1200	1200
Fertilizers purchase (NPS)	1400	1400
Labor for weeding	800	800
Insecticide purchase	600	600
Labor for spray	400	400
Harvesting and threshing	2200	2000
Packing, Loading and store	280	260
Store (bag purchase)	360	320
Total Variable Costs TVC (ETB/ha)	11290	11030
Fixed cost	8000	8000
Total cost (TC)	19290	19030
Net Return (GR-TC)	**38790**	**31242**
Benefit cost ratio (NR/TVC)	**2.01**	**1.64**

Farmers' preference to demonstrated varieties

The farmers' preferences towards the demonstrated varieties were assessed by organizing focus group discussion with 76 farmers and 12 others (researchers, SMS and DAs). Pair wise ranking was used to identify farmers' preference of variety traits. The varieties preference ranking was conducted based on a jointly set variety selection criteria or attributes. Accordingly, yield, disease tolerance, number of branches/plant, pod/plant and early maturity were the top five priority concern given by farmers (Table 4). Based on the identified criteria, Hortu variety was preferred (ranked first) to Harena variety(Table 5).

Table 4. Pair wise ranking result to rank variety traits in order of importance

Code	Variety traits	A	B	C	D	E	F	G	H	I	J	Frequency	Rank
1	A											7	2nd
2	B	2										7	2nd
3	C	1	2									4	6th
4	D	1	2	4								6	4th
5	E	1	5	5	4							6	4th
6	F	1	2	3	4	5						3	7th
7	G	1	2	3	4	5	6					0	10th
8	H	1	2	3	4	5	6	8				1	9th
9	I	1	2	3	4	5	6	9	9			2	8th
10	J	10	10	10	10	10	10	10	10	10		9	1st

A=Disease tolerance, B=Number of branches, C=Seed/pod, D=Pod/plant, E=Early maturity, F=Uniformity of maturity, G=Stem strength, H=Stem strength, I=Seed color, J=Plumpness, Yield

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

No	Varieties	Rank	Reasons
1	Harena	**2nd**	Low yielder, lower number of branches, seed/pod (4-8), pod/plant(28), late mature, non uniformity of maturity, less tolerant to disease,
2	Hortu	**1st**	High yielder, higher number of branches(7), early mature, tolerant to disease, good seed color , number of pod/plant (56), seed/pod(4-8), uniformity of maturity, resistant to water lodging,

Conclusions and Recommendations

Pre extension demonstration and evaluation of field varieties was carried out on seven (7) representative trial farmers' fields. Improved variety viz. *Hortu* was demonstrated along with Harena variety which is the standard check. Accordingly, Hortu gave higher yield than Harena variety.

Moreover, Hortu was selected by participant farmers in all districts due to it is high yielder, higher number of branches (7), early mature, tolerant to disease, good seed color , number of pod/plant (56), seed/pod (4-8), uniformity of maturity, resistant to water lodging. Based on these facts, Hortu variety was recommended for further scaling up.

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Pre-Extension Demonstration of Field Pea Varieties in Selected Districts of Bale Highlands, Oromia, Ethiopia

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Abstract

Pre extension demonstration of improved field pea varieties was conducted in Goba, Sinana and Agarfa districts of Bale zone. The main objective of the study was to demonstrate and evaluate recently released (Weyib) variety along with standard check. The demonstration was undertaken on adjacent plot of 10mx10m area for each variety with the spacing of 30cm between rows and recommended seed rate of 75kg/ha and fertilizer rate of 100kg/ha 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 ranked using pair wise ranking methods. The demonstration result revealed that Weyib variety performed better than the standard check (Tulu shanan variety) giving an average yield of 34.47*qt/ha, while that of the standard check was 27.26qt/ha. Weyib variety had 17.27% yield advantage over the standard check. Thus, Weyib variety was recommended for further scaling up.*

Key words: *Demonstration, Farmers' preference, field pea, Weyib, Selection criteria*

Introduction

Field pea is the most important high land pulse which is mainly used for human consumption in Ethiopia. It is considered as the least expensive source of protein and income for the poor farmers (Merkine, 2017). Among the pulse crops produced in Bale zone, 9,562.24 hectare of land was covered by field pea with average productivity of 20.15 quintal per hectare (CSA, 2017).

It contains high levels of amino acids, lysine and tryptophan, which are relatively low in cereals. It also contains approximately 21-25 % protein and rich in carbohydrates. Moreover, it plays a significant role in soil fertility restoration as a suitable rotation crop that fixes atmospheric nitrogen. It is used as source of protein and income for the poor farmers (Telaye *et al*.,

1994).However, local varieties are becoming low yielding and less profitable to subsistence farmers. The reduction in yield is due to pests like pea weevil and pea aphid; diseases like Ascochyta blight and powdery mildew, poor management practices and climatic changes (Fikere, 2010).

By considering this prevailing problem, researchers from Sinana Agricultural Research Center had made significant efforts by releasing high yielding and disease tolerant variety namely Weyib with yield potential of 43 quintal per hectare. The yield advantage of Weyib is 21.72% and 37.92%, respectively. However, this variety was not evaluated by target beneficiaries, since it was released.

Participatory technology evaluation on farmers management condition may have many advantages, such as increased and stable crop productivity, faster release and adoption of varieties, better understanding farmers' criteria for variety selection, enhanced biodiversity, increased cost effectiveness, facilitated farmers learning and empowerment (Sperling et al, 2001).The two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process (Getachew et al, 2008). Hence, participatory on farm demonstration of these varieties under farmers' condition and enhancing farmers to select variety/ies of their interest to their locality is a vital task.

Objectives of the study

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

Methodology

Description of the study area

The activity was carried out at Goba, Sinana and Agarfa 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

Pre extension demonstration of improved field pea varieties was carried out at Goba, Sinana and Agarfa districts of Bale zone. Purposive sampling methods were employed to select the districts based on the potential of the crop. Two PAs from Goba and Agarfa and three PAs from Sinana

were selected based on accessibility or vicinity to the road. Similarly, one trial farmer from each PA was used to carry out the demonstration process considering each farmer's field as replication of the trial.

Materials used and field design

Improved field pea variety (Weyib) was demonstrated and compared with standard check Tulu shanan. The demonstration was under taken on simple plot design of 10mx10m area for each variety. Full packages were applied in which row planting; recommended seed rate of 75kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. In addition, twice hand weeding was done on time (i.e. the first weeding one month after planting and the second weeding was done one month later after of the first weeding). SARC was the source of agricultural inputs (seed, fertilizers and chemicals in case needed). Hosting farmers provided their land. Land preparations were carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up and visit, harvesting, threshing were handled and managed by SARC.

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 and simple matrix ranking were used to compare traits of demonstrated varieties.

Farmers' variety evaluation and selection

Farmers have a broad knowledge base 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 Goba, Sinana and Agarfa 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.

Results and Discussion

Training

Training was given to farmers, DAs, and agricultural experts on field pea crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture and natural resource office office, Zone and district level cooperative promotion offices, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training. In general, 61 farmers, 33 SMS and 25 DAs were participated on the training.

Table 1. Participants of training

SMS			**DAs**			**Farmers**				
Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Male (youth)	Female (youth)	Total
28	5	33	22	3	25	53	4	4	0	61

Yield performance of Demonstrated varieties

The mean yield of demonstrated varieties of field pea collected from all sites were summarized in the following table. The demonstration result revealed, the newly released field pea variety (Weyib) showed better performance than the standard check Tulu shanan variety at all demonstration sites. The mean yield of Weyib variety was 30.98qt/ha, 39.3qt/ha and 30.13qt/ha at Goba, Sinana and Agarfa districts, respectively with the overall mean of 33.47 quintal per hectare. Similarly, the mean yield of Tulu shanan variety was 31.3qt/ha, 25.15qt/ha and 26qt/ha at Goba, Sinana and Agarfa districts, respectively with the overall mean of 27.48 quintal per hectare.

Table 2.Yield performance of the demonstrated varieties

District	PA	Yield obtained (Qt/ha)	
		Tulu shenen	Weyib
Goba	Aloshe	27.48	27.96
	Sinja	35.12	34
	Mean	31.3	30.98
Sinana	Selka	25.13	33.8
	Gamora	26.44	42.86
	N/Robe	23.87	41.24
	Mean	25.15	39.3
Agarfa	Ali	24.82	27.89
	Ilani	27.18	32.37
	Mean	26	30.13
Overall mean		27.48	33.47

Comparison of yield advantage of improved varieties

The yield advantage of the demonstrated variety over the standard check was calculated using the formula shown below., Accordingly, the result showed that Weyib variety had 21.78% yield advantage over the standard check (Tullu shanan variety).

$$\textbf{Yield advantage \%} = \frac{\textbf{Yield of new variety (qt/ha)-Yield of commercial variety (qt/ha)}}{\textbf{Yield of commercial variety (}\text{qt/ha)}} \textbf{ X 100}$$

Yield Advantage of **Weyib** over T/shanan: $\frac{33.47-27.48}{27.48}$x 100% =**21.78%**

Economic Evaluation

As shown in the above table (table 3) the cost benefit ratio analysis showed that, the net return gained from Weyib and Tulu shanan varieties was 34502.00 birr and 25198.00 birr per hectare, respectively. Weyib variety had higher cost benefit ratio (1.81) than Tulu shanan variety which was 1.34. This means, Weyib variety is more profitable than Tulu shanan variety with the same cost expenditure for both varieties per unit area.

Table 3. Cost-Benefit Analysis of the Demonstrated varieties

Variables	Varieties	
	Weyib	Tulu shanan
Yield obtained (qt/ha)	33.47	27.48
Sale price (ETB/qt)	1600	1600
Gross Returns TR (Price X Qt)	53552	43968
Land preparation	4050	4050
Seed purchase	1200	1200
Fertilizers purchase (NPS)	1400	1400

Labor for weeding	800	800
Insecticide purchase	600	600
Labor for spray	400	400
Harvesting and threshing	2000	1800
Packing, Loading and store	260	240
Store (bag purchase)	340	280
Total Variable Costs TVC (ETB/ha)	11050	10770
Fixed cost	8000	8000
Total cost (TC)	19050	18770
Net Return (GR-TC)	34502	25198
Benefit cost ratio (NR/TVC)	1.81	1.34

Farmers' preference to demonstrated varieties

The farmers' preferences towards the demonstrated varieties were assessed by conducting group discussion with farmers. Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, disease tolerance, number of branches/plant, pod/plant and early maturity were the top five priority concern given by farmers.Weyib variety was preferred to Tulu shanan variety for its tolerance to disease, high seed/pod (2-7), good crop stand, higher number of branches and better stem strength. But, it is late maturing than Tullu Shanan variety (Table 5).

Table 4. Pair wise ranking result to rank variety traits in order of importance

code	variety traits	A	B	C	D	E	F	G	H	I	J	Frequency	Rank
1	A											7	2nd
2	B	2										7	2nd
3	C	1	2									4	6th
4	D	1	2	4								6	4th
5	E	1	5	5	4							6	4th
6	F	1	2	3	4	5						3	7th
7	G	1	2	3	4	5	6					0	10th
8	H	1	2	3	4	5	6	8				1	9th
9	I	1	2	3	4	5	6	9	9			2	8th
10	J	10	10	10	10	10	10	10	10	10		9	1st

A=Disease tolerance, B=Number of branches, C=Seed/pod, D=Pod/plant, E=Early maturity, F=Uniformity of maturity, G=Stem strength, H=Stem strength, I=Seed color, J=Plumpness, Yield

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

No	Varieties	Rank	Reasons
1	Tulu shanan	**2nd**	early mature, tolerant to disease, seed/pod(1-6), fewer number of pod/plant, poor crop stand, good stem strength
2	Weyib	**1st**	Tolerant to disease, seed/pod (2-7), good crop stand, higher number of branch, better stem strength but late mature.

Conclusions and Recommendations

Pre extension demonstration and evaluation of field varieties was carried out on representative trial farmers' fields. Improved variety viz. *Weyib* was demonstrated along with Tulu shanan variety which is the standard check. Accordingly, Weyib gave higher yield than Tulu shanan variety.

Moreover, Weyib was selected by participant farmers in Sinana and Agarfa districts due to disease tolerance, seed/pod (2-7), good crop stand, higher number of branch, better stem strength but it is late mature. Similarly, farmers selected Tulu shanan variety in Goba district due to early mature, plumpness, tolerant to disease, seed/pod, higher number of pod/plant, good crop stand, better stem strength and good stand. Based on these facts, Weyib variety was recommended for further scaling up in the area it was selected.

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Pre extension Demonstration of Improved Faba Bean Varieties in Bale and West Arsi Zones, Southeastern Oromia, Ethiopia

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Abstract

Pre extension demonstration of improved faba bean varieties was conducted in Adaba and Dodola districts of West Arsi Zone and Sinana, Goba and Agarfa districts of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Aloshe) variety along with standard check. The demonstration was undertaken on adjacent plots of 10mx10m area for each variety with the spacing of 40cm between rows and recommended seed rate of 180kg/ha and fertilizer rate of 100qt/ha 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 and simple ranking methods. The demonstration result revealed that Aloshe variety performed better than the standard check (Mosisa variety) giving an average yield of 35.97qt/ha, while that of the standard check was 28.5qt/ha. Aloshe variety had 26.21% yield advantage over the standard check. This variety was selected by farmers in Adaba, Dodola and Agarfa. Thus, Aloshe variety was recommended for further scaling up in the study areas and other areas with similar agro-ecologies.

Key words: *Demonstration, Farmers' preference, faba bean, Aloshe, Selection criteria*

Introduction

Faba bean (*Vicia faba* L) is mainly grown in the highlands (1800-3000 m.a.s.l) of Ethiopia (Yohannes, 2000).Faba bean production ranks the 1st among pulse crops in area and volume of production in the country. From 1,598,806.51hectares of land allocated for pulse in 2017/2018 production season, faba bean covered 437,106.04hectaresof land from which 9,217,615.35 quintals of grain was produced with the productivity of 21.09 qt/ha (CSA, 2018).

In Bale, 15,347.32 ha of land was covered by faba bean and 372,559.31 quintals of grain was produced with the productivity of 24.28 qt/ha (CSA, 2017). Faba bean has ecological and economic importance and used for food (rich in protein), income source and foreign currency (attractive market price), soil fertility restoration (NP) and food security. Bale and West Arsi Zones are characterized by integrated (mixed) farming systems in which most of the crop areas were under cereal based mono-cropping (Bekele, 2011). Crop diversification can be a means to stay in sustainable crop production in the study zones. Faba bean are the best break crops for wheat production. Bread wheat grown after these crops gave higher grain yield than after cereal crops with a yield advantage of **15%** (Sinana ARC Profile, 2014).

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, **Aloshe variety** has recently released by SARC with yield potential of 35-50qt/ha. The yield advantage of Aloshe over standard and local checks is 20.39 % and 35.08%, respectively.

The two way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development process (Getachew et al, 2008). Thus, undertaking participatory demonstration, evaluation, validation and dissemination of improved faba bean varieties with the participation of farmers and other stakeholders for sustainable production and productivity is paramount.

Objectives of the study

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

Methodology

Description of the study area

The research was carried out at Adaba and Dodola districts of West Arsi Zone and Goba, Sinana and Agarfa districts of Bale 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

Pre extension demonstration of improved faba bean varieties was carried out at Adaba and Dodola districts of West Arsi Zone and Goba, Sinana and Agarfa districts of Bale zone. Purposive sampling methods were employed to select the districts based on the potential of the crop. One PA from Adaba, two PAs from Dodola, Goba, Agarfa and Sinana were selected based on accessibility or vicinity to the road. Similarly, two trial farmer from each PA of Adaba and Dodola districts and one trial farmer from each PA of Goba, Sinana and Agarfa districts were used to carry out the demonstration process considering each farmer's field as replication of the trial. The activity was done on a total of 12 trial farmers.

Materials used and field design

Improved faba bean variety (Aloshe) was demonstrated and compared with standard check Mosisa. The demonstration was undertaken on simple plot design of 10m x 10m area for each variety. Full packages were applied in which row planting with the spacing of 40cm between rows; recommended seed rate of 180 kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. In addition, twice hand weeding was done on time (i.e. the first weeding one month after planting and the second weeding was done one month later after of the first weeding).

SARC was the source of agricultural inputs (seed, fertilizers and chemicals in case needed). Hosting farmers provided their land. Farm operations (land preparation-ploughing four to five times using oxen plough) were carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up and visit, harvesting, threshing were handled and managed by SARC.

Data collection

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' preference to the demonstrated varieties was identified.

Data analysis

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

Farmers' variety evaluation and selection

Farmers have a broad knowledge base 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 in Adaba, Dodola, Goba, Sinana and Agarfa districts.

Field day

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

Results and Discussion

Training

Training was given to farmers, DAs, and agricultural experts on faba bean crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture and natural resource office, Zone and district level cooperative promotion offices, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training. In general, 61 farmers, 33 SMS and 25 DAs were participated on the training.

Table 1. Participants of training

SMS			DAs			Farmers				
Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Male (youth)	Female (youth)	Total
28	5	33	22	3	25	53	4	4	0	61

Yield performance of Demonstrated varieties

The mean yield obtained from Adaba, Dodola, Goba, Sinana and Agarfa were summarized in the table below. The newly released faba bean variety Aloshe performed better than the standard check Mosisa all over the locations. It is the high yielder at all demonstration sites. Aloshe variety gave a mean yield of 35.5/ha, 34qt/ha, 40.68qt/ha, 36.85qt/ha and 32.8qt/ha at Dodola, Adaba, Goba, Sinana and Agarfa districts, respectively with overall mean yield of 35.97qt/ha. Similarly, Mosisa variety gave a mean yield of 30.5qt/ha, 29.5qt/ha, 27.75qt/ha, 26.14qt/ha and 28.6qt/ha at Dodola, Adaba, Goba, Sinana and Agarfa districts, respectively with overall mean yield of 28.5qt/ha. It also has 26.21% yield advantage over the standard check.

Table 2. Yield performance of the demonstrated varieties

No	District	PA	Yield obtained (Qt/ha)	
			Aloshe	Mosisa
1	Dodola	Barisa	32.38	29.21
		Kechema chare	38.62	31.79
		Mean	35.5	30.5
2	Adaba	Ejersa	34	29.5
		Aloshe	41.8	26.23
		Sinja	39.56	29.27
3	Goba	Mean	40.68	27.75
		N/Robe	34.12	23.97
		Selka	39.58	28.31
4	Sinana	Mean	36.85	26.14
		Ali	29.73	25.67
		Ilani	35.87	31.53
5	Agarfa	Mean	32.8	28.6
6	Overall mean		35.97	28.5

Comparison of yield advantage of improved varieties

The yield advantage of the demonstrated variety over the standard check was calculated using the formula shown below. Accordingly, the result showed that Aloshr variety had 26.21%yield advantage over the standard check (Mosisa variety).

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

Yield Advantage of **Aloshe** over Mosisa: $\frac{35.97-28.5}{28.5}$ x 100% =**26.21%**

Economic evaluation

As shown in able 3 below, the cost benefit ratio analysis showed that, the net return gained from Aloshe and Mosisa varieties was 42716.00 birr and 29760.00 birr per hectare, respectively. Aloshe variety had higher cost benefit ratio (1.94) than Mosisa variety (1.38). This means, Aloshe variety is more profitable than Mosisa variety with the same cost expenditure for both varieties per unit area.

Table 3. Cost-Benefit Analysis of the Demonstrated varieties

Variables	**Varieties**	
	Aloshe	**Mosisa**
Yield obtained (qt/ha)	35.97	28.50
Sale price (ETB/qt)	1800	1800
Gross Returns TR (Price X Qt)	64746	51300
Land preparation	4050	4050
Seed purchase	3240	3240
Fertilizers purchase (NPS)	1400	1400
Labor for weeding	1200	1200
Insecticide purchase	600	600
Labor for spray	400	400
Harvesting and threshing	2500	2100
Packing, Loading and store	280	260
Store (bag purchase)	360	290
Total Variable Costs (TVC) (ETB/ha)	14030	13540
Fixed cost	8000	8000
Total cost (TC)	22030	21540
Net Return (GR-TC)	42716	29760
Benefit cost ratio (NR/TVC)	1.94	1.38

Varieties preference ranking

Farmers' preference of variety traits were identified and presented by pair wise ranking. Accordingly, yield, early maturity, drought tolerance, adaptability to the environment and disease tolerance were the top five variety selection criteria selected by farmers (Table 4). Based on the criteria, farmers have selected Aloshe variety in Adaba, Dodola, Goba and Agarfa districts while farmers in Sinana district have selected Mosisa variety (Table 5 and 6).

Table 4. Pair wise ranking result to rank variety traits in order of importance

code	variety traits	A	B	C	D	E	F	G	H	I	J	K	Frequency	Rank
1	A												6	5th
2	B	1											4	6th
3	C	1	2										4	6th
4	D	1	4	3									4	6th
5	E	5	5	5	5								7	4th
6	F	1	2	3	4	5							2	9th
7	G	1	2	3	4	5	6						0	11th
8	H	1	2	3	4	5	6	8					1	10th
9	I	9	9	9	9	9	9	9	9				8	3rd
10	J	10	10	10	10	10	10	10	10	10			9	2nd
11	K	11	11	11	11	11	11	11	11	11	11		10	1st

A= Disease tolerance, B= Pod/plant, C= Seed/plant, D= Tiller, E= Adaptability, F= Seed size, G= Plant height, H= Marketability, I= Drought tolerance, J= Early maturity, K= Yield

Table 5. Rank of the varieties based on farmers' selection criteria at Adaba, Dodola, Goba and Agarfa

No	Varieties	Rank	Reasons
1	Aloshe	**1st**	High yielder, pod/plant(30), seed/plant(59), more tolerant to disease, tiller(3-4), more adaptable to the environment, more adaptable to the soil, big seed size, good plant height, more marketable, more resistant to drought
2	Mosisa	**2nd**	Low yielder, pod/plant(20), seed/plant(46), less tolerant to disease, tiller(3-4), less adaptable to the environment, less adaptable to the soil, small seed size, shorter plant height, less marketable, less resistant to drought

Table 6. Rank of the varieties based on farmers' selection criteria at Sinana district

No	Varieties	Rank	Reasons
1	Aloshe	**2nd**	Late mature, tiller (3-4), plant height (long),moderate tolerant to frost, seed/pod, pod/plant, tiller (3-5), but more tolerant to disease
2	Mosisa	**1st**	Early mature, good plant height (medium height),seed/pod (2-4), pod/plant (15-28), tiller (3-6)

Conclusions and Recommendations

Pre extension demonstration and evaluation of faba bean varieties was carried out on twelve (12) representative trial farmers' fields. Improved variety viz. *Aloshe* was demonstrated along with Mosisa variety which is the standard check. Accordingly, Aloshe gave higher yield than Mosisa variety.

Moreover, Aloshe was selected by participant farmers in Adaba, Dodola, Goba and Agarfa due to high yielder, pod/plant(30), seed/plant(59), more tolerant to disease, tiller(3-4), more adaptable to the environment, more adaptable to the soil, big seed size, good plant height, more marketable, more resistant to drought. Similarly, farmers selected Mosisa variety in Sinana district due to early mature, good plant height (medium height), seed/pod (2-4), pod/plant (15-28), and tiller (3-6). Based on these facts, Aloshe variety was recommended for further scaling up in the area it was selected.

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Pre-extension Demonstration of Improved Emmer Wheat Varieties in Bale Zone, Oromia National Regional State, Ethiopia

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Abstract

Pre extension demonstration of improved emmer wheat varieties was conducted in Sinana and Goba districts of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Haydaro) variety along with standard check. The demonstration was undertaken on adjacent plots of 10mx10m area for each variety with the spacing of 20cm between rows and recommended seed rate of 150kg/ha and fertilizer rate of 100qt/ha 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 ranked using pair wise and simple ranking methods. The demonstration result revealed that Haydaro variety performed better than the standard check (Sinana 01 variety) giving an average yield of 33.5qt/ha, while that of the standard check was 27.2qt/ha. Haydaro variety had 23.16% yield advantage over the standard check and was aslo selected by farmers in all districts. Thus, Haydaro variety was recommended for further scaling up in the study areas and other areas with similar conditions.

Key words: Emmer wheat, demonstration, Variety

Introduction

Emmer wheat [*Triticumdicoccum*(Schubler)] was first domesticated in the Near East (Charmet, 2011).It is a member of the wheat family of annual grasses. It is grown on a limited scale and comprises about 7% of Ethiopia's entire wheat production and produced mostly in the highlands Bale, Arsi, Shewa, Hararghe, Wello, Gojjam and Gonder (BOSTID, 1996). In Ethiopia, emmer wheat is locally known as 'Hayisa or Matajabo' in Afan Oromo and 'Ajja' in Amharic.

It is used in various ways in the farming community. Some are ground in to flour and baked into special bread (Kita); crushed and cooked with milk or water to make porridge, and some are mixed with boiling water and butter to produce gruel (BOSTID, 1996). Traditionally, it become

more demanding for its high quality of food products (the human diet) and is believed that broken bones heal faster when emmer is consumed in the form of porridge. Due to emmer's high protein content and smooth and easily digestible starch, infants and nursing mothers especially favor the gruel. Thus, it is recommended for mothers as special diet in maintaining their health and strength after childbirth (Tesemma and Belay, 1991). It has also attractive market price.

In the country, emmer wheat production is very low as compared to other crop and has been replaced by tetraploid and hexaploid free threshing wheat (BOSTID, 1996). This is due to lack of improved variety; threshability problem, low cultural practices, and other biotic and abiotic factors. Developing disease tolerant, high yielding, quality and stable variety/ies are very important. Consequently, Haydaro variety has recently released by SARC and it has 18-46qt/ha of yield potential. Thus, this activity was initiated to demonstrate, evaluate and validate improved emmer wheat varieties with the participation of farmers and other stakeholders for sustainable production and productivity.

Objectives of the study

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

Methodology

Description of the study area

The research was carried out at Goba and Sinana 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

Pre extension demonstration of improved emmer wheat varieties was carried out at Goba and Sinana districts of Bale zone. 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. Similarly, one trial farmer from each PA of Goba district and two trial farmers from each PA of Sinana district were used to carry out the demonstration process considering each farmer's field as replication of the trial.

Materials used and field design

Improved emmer wheat variety (Haydaro) was demonstrated and compared with standard check Sinana 01. The demonstration was under taken on simple plot design of 10m x 10m area for each variety. Full packages were applied in which row planting with the spacing of 20 cm between rows; recommended seed rate of 150 kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. In addition, twice hand weeding was done on time (i.e. the first weeding one month after planting and the second weeding was done one month later after of the first weeding).

SARC was the source of agricultural inputs (seed and fertilizers). Hosting farmers provided their land. Farm operations (land preparation-ploughing four to five times using oxen plough) were carried out by trial/hosting farmers, whereas land leveling, planting, first and second weeding, follow up and visit, harvesting, threshing were handled and managed by SARC.

Data collection

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' preference to the demonstrated varieties was identified.

Data analysis

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

Farmers' variety evaluation and selection

Farmers have a broad knowledge base 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 Goba and Sinana districts.

Results and Discussion

Field day

Field day is a method of motivating people to adopt new practices by showing what has already achieved under field conditions. In other words, it is to show the performance and profitability of new practices/technologies/innovation and to convince about the applicability. Besides, it is a way of facilitating people to visit new innovation for the purpose of bringing mass mobilization. In this demonstration study, mini Field day was arranged to create awareness and facilitate experience and knowledge sharing among farmers. The field days were organized at each demonstration site in order to involve key stakeholders and enhance better linkage among relevant actors.Regular joint monitoring and evaluation were undertaken at different crop stages to provide need based technical advice that can fill knowledge/skill gaps. In total, 50 farmers and 8 Experts (DAs & SMS) were participated on the field day.

Table 1: Participants of Variety Selection

Location	Number of participants		
	Farmers	Experts (DAs & SMS)	Subtotal
Goba	26	3	29
Sinana	24	5	23
Total	**50**	**8**	**58**

Training

Training was given to farmers, DAs, and agricultural experts on emmer wheat crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture natural resource office, Zone and district level cooperative promotion offices, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training. In total, 61 farmers, 33 SMS and 25 DAs were participated on the training.

Table 2. Participants of training

SMS			**DAs**			**Farmers**				
Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Male (youth)	Female (youth)	Total
28	5	33	22	3	25	53	4	4	0	61

Yield performance of Demonstrated varieties

The yields of demonstrated varieties of emmer wheat obtained from Goba and Sinana were summarized in the table below. As shown in the table 3 below, the new variety of emmer wheat (Haydaro) gave higher yield than the standard check Sinana 01. The average yield of Haydaro and Sinana 01 is 33.5qt/ha and 27.2qt/ha, respectively. Haydaro had 23.16% yield advantage over Sinana 01.

Table 3: Yield performance of the demonstrated varieties

No	District	Yield obtained (Qt/ha)		
		PA	Haydaro	Sinana 01
1	Goba	Aloshe	26.48	23.85
		Sinja	24.52	22.15
		Mean	25.5	23
2	Sinana	Selka	41.14	30.06
		Gamora	41.86	32.74
		Mean	41.5	31.4
3	Overall mean		33.5	27.2

Comparison of yield advantage of improved varieties

The yield advantage of the demonstrated variety over the standard check was calculated using the formula shown below. Accordingly, the result showed that Haydaro variety had 23.16 % yield advantage over the standard check (Sinana 01 variety).

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

Yield Advantage of **Haydaro** over Sinana 01 $= \frac{33.5-27.2}{27.2} \times 100\% =$ **23.16%**

Economic evaluation

As shown in table 4 below, the cost benefit ratio analysis showed that, the net return gained from Haydaro and Sinana 01 varieties was 18990.00 birr and 12240.00 birr per hectare, respectively. Haydaro variety had higher cost benefit ratio (1.06) than Sinana 01 variety (0.69). This means, Haydaro variety is more profitable than Mosisa variety with the same cost expenditure for both varieties per unit area.

Table 4: Cost-Benefit Analysis of the Demonstrated varieties

Variables	**Varieties**	
	Haydaro	**Sinana 01**
Yield obtained (qt/ha)	33.5	27.2
Sale price (ETB/qt)	1100	1100
Gross Returns (TR) (Price X Qt)	36850	29920
Land preparation	3000	3000
Seed purchase	1500	1500
Fertilizers purchase (NPS)	1400	1400
Herbicide purchase	400	400
Labor for spray	200	200
Fungicide purchase	600	600
Labor for spray	200	200
Harvesting and threshing	2000	1900
Packing, Loading and store	220	200
Store (bag purchase)	340	280
Total Variable Costs (TVC) (ETB/ha)	9860	9680
Fixed cost	8000	8000
Total cost (TC)	17860	17680
Net Return (GR-TC)	18990	12240
Benefit cost ratio (NR/TVC)	1.06	0.69

Variery preferenve ranking

Farmers' preference of variety traits was ranked by using pair wise ranking method. Accordingly, yield, tillering capacity, crop stand, frost tolerance and disease tolerance were the top five traits of emmer wheat varieties selected by farmers (Table 5).Based on these and other traits, participant farmers have selected Haydaro variety as their first choice (Table 6).

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

code	variety traits	A	B	C	D	E	F	G	H	I	J	Frequency	Rank
1	A											9	1st
2	B	1										7	2nd
3	C	1	2									2	8th
4	D	1	2	4								7	2nd
5	E	1	2	5	4							4	6th
6	F	1	2	6	4	5						4	6th
7	G	1	2	3	4	5	6					0	10th
8	H	1	2	8	4	8	8	8				5	5th
9	I	1	2	3	4	5	6	9	8			1	9th
10	J	1	10	10	4	10	6	10	10	10		6	4th

A= Yield, B= Tiller, C= Crop stand, D= Lodging resistance, E= Seed/spike, F= Early maturity, G= Seed size, H= Disease tolerance, I= Seed color, J= Frost tolerance

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

No	Varieties	Rank	Reasons
1	Haydaro	**1st**	High yielder, higher number of tiller, more tolerant to disease, good crop stand, more resistant to lodge, seed/spike, early mature, bigger seed size, good seed color , more tolerant to frost
2	Sinana 01	**2nd**	Low yielder, poor crop stand, less number of seed/spike, late mature, smaller seed size, less tolerant to disease, poor seed color , less resistant to lodge, less tolerant to frost

Conclusions and Recommendations

Pre extension demonstration and evaluation of emmer wheat varieties was carried out on representative trial farmers' fields. Improved variety viz. *Haydaro* was demonstrated along with Sinana 01 variety which is the standard check. Accordingly, Haydaro gave higher yield than Sinana 01 variety.

Moreover, Haydaro was selected by participant farmers in all districts due to high yielder, higher number of tiller, more tolerant to disease, good crop stand, more resistant to lodge, seed/spike, early mature, bigger seed size and good seed color, more tolerant to frost Based on these facts, Haydaro variety was recommended for further scaling up in the area it was selected and similar agro ecology.

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Pre-scaling up of Improved Malt Barley Varieties in Bale and West Arsi Zones, Southeastern Oromia, Ethiopia

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Abstract

Pre scaling up of improved and widely selected malt barley varieties was carried out at Sinana and Goba districts of Bale Zone and Dodola district of West Arsi using one recently released (IBON 174/03) improved variety. The main objective of the study was to make wider awareness on improved malt barley varieties. The the improved malt barley variety (IBON 174/03) was planted on 32x32m (one mide) area with the spacing of 20cm between rows and recommended seed rate of 120kg/ha and fertilizer rates of 100/50kg/ha NPS/UREA. Mini Field day was arranged to create awareness and farmers shared experience and knowledge on malt barley. Regular field monitoring and evaluation were undertaken at different crop stages to provide need based technical advice to farmers. The feedbacks obtained from farmers shows that the IBON 174/03 variety is high yielder, disease tolerant, lodging resistant, and adaptable and has good uniformity, plant height, high number of seed/spike, number of tiller and good crop stand but it has only rwo rows. Therefore, the variety should be further promoted by extension organizations in collaboration with other key actors in the area.

Key words: *Pre scaling up, malt barley, IBON 174.03,*

Introduction

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 (Abu and Teddy, 2014; FAO, 2014). In Ethiopia, barley ranked fifth next to tef, wheat, maize and sorghum (CSA, 2017). It is grown in the agro-ecology ranging from 2300 to 3000 m above sea level having adequate rain fall throughout the growth period **(**Bayeh and Birhane, 2011). From 10,232,582.23 hectares of land allocated for **cereals** in 2017/18 production season, barley (food and malt) covered 951,993.15 ha of land from which 20,529,963.72 quintals of grain was produced with the productivity of 21.57 qt/ha (CSA, 2018).

In Bale, 44,929.97 ha of land was covered by barley and 1,108,131.50 quintals of grain was produced with the productivity of 24.66 qt/ha (CSA, 2017). Yet, malt barley is among the priority commodities that have attracted the attention of malt factories, breweries and policy makers in general. Because, at the present time, it is considered as one of the cash crops and its demand by agro-industries has increased due to the increased capacity of malt barley processing in line with the expansion of the existing and establishments of new brewery plants.

As indicated in business sector report (2011), the demand for malt barley grain is about 600,000 quintals per year and projected to reach 1,700,000 quintals in 2016 to produce 1.3 million qt of malt. However, the current local supply is only about 40% of the demand. The balance has been fulfilled through importing malt and/or malt barley grain forms, which costs the country over thirty million USD or six hundred million Ethiopian Birr (>660,000,000.00 Eth. Birr) per annum (Assela Malt Factory, 2015). On contrary to the demand, malt barley supply in Ethiopia is characterized by continued scarcity due to low productivity attributed by low input utilization, limited availability of improved varieties, existence of pests and diseases and mono-cropping farming system.

Thus, recently released malt barley varieties (Singitan and IBON 174/03**)** were demonstrated with full recommended packages for production and both varieties were selected. Finally, farmer selected IBON 174/03 by setting their own selection criteria. Therefore, this activity is initiated to pre-scale up the selected varieties with the participation of farmers and other stakeholders.

Objectives of the study:

- To create wider awareness and demand on selected improved malt barley varieties in the targeted districts.
- To improve production and productivity of cereal (malt barley) growing farmers found in targeted districts.
- To collect farmers' feedback on provided malt barley for future technology generation.

Methodology

Description of the study area

The research was carried out at Dodola district of West Arsi zone and Goba and Sinana 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

Pre scaling up of improved malt barley varieties was carried out at Dodola district of West Arsi zone and Goba and Sinana districts of Bale zone. 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

One recently released improved malt barley variety and widely selected by farmers during demonstration (IBON 174/03) was planted on the plot size of 32mx32m (1 midde). The variety was treated with full recommended malt barley production and management packages of 120kg/ha seed rate and fertilizer rate of 100/50kg/ha NPS/UREA.

Data collection and 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

Initially, agreement was made with farmers, DAs, supervisors and experts on responsibility sharing since the activity needs collaborative work and partnership. SARC was the source of agricultural inputs (seed of IBON 174/03 with 120kg/ha seed rate**,** and fertilizers-UREA with 50 kg/ha and NPS 100 kg/ha rates).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 32mwas given by each trial farmer for the activity. Besides, hosting farmers agreed up on providing and covering the costs of farm inputs like agro-chemicals such as herbicides, 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.

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).

Results and Discussion

Training

Training was given to farmers, DAs and agricultural experts on malt barley crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture development office, Zone and district level cooperative promotion offices, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training. In general, a total of 61 farmers, 33 SMS and 25 DAs have received the training.

Table 1. Participants of training

SMS			DAs			Farmers				
Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Male (youth)	Female (youth)	Total
28	5	33	22	3	25	53	4	4	0	61

Field Day organized

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.

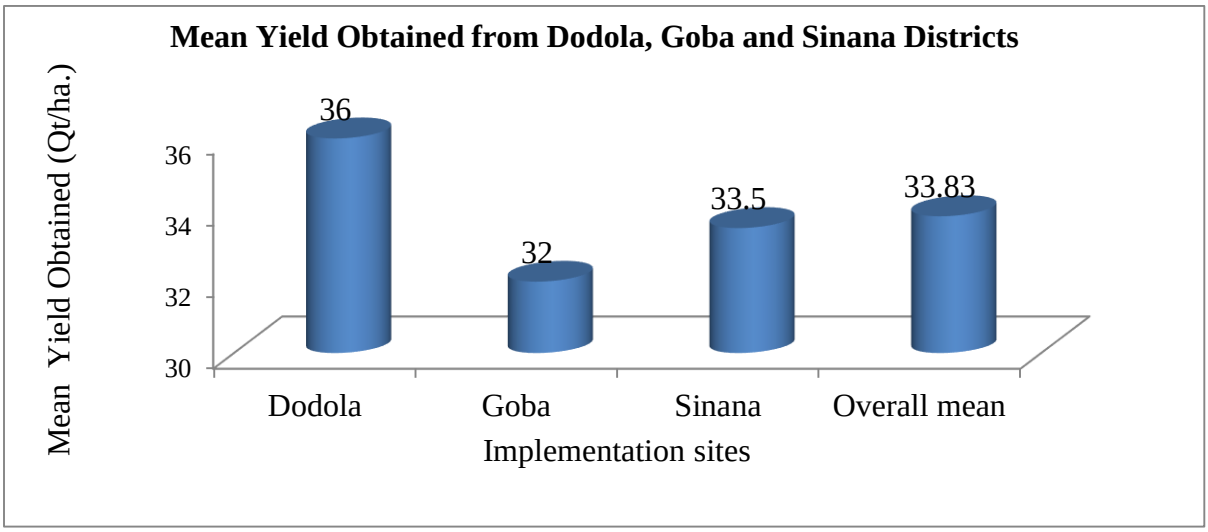
Field day was arranged to create awareness and facilitate experience and knowledge sharing among farmers. Regular field monitoring and evaluation was conducted to provide technical advice to farmers at different crop stages. The field days were organized at each implementation site in order to involve key stakeholders and enhance better linkage among relevant actors.

Table 2. Participants of field day

District	Farmers	Experts	Others	Total
Sinana	32	8	12	52
Goba	28	6	9	43
Dodola	36	8	12	56
Total	96	22	33	151

Yield Performance

The mean yield obtained from Dodola, Goba and Sinana districts were summarized in the graph below. As shown on the graph, the maximum yield of food barley variety (IBON 174/03) was recorded in Agarfa district (36qt/ha) and the minimum yield was obtained in Goba district (32qt/ha). The overall mean yield was 33.83qt/ha.



Feedback and result of focused group discussion (FGD)

Participant farmers have appreciated the IBON 174/03 for its higher yield, disease tolerance, lodging resistance, good adaptability and good uniformity, plant height, high number of seed/spike, number of tiller and good crop stand.

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled by Agriculture and Natural Resource Office (ANRO) in collaboration with other key actors in the area and with close supervision by Sinana Agricultural Research Centre (SARC).Thus, in order to access the seed locally the selected variety (IBON 174/03) 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 malt barley varieties was undertaken in the main season (Bona) in 2018/2010-2019/2011 at Sinana and Goba districts of Bale zone and Dodola district of West Arsi Zone. One recently released improved malt barley variety and widely selected by farmers during demonstration (IBON 174/03) was planted on the plot size of 32mx32m (1 midde). The variety was treated with full recommended malt barley production and management packages.

Mini Field day was arranged to create awareness and farmers shared experience and knowledge on malt barley. Regular field monitoring and evaluation were undertaken at different crop stages to provide technical advices to farmers. The feedbacks obtained from farmers shows that participant farmers liked IBON 174/03 for its higher yield, disease tolerance, lodging resistance, good adaptability and good uniformity, plant height, high number of seed/spike, number of tiller and good crop stand.Thus, the variety should be widely promoted by the district agriculture and natural resource office and other stakeholders.

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Pre-scaling up of Improved Food Barley Varieties in Bale Zone, Southeastern Oromia, Ethiopia

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Abstract

Pre scaling up of improved food barley varieties was carried out at Agarfa, Sinana and Goba districts of Bale Zone. The main objective of the study was to make wider awareness on improved food barley varieties. The improved food barley variety Robera was planted on 32x32m (one mide) area on 12 farmers fields with the spacing of 20cm between rows and recommended seed rate of 120kg/ha and fertilizer rates of 100/50kg/ha NPS/UREA. Mini field day was arranged to create awareness and facilitate experience and knowledge among participant farmers. Regular field monitoring and evaluation were undertaken at different crop stages to provide need based technical advice to farmers. The variety shown good yield performance and was also appreciated by farmers. Therefore, the variety should be further promoted by extension organizations in collaboration with other key actors in the area.

Key words: *Pre scaling up, food barley, Robera*

Introduction

Barley (*Hordeumvulgare* L.) is one of the cereal founder crops, domesticated about 10,000 years ago in the Fertile Crescent (Lev-Yadun *et al*. 2000). Barley is the most important cereal crops cultivated in Ethiopia. Suitable barley growing regions in the country are the highlands ranging from 2300 to 3000masl (Bayeh and Birhane, 2011). Its productivity in Ethiopia (1.965 t/ha) is low compared to world average of 3.095 t/ha (Barley commodity strategic plan document, 2016). From 10,232,582.23 hectares of land allocated for cereal in 2017/18 production season, barley (food and malt) covered 951,993.15 ha of land from which 20,529,963.72 quintals of grain was produced with the average productivity of 21.57 qt/ha (CSA, 2018). In Bale, 44,929.97 ha of land was covered by barley and 1,108,131.50 quintals of grain was produced with the productivity of 24.66 qt/ha (CSA, 2017).

However, grain yields and its quality are still not of the desired level even in areas of adequate rainfall due to susceptibility to diseases, insect pests, inappropriate agronomic practices and low crop management practices. Besides, its potential productivity is limited by lack of sufficient improved food barley varieties. Moreover, low use of recommended full packages is also another yield limiting factor.

Developing high yielding, disease tolerant and stable varieties that can meet increasing food demand of the growing human population, improve the income and livelihood of farmers are very important. Consequently, participatory on farm demonstration and evaluation of improved food barley varieties were carried out in West Arsi and Bale Zones. At the end of the demonstration process farmers selected **Robera variety** among the demonstrated improved food barley varieties. Hence, the task of pre-scaling up is important to disseminate Robera variety of food barley to potential districts.

Objectives of the study

- To create wider awareness and demand on selected improved food barley varieties in the targeted districts.
- To improve production and productivity of cereal (food barley) growing farmers found in targeted districts.
- Farmers' preference feedback on provided food barley collected for future technology generation.

Methodology

Description of the study area

The research was carried out at Goba, Sinana and Agarfa 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

Pre scaling up of improved food barley varieties was carried out at Goba, Sinana and Agarfa districts of Bale zone. 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 Agarfa 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 12 trial farmers.

Materials used and field design

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

Data collection and 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

Initially, agreement was made with farmers, DAs, supervisors and experts on responsibility sharing since the activity needs collaborative work and partnership. SARC was the source of agricultural inputs (seed of Robera with 120 kg/ha seed rate**,** and fertilizers-UREA with 50 kg/ha and NPS 100 kg/ha rates). 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 32mwas given by each trial farmer for the activity. Besides, hosting farmers agreed up on providing and covering the costs of farm inputs like agro-chemicals such as herbicides, 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.

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.

- Telephone (fixed and/or mobile)
- Training (in-room and practical)
- Field visit or experience sharing
- Supervision, monitoring and evaluation
- Group meeting and discussion session
- Field day (to bring mass mobilization)

Results and Discussion

Training

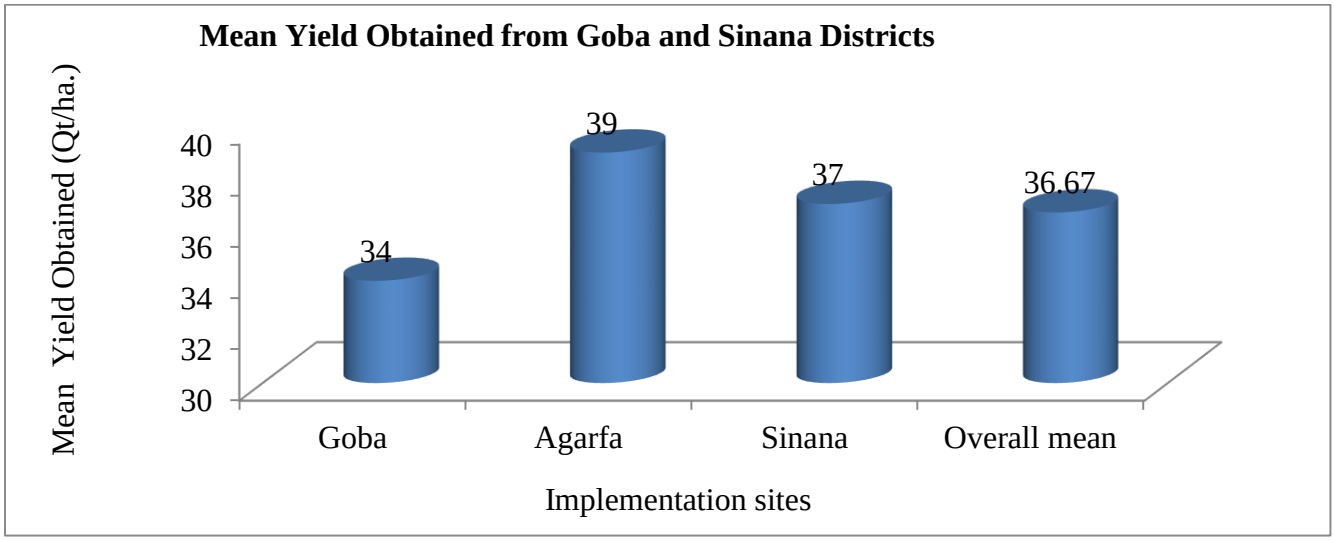
Training was given to farmers, DAs, and agricultural experts on food barley crop production techniques and management packages, agro-chemical applications and safety precautions. Stakeholders such as zone and district level agriculture development office, Zone and district level cooperative promotion offices, zone and district level agricultural inputs regulations and quarantine experts were invited and participated during consultation meeting and training. In general, a total of 61 farmers, 33 SMS and 25 DAs were participated on the training.

Table 1. Participants of training

SMS			DAs			Farmers				
Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Total	Male (Adult)	Women (Adult)	Male (youth)	Female (youth)	Total
28	5	33	22	3	25	53	4	4	0	61

Yield Performance

The mean yield obtained from Goba, Sinana and Agarfa were summarized in the graph below. As shown on the graph, the maximum yield of food barley variety (Robera) was obtained from Agarfa district (39qt/ha) and the minimum yield was obtained from Goba district (34qt/ha) with the overall mean yield of 36.67qt/ha. This shows that, Robera variety performed good at all implementation site since its yield was in the range in the yield potential of it (24-42qt/ha yield potential).



Field Day organized

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.

Field day was arranged to create awareness and facilitate experience and knowledge sharing among participant farmers. The field days were organized at each demonstration site in order to involve key stakeholders and enhance better linkage among relevant actors. Discussion session and result communication forum were also organized.

Table 2. Participants of field day

District	Farmers	Experts	Others	Total
Sinana	28	10	11	49
Agarfa	31	8	9	48
Goba	27	9	11	47
Total	86	27	31	144

Feedback and result of focused group discussion (FGD)

Participant farmers were very much interested in the improved food barley variety. The participant farmers have appreciated the variety for its high yield, disease tolerance, adaptable to the environment and good uniformity, good seed color, many rows(six rows), high number of seed/spike, high number of tillers, good crop stand and resistance to lodging.

Exit Strategy

After pre-scaling up, the wider scaling up/out activities will be owned and handled by Agriculture and Natural Resource Office (ANRO) in collaboration with other key actors in the area and with close supervision by Sinana Agricultural Research Centre (SARC).Thus, in order to access the seed locally the selected variety (Robera) 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 be 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.

Conclusions and Recommendations

Pre-scaling up of improved food barley varieties were undertaken in the main season (Bona) in 2018/2010-2019/2011 at Sinana, Agarfa and Goba districts of Bale zone on twelve (12) farmers' field. One recently released improved food barley variety and widely selected by farmers during demonstration (Robera) was planted on the plot size of 32mx32m (1midde).The variety was treated with full recommended food barley production and management packages.

Mini Field day was arranged to create awareness and farmers shared experience and knowledge on malt barley. Regular field monitoring and evaluation were undertaken at different crop stages to provide technical advices to farmers. The feedbacks obtained from farmers show that participant farmers liked the variety.Thus, the variety should be widely promoted by the district agriculture and natural resource office and other stakeholders.

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Participatory Demonstration and Evaluation of improved Field pea Technologies in Selected Districts of Western Oromia

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Abstract

*The activity was conducted in Chaliya and Jimma Arjo districts of Western Oromia with the objective of demonstrating the newly released field pea varieties; Lemmif and Jida. The districts were selected purposively based on field pea production potential. From each district, one Peasant association (PA) was selected on the basis of accessibility and field pea production potential. Two newly released field pea varieties; Lemmif and Jida were planted on 10m*10m adjacent plots along with the standard check; Gedo-1 variety on 6 farmers' fields. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and managed. At maturity, the varieties were jointly evaluated with a team composed of researchers, farmers and development agents (DAs) on the basis of jointly set criteria such as yield, disease tolerance, seed color, number of pods per plant, number of seeds per pod, seed size and early maturity. Accordingly, farmers in both districts ranked Lemmif variety first and Jida second in most of the criteria including yield, number of seeds per pod, number of pods per plant, seed size and seed color. With regard to yield, Lemmif variety gave the highest average yield (22.12 qt/ha) followed by Jida (21.33 qt/ha) and Gedo-1(16.29 qt/ha). Lemmif and Jida varieties had 35.73 % and 30.94 % yield advantage over Gedo-1, respectively. Furthermore, financial analysis result showed that farmers had obtained higher net profit from Lemmif than Jida and Gedo-1. Therefore; Lemmif variety should be further promoted by the center through its pre-scaling up program.*

Keywords: *Field Pea; Participatory demonstration, evaluation and selection; Yield Advantage; Lemmif, Jida Gedo-1*

Introduction

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

Generally, field pea is a crop of manifold merits in the economic lives of the farming communities of high lands of Ethiopia. It is a rich source of protein (25%), carbohydrates (12%),

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

Field pea with other food legumes covers about 13.24 % of the total 12.49 million hectares of crop areas in Ethiopia and is the 4th most important stable food legume among the highland pulses in rural Ethiopia (CSA, 2016). According to CSA (2016), in Ethiopia field pea covers about 221, 415.67 ha of the total crop land with a total production of 3, 233, 901.34 Quintals. The crop constitutes about 13.40 % of the total area covered by pulses and 11.68 % of the total annual production of pulses in the country. In Oromia region, the total production was 1,409,959.49 quintal for the same year with the region contributing 44 % of the total volume of field pea produced in the country The total area cultivated by field pea small holder farmers for the meher season 2015/2016 in East Wollega and West Shewa zones were 2,563.80 ha and 7,257.28 ha; respectively.

The estimated average productivity of field pea in East Wollega and West Shewa zones were 9.57 quintals per hectare and 19.38 quintals per hectare; respectively, which is low compared to Oromia Region average of 16.90 quintals per hectare in 2015/16 (CSA 2016). Most parts of Western Oromia are one of the potential areas for field pea production. In these areas, farmers produced Field pea crop mainly for the home consumption and market purpose. However, farmers found in these areas have little access to improved field pea technologies. To solve this problem, Bako Agricultural Research Center has recently released two improved varieties namely Lemmif and Jida with the average yield 23-30 qt/ha and 22-32 qt/ha respectively on farmers' fields. This participatory demonstration work was therefore conducted to demonstrate the newly released varieties on farmers' fields

Research Objectives

The demonstration research was conducted to achieve the following specific objectives

- To evaluate the yield performance and profitability of improved field pea technologies under farmers' condition
- To create awareness on the importance and availability of the technology

Methodology

Site and farmers' selection

The demonstration activity was conducted in Chaliya and Jimma Arjo districts. Selection of the districts was based on potentiality for field pea production and accessibility for supervision. One potential PA from each district was selected and in each PA 1 FRG unit comprising of 15 farmers was established. Three hosting farmers were selected from each district and participated on the activity in collaboration with experts and DAs of the respective district office of agriculture and Natural Resource.

Training of farmers, agricultural experts and development agents

After sites and farmers' were selected both theoretical and practical training were given to farmers, development agents and district experts. The training was focused on field pea production management, breeding aspect and post harvesting (seed quality) handling.

Input distribution and Planting

After the plots were properly ploughed and made ready for planting, all the necessary inputs (seed, fertilizers) were delivered to the farmers. Planting was carried out by FRG farmers with technical assistance from researchers and technical assistants.

Plot size and treatment arrangement

The two newly released field pea varieties; namely, Lemmif and Jida were planted with standard check Gedo-1 on adjacent plots of 10m*10m each. The recommended seed rate of 150 kg/ha and fertilizer rate of 100 kg/ha NPS were applied for all of the plots. Every field were supervised to check the status and to identify any management gaps. At maturity stage, participatory variety evaluation was arranged to evaluate the demonstrated varieties based on jointly set criteria.

Technology gap and Technology index

Technology gap indicates that the gap between demonstration yield and research yield reported when the variety was released. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties.

Technology gap = Potential yield qt/ha – Demonstration yield

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

Data collection

Qualitative and quantitative data such as yield data, total number of farmers participated on training, total number of farmers, DAs and experts participated on field visits, farmers' perception on the attributes of the technology, variable costs incurred and revenue obtained were collected through own observation, household interview and focused group discussion. Ranking of variety selection criteria was done using pairwise ranking while variety ranking was carried out using 3-point Likert scale (because there are only three varieties)

Economic evaluation of the varieties

Partial budgeting analysis was used to determine the level of profitability of improved field pea technology over the standard variety. The success of this partial budgeting depends on prediction accuracy, which depends on the accuracy of the information and estimates it contains. It crystallizes ultimately into the statement of costs and returns based on input and output data. They measure changes in income and returns to limited-resources, provide a limited assessment of risk and, through sensitivity analysis, suggest a range of prices or costs at which a technology becomes profitable (CIMMYT, 1988).

Data analysis

Descriptive statistics such as mean, frequency, and percentages and inferential statistics such as F-tests (ANOVA).were employed to analyze yield and economic returns. Qualitative data obtained from matrix ranking was analyzed using frequency and mean

Results and discussions

Participatory Variety Evaluation and Selection

The demonstrated varieties were evaluated against the most important criteria that includes field pea yield, number of pod per plant, number of seeds per pod, grain color, disease tolerant, grain size and maturity time. According to the farmers' evaluation results, Lemmif variety was ranked and selected first followed by Jida and Gedo-1(Table 1). Except its late maturity, Lemmif variety had ability to tolerate disease, large number of pods per plants, large number of seeds per pods, good grain size, grain color and marketability.

Table1: Farmers ranking of field pea varieties across the districts.

Variety	Chaliya			Jimma Arjo			Overall Rank
	Total Score	Mean score	Rank	Total Score	Mean score	Rank	
Gedo-1	20	2.50	3rd	21	2.62	3rd	3rd
Lemmif	27	3.37	1st	29	3.62	1st	1st
Jida	25	3.12	2nd	24	3.00	2nd	2nd

NB. 1=Number of pod per plant, 2= Number of seed/pod, 3=Disease tolerant, 4= Early maturity, 5= Grain size, 6=Grain color, 7= Marketability , 8= Yield

On farm yield performances of field pea varieties

The combined mean analysis result of on farm yield performance of the demonstrated varieties is summarized in below (table 2). The mean yield of 22.11 ± 0.60 qt/ha, 21.33 ± 0.82 qt/ha and 16.29 ± 0.76 qt/ha was obtained for Lemmif, Jida and Gedo-1 varieties; respectively.

Table 2: Mean yield of field pea varieties across the districts

Variety	N	Mean	SD	Min	Max
Lemmif	6	22.11 ± 0.60	2.03	19.35	24.65
Jida	6	21.33 ± 0.82	1.85	18.36	23.47
Gedo1	6	16.29 ± 0.76	1.46	14.44	18.11

As shown in the above ANOVA table, there is statistically highly significant difference among the varieties demonstrated; Lemmif, Jida and Gedo-1, at ($p<0.01$). The significance mean yield difference has existed between Lemmif and Gedo-1 and Jida and Gedo-1, but there was no significant mean yield difference between Lemmif and Jida varieties.

Table 3: show Analysis of variance for yield of the field varieties

Varieties	N	Mean yield	SD	F	P
Lemmif	6	22.11	2.03		
Jida	6	21.33	1.85		
Gedo-1	6	16.29	1.46		
Total				18.34	0.0002

Yield Advantage

The yield advantage of Lemmif and Jida varieties over the standard check Gedo-1 variety is shown in table 4 below. The result shows Lemmif variety had 35.73 % yield advantage over Gedo-1 while Jida variety had 30.94 % yield advantage over Gedo-1.

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

Table 4. Yield advantage of newly released field pea varieties over the standard check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the standard check (Gedo1)
Lemmif	22.11	35.73 %
Jida	21.33	30.94 %
Gedo1	16.29	-

Technology gap and Technology

The technology gap and technology index of demonstrated varieties (Gedo1, Lemmif and Jida) were presented in 5 below table. The result indicate that the yield gap for Lemmif, Jida and Gedo-1 varieties was 4.39 qt/ha, 5.67 and 4.31 qt/ha, respectively. The lower yield gap shows the demonstration yield is very close to the yield reported under research. The technology index for Lemmif, Jida and Gedo-1 varieties was 16.57 %, 21 % and 20.92 %; respectively.

Table 5: Technology gap and index for field pea varieties at Chaliya and Jimma Arjo districts

Parameter	Field Pea Varieties		
	Lemmif	Jida	Gedo-1
Yield gap (qt/ha)	4.39	5.67	4.31
Technology index (%)	16.57	21	20.92

Financial analysis

The financial analysis result showed that farmers will be benefited by producing all the three varieties. As shown in table 6 below, the highest gross profit (28,778 Birr) per hectare was obtained from Lemmif variety followed by Jida (27,378 Birr) and Gedo-1(18, 564 Birr). The financial analysis result also revealed the highest returns to investment (384 %) was gained from Lemmif followed by Jida (365 %) and Gedo-1 (247 %) varieties. From this result, it can be concluded that farmers will be benefited more if they use the demonstrated field pea varieties.

Table 6. Gross margin analysis of field pea demonstration

Variety	Yield (qt/ha)	Market price (Birr)	Fertilizer Cost (Birr)	Seed cost (Birr)	Labor cost (Birr)	TVC	TR (P*Q)	GM (Profit)	Return to investment (%)
Lemmif	22.12	1600	1500	2000	4000	7500	35,392	28,778	3.84 (384 %)
Jida	21.33	1600	1500	2000	4000	7500	34,128	27, 378	3.65 (365 %)
Gedo-1	16.29	1600	1500	2000	4000	7500	26,064	18,564	2.47 (247 %)

Training and field visit

Training and field were used in demonstration process to create awareness and transfer knowledge related improved field pea production technologies. As shown in table 8.a total of 30 farmers, 8experts and 6DAs were trained on topics such as field pea production and managements. In addition to the training, field visits on which 58farmers 6expers and 8DAs have participated was arranged at vegetative and maturity stages of the crop for creating an opportunity for farmers to learn from each other and agricultural experts.

Table 8. Gender disaggregated number of stakeholders' participated on Training

Events	Participants									
Training	Farmers			DAs			Experts			Total
	M	F	Total	M	F	Total	M	F	Total	
	24	6	30	7	1	8	6	0	6	44
Field visit	47	11	58	7	1	8	8	0	8	74

Conclusions and Recommendations

Improved field pea varieties were demonstrated in Cheliya and Arjo districts in response to the low productivity problem often raised by the farming communities in the area. The demonstration result revealed that the improved field pea variety called Lemmif had better yield advantage over the standard check and preferred by farmers for its better grain yield tolerance to diseases, number of pods per plants, number of seeds per pods, early maturity, grain size, grain color and marketability. The financial analysis result also confirmed that producing field peas by using improved varieties and management practices is profitable. From the result of the study, it can be concluded that the demonstrated varieties are an important input for solving the low productivity problem of field pea in the study areas and other other areas with similar agro-ecologies .Thus, Lemmif variety should be further promoted to reach more farmers with the technologies.

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Participatory Demonstration and Evaluation of Yam Technologies in selected districts of Western Oromia

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Abstract

*This activity was conducted in Wayu Tuqa district of East Wollega with the objective of demonstrating the recently released yam varieties, Bulcha, Lalo and commercial check to the farming community in the district. The district was purposively selected based on potentiality for yam production; and one potential PA from the district was selected on the basis of accessibility and potentiality. After selecting, establishing and training farmers two recently released yam varieties from Bako Agricultural Research Center; Bulcha and Lalo and commercial check; as a check, were planted on 10m*10m adjacent plots on 4 farmers' fields. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. To this end, yield, number of tuber/ plant (both in length and width), tuber size, tuber weight, early maturity, disease tolerant, taste and cooking time required were considered as the most important criteria listed by farmers' for selection among the demonstrated varieties. Accordingly; Bulcha variety was ranked and selected first there by Lalo second and finally commercial check as third in most of the criteria including yield and impressed the farmers; especially number of tuber/ plant (both in length and width), tuber size and tuber weight,. With regard to yield, 459.11 qt/ha, 220 qt/ha and 114.15qt/ha were obtained from Bulcha, Lalo and commercial check; respectively putting Bulcha on the first rank, then by Lalo and finally commercial check. Besides; Bulcha and Lalo had 302.20 % and 92.73 % yield advantage; respectively over the check. The mean yield comparison (t-test) results showed that as there is highly significant difference at* ($p<0.05$) *among the varieties demonstrated and even within the released varieties; Bulcha and Lalo. The financial analysis result also showed that farmers can be profitable by producing Bulcha variety. Therefore; as the variety has met the intended criteria of the farmers and selected by farmers' at large the pre-scaling up activity should follow next on wider area and on more number of farmers' in the coming years.*

Keywords: Yam; Participatory demonstration, evaluation and selection; Yield Advantage; *Bulcha, Lalo*

Introduction

Yams (*Dioscorea* spp.) are the Dioscoreaceae vine plants grown and staple food in tropical and sub-tropical regions that produce underground or aerial tubers (IITA, 2010). Yams are edible energy-rich tuber crops developed from modified and thickened underground stems storage

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

Unlike the other root and tuber crops the white and yellow yam (*Dioscorea rotundata* and *Dioscorea cayenensis [esculenta]*, respectively) are thought to be indigenous to West Africa, whereas the water yam (*Dioscorea alata*) is thought to have originated in Southeast Asia (Joseph et.al. 2016). Despite the intense labor requirements and production costs, consumer demand for yam is very high in West Africa; making yam cultivation quite profitable for farmers (IITA, 2010).The world average annual yield of yams was 10.2 tonnes per hectare in 2010. The most productive yam farms in the world were in Colombia, where nationwide average annual yield was 28.3 tonnes per hectare (FAO, 2011). With some farms reporting yields significantly above 30 tonnes per hectare for yellow yam and others reporting less than 1 tonne per hectare (Opara, 2003).

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

According to Zeven and Wet (1982) Ethiopia is the center of origin for one of *Dioscorea* species (*D. abyssinica Hochst.ex Kunth*). Many different accessions of this species are extensively cultivated by subsistence farmers in the Southern, South-western and Western parts of Ethiopia across a range of agro-ecologies (Miege and Sebsebe, 1997). More importantly people in these parts of Ethiopia use yams as the most preferred food item for distinguishable guests and during the main traditional celebration of Meskel Holiday (Muluneh *et al*., 2005). Yam (*Dioscorea* spp.) is widely grown in many parts of Ethiopia particularly in southern and southwest parts of the country and plays a vital role in local subsistence in the region. It serve as a 'life saving' plant group for the marginal farming and forest dwelling communities, during periods of food scarcity (Agbaje *et.al.*, 2003). True yams are ubiquitous lowland tropical food plants (Ikeorgu, 2000); and are a staple foodstuff and also important as a secondary (famine) food. Besides; yam is an

attractive crop in poor farms with limited resources and is also available all year round making it preferable to other unreliable seasonal crops. These characteristics make yam a preferred food and a culturally important food security crop in some sub-Saharan African countries (Izekor and Olumese, 2010).

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

Therefore; by recognizing this fact actually BARC has been putting great effort on generating high yielding, disease tolerant and quality yam varieties and has recently released two varieties; Bulcha and Lalo with potential yield of 460 qt/ha and 227 qt/ha; respectively on farmers' field, to revert the scenario and alleviate the problem of lack of access to improved varieties that in turn worsen low productivity as well as co-related challenges sustainably. Consequently; this calls for demonstrating, validating and disseminating of the released high yielding, disease tolerant and quality yam varieties that can make farmers' productive. To this end; cognizant also that BARC extension team initiated this activity with these underlying objectives.

Objectives of the study

- To evaluate the productivity and profitability of yam technology under farmers' condition
- To create awareness on the importance and availability of the technology
- To collect feedbacks from the participants for further research design and the way forward;

Methodology

Site and Farmers Selection

One district was selected based on potentiality for yam production and accessibility for supervision. One representative PA from the district was selected based on the aforementioned criteria. In each kebele one FRG member comprising of 15 farmers was established and managed. A total of 4 hosting farmers from the district were selected and participated on the activity in collaboration with district agriculture and natural resource office and respective DA.

Provision of training

After site and farmers' were selected both theoretical and practical training were given to farmers, Development agent and district experts. Training provided on the following areas; such as, yam production management, breeding aspect, post harvesting (seed quality). The aim of training was to create awareness of farmers', Development agent and district experts on yam technology.

Input distribution and Planting

After the plots were properly ploughed and made ready for planting ahead of the planting date, all necessary inputs (seed, fertilizers) were delivered to the farmers. Planting was made on the farmers' field by BARC researchers, TAs as well as FRG farmers.

Field design and management

Three yam varieties of these two recently released yam varieties from Bako Agricultural Research Center; Bulcha and Lalo, along with one commercial check (commonly known as local varieties) on the hands of farmers' were planted side by side on adjacent plots of $100m^2$ each. The demo plots were replicated by hosting farmers. The Plots were managed jointly by the researcher, extension workers and hosting farmers. Spacing of 70cm and 25 between rows and plants; respectively was used for the Demonstration. The recommended tuber pieces of 444 cuttings and fertilizer rate of 100 kg/ha of NPS and 100 kg of UREA were used. All other recommended agronomic practices were maintained equally for all plots.

Technology gap and Technology index

Technology gap indicates that the gap between demonstration yield and research yield reported when the variety was released. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more the feasibility of the varieties.

Technology gap = Potential yield qt/ha – Demonstration yield

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

Data Collection

For this activity all the necessary qualitative and quantitative data were collected; the collected data includes yield data, total number of farmers participated on training, total number of farmers, DAs, experts participated on field visits, farmers' perception on the attribute of the technology, costs and income gained.

Data analysis

The data was analyzed using descriptive statistics such as mean, frequency distribution, tables and percentages. Also quantitative data collected were subjected to SPSS software to analyses mean, standard deviation, t-test and ANOVA table. Besides; Score ranking techniques was used to evaluate and select best bet variety/ies and /or technology/gies and to rank their criteria and parameters according to real situation of the area. Further, gross margin analysis is very useful in a situation where fixed capital forms a negligible portion of production

Results and discussion

Participatory Variety Evaluation and Selection

As shown in table 1 below, results of ranking and scoring of yam varieties reealed that the highest ranking score was recorded for Bulcha variety (4.25), followed by Lalo variety (3.88), while the lowest score was recorded for the commercial check (3.37). Consequently; Bulcha variety was ranked as best followed by Lalo variety and finally the least ranked variety was the commercial check. Besides; except its late maturing nature of the variety farmers selected Bulcha variety as a best because its ability to tolerate disease, number of tuber per plant, tuber weight, tuber size and yield. Furthermore, secondly selected Lalo variety though relatively low yielder than Bulcha some of the traits acquired made the variety to be preferred to Bulcha variety; for instance, especially its taste, medium maturity and less time required for cooking. The least ranked and selected variety the commercial check was mainly low yielder as compared to the two varieties; Bulcha and Lalo varieties Generally; based on overall mean score observed against the weight attaches for each of the traits set and listed for evaluation and selection Bulcha was ranked and selected as the best variety there by Lalo next that suits the need of the farmers and most preferred variety by the farmers' at large.

Table 1. Score ranking for Yam technologies in the study area

Variety	Scores			Overall Rank
	Total Score	Mean score	Rank	
Lalo	31	3.88	2nd	2nd
Bulcha	34	4.25	1st	1st
Commercial check	27	3.37	3rd	3rd

N.B. 1= Tuber Size; 2= No. of tuber/ Plant; 3= Tuber Weight; 4= Taste; 5= Disease Tolerant; 6= Early Maturity; 7= Cooking Time and 8= Yield

On farm yield Performances of Yam Varieties

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties was still promising. Accordingly; the combined mean analysis result on yield performance of the varieties demonstrated for the district; Wayu Tuqa, is summarized in below (table 2). Hence; a mean yield of 220 ± 0.60 qt/ha, 459.11 ± 0.82 qt/ha and 114.15 ± 0.76 qt/ha for Lalo, Bulcha and Commercial check varieties; respectively were gained.

Table 2: Mean yield of field pea varieties across the districts

Variety	N	Mean	SD	Min	Max
Lalo	4	220 ± 0.69	1.38	218.76	221.93
Bulcha	4	459.11 ± 0.29	0.59	458.74	459.98
Commercial check	4	115.98 ± 0.61	1.23	112.83	115.55

Moreover, statistically ANOVA table result summarized and presented in (table 3) below showed as there is highly significant difference among the varieties demonstrated; Lalo, Bulcha and the commercial check and also there is significant difference among farmers on mean yield gained at ($p<0.001$).

Table 3: show Analysis of variance for yield of the field varieties

Varieties	N	Mean yield	SD	F	P
Lalo	3	220	1.38		
Bulcha	3	459.11	0.59		
Commercial check	3	115.98	1.23		
Total				7.39	0.0000

Further, varieties mean yield comparison (t-test) result summarized in (table 4) below also verified that statistically as there is highly significant difference among the varieties demonstrated mean yield performance; Lalo, Bulcha and the commercial check. Also the statistical result observed from the study also confirmed that even as there is highly significant difference on mean yield obtained between the released varieties (Bulcha and Lalo) at ($p<0.05$).

Table 4: Varieties mean yield comparison (t-test) for the varieties

Varieties Mean yield comparison (t-test)	Mean	Std Error	P value
Bulcha * Lalo	239.13	0.45	0.0000
Lalo * Check	105.82	0.43	0.0000
Bulcha * Check	344.96	0.46	0.0000

Yield Advantage

Calculating yield advantage of the varieties helps: to show the extra benefit in percentage that the farmers' obtained from producing improved variety. Besides; it helps to recommend based on the relative yield advantage over other varieties. Accordingly; Bulcha had higher yield advantage over other varieties which is 302.20 % then by Lalo 92.73 % and could be calculated using the underlying formula.

Table 5.Yield advantage of newly released Yam varieties over the commercial check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the standard check (commericial)
Bulcha	459.11	302.20 %
Lalo	220	92.73 %
Commercial check	114.15	

Technology gap and Technology index

From the above (table 6) the yield gap is 7 qt/ha and 0.85 qt/ha for Lalo and Bulcha varieties; respectively. This indicates that the lowest gap was observed on Bulcha variety which in turn shows the demonstration yield is very close to the potential yield. Moreover; the technology index were 3.08 % and 0.19 % for Lalo and Bulcha varieties; respectively. That means both varieties are with the lowest index and this dictates both varieties are feasible to the farmers in the study area and other similar agro-ecologies.

Table 6: Technology gap and index for Lalo and Bulcha varieties at Wayu Tuqa district

Parameter	Field Pea Varieties		
	Lalo	Bulcha	Commercial check
Yield gap (qt/ha)	7	0.85	-
Technology index (%)	3.08	0.19	-

Financial analysis

The financial analysis result was summarized and presented in below table 7 below. According to te results obtained; 471,278.8 Birr, 213,040 Birr and 98,722 Birr per hectare were gained from Bulcha, Lalo and Commercial check; respectively and the highest profit were obtained from Bulcha followed by Lalo and while the lowest was obtained from Commercial check. The study result also revealed that the highest returns to investment (1919 %) was obtained from Bulcha followed by Lalo (867 %) and the lowest (402 %) for the commercial check. Therefore; from this result it can be concluded that as Bulcha and Lalo varieties were high yielder and more profitable than commercial check.

Table 7. Gross margin analysis of yam demonstration for Wayu Tuqa district

Variety	Yield (qt/ha)	Market price (Birr)	Fertilizer Cost (Birr)	Seed cost (Birr)	Labor cost (Birr)	TVC	TR (P*Q)	GM (Profit)	Return to investment (%)
Lalo	220	1080	2760	1800	20,000	24,560	237,600	213,040	8.67 (867 %)
Bulcha	459.11	1080	2760	1800	20,000	24,560	495,838.8	471,278.8	19.19 (1919 %)
Check	114.15	1080	2760	1800	20,000	24,560	123,282	98,722	4.02 (402 %)

Training and field visit

Training and field were used in demonstration process to create awareness and transfer knowledge related improved yam production technologies. As shown in table 8.a total of 15 farmers, 8experts and 6DAs were trained on topics such as field pea production and managements. In addition to the training, field visits on which 58farmers 6expers and 8DAs have participated was arranged at vegetative and maturity stages of the crop for creating an opportunity for farmers to learn from each other and agricultural experts.

Table 8. Gender disaggregated number of stakeholders' participated on Training

Events	Participants									
Training	Farmers			DAs			Experts			Total
	M	F	Total	M	F	Total	M	F	Total	
	12	3	15	7	1	8	6	0	6	44
Field visit	47	11	58	7	1	8	8	0	8	74

Conclusions and recommendations

Pre-extension demonstration of improved yam technologies was carried out in one selected district of Wayu Tuqa of East Wollega zone of Western Oromia. Two newly released yam varieties (Bulcha and Lalo) were planted along with commercial check on 10m*10m adjacent plots of land and on a total of 4 hosting farmers from the district.

At maturity stage participatory variety evaluation and selection was arranged and held so as to evaluate, rank and select best suiting variety/ies in accordance with their real situation. Bulcha variety was selected in all of the traits except it is a late maturing variety than the other two and

then Lalo medium maturing and the best variety farmers selected one after the other. Since Bulcha variety suits the farmers' selection criteria and ranked as high yielder the variety was selected first there by Lalo. Accordingly; the two demonstrated improved varieties were much better in yield performances than varieties on the hands of the farmers'.

Moreover; varieties demonstrated were far better in financial profitability, yield advantage and suiting farmers' need. Further; statistically the combined mean yield performance analysis results of the varieties showed that as there is highly significant difference at ($p<0.05$). Eventually; farmers' evaluated, preferred and selected Bulcha first and Lalo variety second. But as farmers' evaluated though medium yielder and secondly selected; Lalo variety, owns beautiful traits that ought not to hinder/neglect the variety from disseminating on large scale. Therefore; this entail for scaling up of both varieties on more number of farmers and on wider areas where the activity is carried out and other similar agro-ecologies.

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Participatory Demonstration and Evaluation of Improved Small pod Hot pepper Varieties in Selected Districts of Wayu Tuqa and Ilu-Harar of Western Oromia

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Abstract

*The activity was conducted in Wayu Tuqa and Ilu-Harar districts of East Wollega and Ilu-Ababora zones of Western Oromia with the objective of demonstrating the recently released small pod hot pepper varieties, Kume, Dinsire and commercial check to the farming community in the districts. The districts were purposively selected based on potentiality for small pod hot pepper production; and one potential PA from each of the district was selected on the basis of accessibility and potentiality. After selecting, establishing and training farmers', three small pod hot pepper varieties of which two newly released small pod hot pepper varieties from Bako Agricultural Research Center; Kume and Dinsire ; and one commercial check; were planted side by side on 10m*10m adjacent plots on a total of 6 farmers' fields in both the districts. All recommended agronomic practices were equally applied to all the plots and the fields were closely supervised and were managed well. At maturity, the varieties were jointly evaluated with a team composed of researchers, Farmers and DAs. To this end; despite the slight variability in criteria set by farmers at the respective locations yield, pod color, disease resistance/ tolerance, number of pod per plant, number of seeds per pods, early maturity and pod size were considered as most important traits listed by farmers' for selection among the demonstrated varieties. In both the locations farmers' evaluated the demonstrated varieties; accordingly, Kume variety was*

ranked and selected first there by Dinsire second and finally commercial check as third in most of the criteria including yield and impressed the farmers; especially number of pods/ plant, pod color and number of seeds per pod. With regard to yield, 6.44 qt/ha, 6.04 qt/ha and 3.68 qt/ha were obtained from Kume, Dinsire and commercial check; respectively putting Kume on the first rank, then by Dinsire and finally commercial check. Besides; Kume and Dinsire had 75 % and 64.13 % yield advantage; respectively over the check and this implied that both Kume and Dinsire varieties had higher yield advantage than check. Further; statistically ANOVA table and mean yield comparison (t-test) results of on farm yield performances showed that as there is highly significant difference at ($p<0.05$) *among the varieties demonstrated and even significant difference between the released varieties; Kume and Dinsire. Furthermore; in terms of profitability, financial analysis result of the study also showed that using Kume variety could make the most profitable then by Dinsire and finally the least from check. Therefore; as the variety has met the intended criteria of the farmers and selected by farmers' at large the pre-scaling up activity should follow next on wider area and on more number of farmers' in the coming years.*

Keywords: Small pod hot pepper; Participatory demonstration, evaluation and selection; Yield Advantage; *Kume; Dinsire*

Introduction

Pepper has originated in Mexico and Central America regions and subsequently spread into Africa and Asia continents. It is the world's most important type of spice which provides nutritional value to consumers particularly vitamin A and E, flavoring and coloring food (Boseland and Votava 2000). The largest pepper producer countries in the world were Vietnam which produces (100,000 metric tonnes) followed by India (48,000 metric tonnes), Indonesia (37,000 metric tonnes), Brazil (35,000 metric tonnes), Malaysia (25,672 metric tonnes), Republic of China (23,300 metric tonnes) (Rosli et al. 2013). Likewise, the top five largest pepper producer countries in Africa were Madagascar which produces 6981 metric tonnes followed by Ethiopia (4511 metric tonnes), Ghana (3767 metric tonnes), Rwanda (2535 metric tonnes), and Uganda (2063 metric tonnes) (FAOSTAT 2016).

Ethiopia is a homeland for many spices and grows more than 14 types of spices, such as pepper (green, red and black), paprika, turmeric, fenugreek, garlic, korarima, coriander, ginger, cardamom, black cumin, white cumin, and basil (Girma et al. 2008). The past history of pepper in Ethiopia is possibly the most earliest than any other vegetable product. In Ethiopia the total production share of pepper is high as compared with other vegetables such as lettuce, tomatoes, head cabbage, onion and others (CSA, 2016). Similarly; hot pepper is widely cultivated in different agro-ecologies of Ethiopia. The Ethiopian Export Promotion Agency (2014) has carried out a spice potential market study in Oromia, Amhara and SNNPRS, and it identified the land

coverage for pepper in the three regions. It is extensively grown in most parts of the country, with the major production areas concentrated at altitude of 1100 to 1800 m.s.l. (MoARD, 2015).

The total production of pepper in the country for the year 2008/09 Ethiopian main cropping season was estimated to be 2,627908.26 quintals. In addition in Oromia region, the total production was 1,271,360 quintal for the same year. Therefore, the contribution of the Oromia region for the country production was 48 %. The total area cultivated by hot pepper small holder farmers for the meher season 2015/2016 in East Wollega and Iluababor zones were 4,442.39 ha and 9,226.26 ha; respectively. The estimated average productivity of red pepper in East Wollega and Iluababor zones were 19.92 quintals per hectare and 25.96 quintals per hectare; respectively, which is high compared to Oromia Region average of 19.09 quintals per hectare in 2015/16 (CSA 2016).

To this end, actually BARC has recently released small pod hot pepper varieties; Kume and Dinsire with an average potential yield of 64.80-80.84 qt/ha at the research field and 50.82-58.91 qt/ha on the farmers' field; respectively, for green pod. Whereas, it is 9.20-12.70 qt/ha at the research field and 7.1-8.2 qt/ha on the farmer's field; respectively, for the pod purpose (MoARD, 2015). This is to combat with and to alleviate the problem of low supply of improved varieties as well as co-related challenges sustainably. Besides; it is possible to increase the extension horizon of small pod hot pepper production at farmer's field through the use of these improved resistant or tolerant varieties to diseases/insect pests with improved management practice and its full recommended package. Thus, this project aimed at demonstrating and evaluating those technologies and varieties at farmers' field there by expanding (scaling up/out) of those selected technologies to the end users based on farmers' selection criteria. These in turn increase household income and contribute more to produce the crop that has high market demand. Consequently; this calls for demonstrating, validating and disseminating of the released high yielding, disease tolerant small pod hot pepper varieties that can make farmers' productive. Therefore; by recognizing this fact BARC extension team initiated this activity with these underlying objectives.

Objectives of the study

- To evaluate the productivity and profitability of the technology under farmers' condition
- To create awareness on the importance and availability of the technology
- To collect feedbacks from the participants for further research design and the way;

Methodology

Site and farmers' selection

This activity was conducted in selected districts of East Wollega and the then Iluababora zones of Western Oromia. Selection of the districts was based on potentiality for small pod hot pepper

production and accessibility for supervision. Accordingly, Wayu Tuqa and Ilu-Harar districts were selected based on the aforementioned criteria. One potential PA from each district was selected and in each PA, one FRG unit comprising of 15 farmers was established. A total of 3 hosting farmers from each district were selected and participated on the activity in collaboration with district agriculture and natural resource office and respective DA.

Provision of training

After sites and farmers' were selected both theoretical and practical training were given to farmers, Development agent and district experts. Training provided on the following areas; such as, small pod hot pepper production management, breeding aspect, post harvesting (seed quality). The aim of training was to create awareness of farmers', Development agent and district experts on small pod hot pepper technology.

Input distribution and Planting

After the plots were properly ploughed and made ready for planting ahead of the planting date, all necessary inputs (seed, fertilizers) were delivered to the farmers. Planting was made on the farmers' field by BARC researchers, TAs as well as farmers.

Design of the activity

Three small pod hot pepper varieties; of which two newly released small pod hot pepper varieties from Bako Agricultural Research Center; namely, Kume and Dinsire and commercial check were planted on adjacent plots of 10m*10m each. The demo plots were replicated by hosting farmers. All the necessary recommended agronomic practices were equally applied for all of the plots. Accordingly; spacing of 70cm and 30 between rows and plants; respectively was used for the demonstration. Besides; the recommended seed rate of 5 kg/ha and fertilizer rate of 207 kg/ha NPS and 137 kg/ha UREA were used. All other recommended agronomic practices were maintained equally for all plots. Every field were supervised to check the status and to identify gaps. The Plots were managed jointly by researchers, extension workers and hosting farmers. At maturity stage, participatory variety evaluation platform were arranged to attend the experimenting farmers, neighboring farmers, researchers from BARC and other stakeholders.

Data collection

Both qualitative and quantitative data were collected. The collected data were: yield data, type and number of stakeholders participated in training, type and number of stakeholders participated in field visits, farmers' perception on the attribute of technology, costs and income gained.

Data analysis

The data was analyzed using descriptive statistics such as mean, frequency distribution, tables and percentages. Also quantitative data collected were subjected to SPSS software to analyses mean, standard deviation, t-test and ANOVA table. Besides; pair ranking techniques was used to evaluate and select best bet variety/ies and /or technology/gies and to rank their criteria and parameters according to real situation of the area. Further, gross margin analysis is very useful in a situation where fixed capital forms a negligible portion of production. Thus; it is the difference between gross income and the total variable cost (Mohammed *et.al.*, 2016). Furthermore; technology gap and technology index could be calculated using the following formula.

Results and discussion

Participatory variety evaluation and selection

At maturity farmers were invited to evaluate the varieties based on their criteria. At outset they were helped to jot down their selection criteria at random. Then the farmers' evaluated the varieties against the ordered criteria. Pair-wise ranking technique was used to order the criteria on the basis of the weight attached. Accordingly; yield estimation, color, disease resistance/ tolerance, number of pod per plant, early maturity and pod size were considered as most important traits for selection.

Table 1: Pair-wise ranking of small pod hot pepper varieties

Parameters	Yield	Color	Disease Tolerance	No of pod Per plant	Early Maturity	Pod size	Frequency	Rank
Yield		1	1	1	1	1	5	1st
Color			3	4	2	2	2	4th
Disease Tolerance				3	3	3	4	2nd
No of pod per plant					4	4	3	3rd
Early Maturity						6	0	6th
Pod size							1	5th

Table 2: Varietal ranking based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Dinsire	**2nd**	High yielder, good color, disease tolerant, medium maturing, good pod size, high number of pods per plant
2	Kume	**1st**	Very high yielder, very good color, disease tolerant, relatively late maturing, very good pod size, very high number of pods per plant
3	Check	**3rd**	Low yielder, good color, less disease tolerant, early maturing, medium pod size, less number of pods per plant

On farm yield performance

In spite of the inevitable variability in performance between and even within locations, yield performance of the varieties was still promising. Accordingly; the combined mean analysis result on yield performance of the varieties demonstrated is summarized in below (table 2). Hence; a mean yield of 6.44 ± 0.09 qt/ha, 6.04 ± 0.15 qt/ha and 3.68 ± 0.12 qt/ha for Kume, Dinsire and check; respectively was gained.

Table 3: Mean yield of small pod hot pepper varieties across the districts

Variety	N	Mean	SD	Min	Max
Dinsire	6	6.04 ± 0.09	0.23	5.79	6.38
Kume	6	6.44 ± 0.15	1.40	6.07	6.93
Check	6	3.68 ± 0.12	0.30	3.33	4.04

The ANOVA table result summarized in below (table 4) shows that as there is highly significant difference among the varieties; Kume, Dinsire and commercial check at ($p<0.05$). Further; there is significant difference among the farmers on mean yield performances at ($p<0.05$).

Table 4: Analysis of Variance table for yield across districts

Varieties	N	Mean yield	SD	F	P
Dinsire	3	6.04	0.23		
Kume	3	3.44	1.4		
Commercial check	3	3.68	0.3		
Total				7.39	0.0000

Furthermore; varieties mean yield comparison (t-test) result summarized in below (table 5) also verified that highly significant difference exist among the varieties demonstrated and even between the newly released; Kume and Dinsiri, varieties across the districts at ($p<0.05$).

Table 5: Mean comparison (t-test) for yield across the districts

Varieties t-test	Mean	Std Error	T	P- value
Kume*Check	2.76	0.20	14.13	0.0000
Dinsire*Check	2.36	0.17	13.81	0.0000
Kume*Dinsire	0.4	0.09	4.55	0.0061

Yield advantage

Calculating yield advantage of the varieties helps: to show the extra benefit in percentage that the farmers' obtained from producing improved variety. Besides; it helps to recommend based on the relative yield advantage over other varieties. Accordingly; as summarized and presented in (table 6) below Kume had higher yield advantage over other varieties was 75 % then by Dinsire 64.13 % and Calculated using the underlying formula.

Table 6. Yield advantage of demonstrated small pod hot pepper varieties over the commercial check

Demonstrated Varieties	Yield obtained (qt/ha)	Yield advantage over the check
Kume	6.44	75 %
Dinsire	6.04	64.13 %
Check	3.68	-

Technology gap and Technology index

Technology gap indicates that the gap in the demonstration yield over potential yield. The observed technology gap is attributed to dissimilarities in fertility, acidity, rainfall and other natural calamities (Dhaka *et.al*., 2010). Its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations. The yield gaps can be further categorized into technology index which is used to show the feasibility of the variety at the farmer's field. The lower the values of technology index the more feasible the varieties**.** To this end, the technology gap and index of demonstrated varieties (Kume and Dinsire) were calculated using the underlying formulas and presented in below (table 8).

Technology gap = Potential yield qt/ha – Demonstration yield

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

Table 7: Technology gap and index for Kume and Dinsire varieties across the districts

Parameter	Small pod hot pepper varieties	
	Kume	Dinsire
Yield gap (qt/ha)	1.21	1.41
Technology index (%)	15.82	18.93

From result of (table 7) above the yield gap were 1.21 qt/ha and 1.41 qt/ha for Kume and Dinsire varieties; respectively. Besides; both varieties showed the lowest gap which in turn shows the demonstration yield is very close to the potential yield. More over; the technology index were 15.82 % and 18.93 % for Kume and Dinsire varieties; respectively. That means both varieties have an average technology index of 17.37 % and this dictates the varieties are feasible to the farmers in the study area and other similar agro-ecologies.

Financial analysis

The financial analysis result was summarized and presented in table 8 below. According to the resuts obtained; 41,543.80 Birr, 38,343.80 Birr and 19,463.80 Birr per hectare profit were gained from Kume, Dinsire and Commercial check; respectively and the highest profit were gained from Kume variety followed by Dinsire while the lowest was obtained from Commercial check. Similiarly, the highest returns to investment (416 %) was gained from Kume followed by Dinsire (384 %) while the lowest (195 %) was obtained from the Check. Therefore; from this result it can be concluded that as Kume and Dinsire varieties were high yielder and more profitable than commercial check and thus; using improved variety/ies seed of Kume and/or Dinsire were economically profitable than commercial check.

Table 8. Gross margin analysis of small pod hot pepper varieties demonstration across districts

Variety	Yield (qt/ha)	Market price (Birr)	Fertilizer Cost (Birr)	Seed cost (Birr)	Labor cost (Birr)	TVC	TR (P*Q)	GM (Profit)	Return to investment (%)
Kume	6.44	8000	5776.20	1200	3000	9976.20	51,520	41,543.80	4.16
Dinsire	6.04	8000	5776.20	1200	3000	9976.20	48,320	38,343.80	3.84
Check	3.68	8000	5776.20	1200	3000	9976.20	29,440	19,463.80	1.95

Training and field visit

Training and field were used in demonstration process to create awareness and transfer knowledge related improved yam production technologies. As shown in table 8.a total of 25farmers, 8experts and 6DAs were trained on topics such as field pea production and managements. In addition to the training, field visits on which 58farmers 6expers and 8DAs have participated was arranged at vegetative and maturity stages of the crop for creating an opportunity for farmers to learn from each other and agricultural experts.

Table 9. Gender disaggregated number of stakeholders' participated on Training

Events	Participants									
Training	Farmers			DAs			Experts			Total
	M	F	Total	M	F	Total	M	F	Total	
	19	6	25	7	1	8	6	0	6	44
Field visit	47	11	58	7	1	8	8	0	8	74

Conclusions and recommendations

This pre-extension demonstration of improved small pod hot pepper technologies was carried out in two selected districts of Wayu Tuqa and Ilu-Harar of East Wollega and the then Iluababor zones of Western Oromia. Two newly released small pod hot pepper varieties (Kume and Dinsire) were planted along with commercial check on 10m*10m adjacent plots of land and on a total of 3 hosting farmers from each district. At maturity stage participatory variety evaluation and selection was arranged and held so as to evaluate, rank and select best suiting variety/ies in accordance with their real situation. To this end; Kume variety was selected in all of the traits except relatively late maturing nature than the other two and then Dinsire medium maturing and the best variety farmers selected one after the other. Since Kume variety suits the farmers' selection criteria and ranked as high yielder the variety was selected first there by Dinsire. Accordingly; the two demonstrated improved varieties were much better in yield performances than varieties on the hands of the farmers'.

Moreover; varieties demonstrated were far better in financial profitability, yield advantage and suiting farmers' preference. Further; statistically the combined mean yield performance analysis results of the varieties showed that as there is highly significant difference at ($p<0.05$). But of course there was a problem of varietal mix up which requires purification for the coming seasons. As per recommendation from M and E committee of the center and field observation it was decided that since the varieties are promising the scaling up/out activity to be carried out after purifying the varieties in research station in the coming years.

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Scaling up of Crossbred Heifers in Adami Tulu Jiddo Kombolcha District, Oromia, Ethiopia

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Abstract

The scaling up work was conducted with an objective of improving milk production through distribution of F1 Boran and Holsten Frisian cross bred dairy heifers. It has also envisioned improving farmers' income and knowledge on dairy husbandry. A total of 76 farmers were selected for the activity from five kebeles in Adami Tulu Jiddo kombolcha district. A total of 52 pregnant heifers and 24 cows having first calves were and distributed to 76 participating farmers with a subsidized price. The distributed heifers gave an average milk yield of 6.67 lit/day with a gross average economic return of 5,436.00 ETB per month/*animal. The participant farmers were also obtained 0.76 and 0.60 kg of cheese and butter per week respectively. Generally, the crossbred heifers were found to be an important dairy technology options that can bring improvement in the income of small-scale farmers. Thus, multiplication and distribution of such cross bred heifers is recommended to reach more small-scale farmers in the study area. Furthermore, further research studies focusing on the impact of cross bred heifers on livelihood improvement is suggested.*

Key words: Scaling up, crossbred, heifers

Introduction

Although the contribution of livestock farming is vital, its productivity in Ethiopia is generally very low due to lack of dairy development technologies, policies, marketing system, infrastructure, information system, credit facilities, incentives, environmental issues and quality control (Azage and Alemu, 1998). Lack of participatory research, education and farmers training, strong extension system and consultation and dairy cooperatives are the major institutional constraints for the development of the sub-sector (Abaye *et al.*, 1991). Underdeveloped and lack of improved animal genetic resources, feed resources and feed markets, nutrition and feeding systems, animal health and disease control, management skill and processing and preservation of products are also the major technical constraints of dairy development in the country (Abaye *et al.*, 1991; EARO, 1998). Due to these multifaceted constraints, the country could not be self-sufficient in milk and milk products and a considerable amount of foreign exchange have to be spent on the import of dairy products. In Ethiopia, an average per capita consumption of whole milk is far below that of the world and even than that of Sub-Saharan Africa (FAO, 2004). Annual production of milk could not cope with the rapidly growing human population and the demand-supply gap has to be bridged with net import (FAO, 2004). The import of milk was

increased from 2,082 metric tons in the year 1995 and had increased to 11, 202 metric tons in the year 2002 (FAO, 2004) with increasing trend with the population of the country. Currently the human population of Ethiopia is increasing with annual growth rate of about 3% this figure will increase to about 110 million in the year 2020. Similarly, urban population is expected to increase from the current 11 million to about 16.5 million by the year 2020. Population growth and urbanization are partly expected to add more stress on demands for dairy products.

The definition of food security as agreed at the World Food Summit in 1996, and refined in later years thus states… "Food Security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". Food security is not just a supply issue, but also a function of income and purchasing power, and hence its strong relationship with poverty. This signifies the importance of dairy farming as a means of meeting human nutritional needs and improving farmers' income and living standards. Thus, to improve the situation specially related with improving the milk production in the country, efforts have been made among which breed improvement through crossing is one of them. To this end, at Adami Tulu Agricultural Research center; attempts have been made to evaluate the performance of some indigenous breeds (Borana and Barka) and their crosses with three selected temperate breeds (Holstein Friesian, Simmental and Jersey). As a result, evidenced from on-station and on farm performance evaluations up to demonstrations; crosses with 50-62.5% exotic blood levels were recommended to be suitable for Ethiopian smallholder farmers in general and central rift valley areas in particular with improved productivity.

Yet, research technologies generated on station so far could not reach resource poor farmers due to lack of technology promotion interventions beyond the on-farm demonstration and evaluations. This scaling up activity was therefore conducted to promote the technology in collaboration with district extension office and other stakeholders.

Objectives

- To improve milk production and productivity in the study area
- To improve participating farmers income

Methodology

Description of the study area

The activity was implemented in the Eastern Showa Zone of Oromia region, Ethiopia. The specific location of the project was Adami Tulu and Jido Kombolcha (ATJK) district. The district has an altitude ranging from 1500 to 2300 meters above sea level; Mount Aluto is the highest point. Rivers found in the district include the Bulbula, Jido, Hora Kalio and Gogessa. The district has a total land area that constitute 27.2% arable or cultivable, 21.6% pasture, 9.9%

forest, 15.7% swampy and the remaining 25.6% considered as degraded or otherwise unusable lands. The crops produced in the area are mainly maize, haricot bean, wheat, teff and barley. The specific Kebeles selected for this activity encompass five accessible Kebeles located around Adami Tulu Agricultural Research Center (ATARC) located in Central Rift Valley at 168 km on the way to Hawasaa.

Sites Selection

Site was selected with the participation of farmers, Development Agents and District experts. The sites were selected depending on the availability of land, vicinity to ATARC and the technical feasibilities such access to feed resources, water supply topography and main road. Thus, a total of five (5) kebele's were selected

Farmers' selection and grouping

The scaling up activity was conducted on the already established farmers' groups having an interest to participate in crossbred dairy heifers scaling up activity. The groups were initially organized considering gender participation, each group having at least 20-30% women members. Generally, the following criteria were considered to select participating farmers

- Willingness to accept the technology,
- Willingness to construct house for the heifers
- Willingness to work in groups
- Willingness to keep appropriate records
- Implement all the recommendations forwarded by researchers and development workers by incorporating their own indigenous knowledge.
- Willingness to participate on community meeting, visits and training,
- Willingness to contribute for some costs of inputs,
- Willingness to participate on group member meeting

Signing of Memorandum of Understanding (MoU)

The MoU document on the implementation of the project was prepared and signed among the participant farmers, Adami Tulu Rsearch Center and the District Bureau of Agriculture and Natural Resources. The MoU has also served as a binding document for the farmers not to sell, exchange or provide as gift, the distributed heifers until the project duration is completed.

Farmers Training

After group establishment, training was given by multidisciplinary groups of researchers. The training component included improved animal husbandry and management practices, such as feeding, feed preservation and formulation, cleaning and sanitation, heat detection, health care,

milking practices, record keeping, budgeting and accounting. The training was given at FTCs and Adami Tulu Agricultural Research Center. In addition to classroom training, field visits were arranged for farmers to visit different types of feeds that are available at ATARC on-station.

House construction

The participant farmers constructed barns with feeding and watering troughs and calf pen following the recommendations given during training. The heifers were distributed after making sure each participating farmer has prepared the house.

Heifers' distribution

About seventy-five (75) Holstein Friesian and Boran cross breed heifers with 50% blood level were made available for the farmers. The heifers were estrus synchronized and bred with Artificial Insemination before distribution. Those animals confirmed for pregnancy were managed on station until they were dispatched. The animals were distributed for subsidized prices determined by the government and also agreed upon on the memorandum of understanding.

Health Care and AI Services

The participant farmers were trained with the health aspects of dairy animals. For the first two years of project life all the routine health care including periodical vaccination and AI services were handled by the project with the help of professionals at Adami Tulu Research Center.; In the remaining years before project completion and after that health care and AI were handled by the farmers through nearby health technicians.

Data collection

Necessary data about Milk yield, amount of cheese & butter produced, Numbers of farmers participated on trainings & visits and income gained were collected by the farmers and researchers. Yield and financial related data were recorded by data collection sheets. Farmers were provided data sheets for registering the daily milk yield, chees and butter produced per week. Other data including economic data were collected using data collection sheet by researchers.

Data analysis

The collected data was analyzed using SPSS and presented using table. Descriptive statistics mainly mean was used to analyze the daily milk yield, cheese and butter production per week.The gross financial performance analysis was done using the current market price data in ETB considering all the milk produced is sold.

Results and discussions

Number of heifers distributed

A total of 52 pregnant and 24 heifers having first born calves were distributed to participating farmers. The distributed animals were Boran X Holstein Frisian of 50% blood level. The heifers were estrus synchronized and bred with Artificial Insemination before distribution. The following table describes the number of distributed heifers per each kebele.

Table 1. Number of heifers distributed

Kebele	**Number of heifers distributed**
Edo Gojola	11
Gerbi	11 (all with them have calve)
A/shisho	11 (all with them have calve)
Haleku	11
Bulbula (Haalimtoota)	11 (With one calve)
Bulbula (Badhaasii)	11
Bulbula (Daraartuu)	10 (With one calve)
Total	76 heifers and 24 calves

Milk Production Performance of the distributed heifers

The distributed heifers gave an average milk yield of 6.67 per day (Table 2). This result is numerically comparable with the performance evaluation results reported by Belay (2012) and Endris (2017). However, the result is higher than studies reported by Birhanu & Chakravarty, (2013) and Yohannes et,al. (2017), but lower than on station performance evaluations reported by Sendros and Tesfaye (1998). The result is also lower than the 7.4lit/day reported by Fikirneh and Chali(2002) in their demonstration work conducted at Lume and Adama. The difference observed in milk yield is due to the difference in level of feed supplementation and other management practices performed by farmers. Apart from selling or consuming raw milk, the participant farmers were processing some left over amount into butter and cheese. Hence, participant farmers obtain 0.76 and 0.60 kg of cheese and butter per week respectively

Table 2. Production Performance of the distributed heifers

Kebele	Number of Distributed heifers	Average milk yield/cow/day (liter)	Amount of cheese & butter produced/week	
			Cheese/kg	Butter/kg
Edo Gojola	11	6.5	0.67	0.65
Gerbi	11	9	0.67	0.69
A/shisho	11	5.5	1.00	0.60
Haleku	11	7	0.33	0.83
Bulbula (Haalimtoota)	11	5.75	0.83	0.50
Bulbula (Badhaasii)	11	6	1.00	0.33
Bulbula (Daraartuu)	10	7	0.83	0.50
Total	76 heifers	6.67	0.76	0.60

Gross income obtained from milk production

Gross income was calculated based on average milk yield obtained per day assuming that the whole is sold at a farmgate market price of 28 ETB/lit. Accordingly, the analysis result showed that a farmer can get an average monthly gross income of 5,436.00 ETB per month from an average daily milk yield of 6.67lit/day from a single heifer with the blood level of 50% (HFXB).

Table 3: **Gross income performance of the distributed heifers**

Kebele	No of Heifer	Lit/Day	Price/ lit	Income/day/ Heifer	Income/month/Heifer	Income/Heifer/ group/month
Edo Gojola	11	6.5	28	182	5460	60,060.00
Gerbi	11	7.5	28	210	6300	69,300.00
A/shisho	11	5.5	28	154	4620	50,820.00
Haleku	11	7	28	196	5880	64,680.00
Bulbula (Haalimtoota)	11	5.8	28	162.4	4872	53,592.00
Bulbula (Badhaasii)	11	6	28	168	5040	55,440.00
Bulbula (Daraartuu)	10	7	28	196	5880	58,800.00
Average	11	6.67	28	181.2	5436	59,796.00

Training and Field visits

Different trainings were provided to participating farmers in collaboration with Dairy and Animal feeds research team. The training was provided on improved animal production, health, feeding & Management practices for farmers, & DA's. The training was provided for two consecutive years. Furthermore, field visits were also arranged to participating farmers to observe different types of dairy feeds adaptable to the farming system of the area.

Table 4: Number of training and field visit participants

Training topic	No of participants												
	Farmers		Total	DA'S		Total	SMS		Total	Others		Total	Overall total
	M	F		M	F		M	F		M	F		
Dairy production and management	55	21	76	4	0	4	8	0	8	10	1	11	99

Conclusions and recommendations

Scaling up crossbred dairy heifers was conducted with an objective of improving milk production and income of farmers through distribution of F1 Boran and Holsten Frisian cross bred dairy heifers. The study result indicated that the heifers distributed were beneficial when compared with local cows. The average milk yield obtained per cow/day was comparable with on-station results and other similar works if proper feeding and management practices are properly done. Despite the local management challenges, the crossbred heifers are still found to be an important technological option that can bring significant improvement in the income of small-scale farmers. Thus, multiplication and distribution animals and trainings of farmers should continue to reach more small-scale farmers in the study area.

Furthermore, impact studies should be conducted to measure the change in livelihood of farmers due to the crossbred dairy interventions in the study area.

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Pre-extension Demonstration of OARI-Assela Model-3 Multi Crop Thresher for Wheat and Sorghum in Arsi Zone

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Abstract

The research activity was carried out in two purposively selected districts namely Merti and Chole from Arsi zone with the objectives of evaluating the performance and profitability of the multi-crop thresher under farmers' management, creating awareness on the importance of the technology and 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. Practical training was given to a total of ninety two farmers on OARI-Assela Model-3 Multi Crop Thresher technology. The demonstration was conducted on four hosting farmers from FRGs. The results of the study depict that average threshing capacity of multi crop thresher for wheat and sorghum were 21.5 and 50 quintals in eight working hours. Whereas the average threshing capacity for wheat and sorghum 3.6 and eight 8.5 quintals in eight working hours. The demonstrated thresher machine had relative advantage over traditional practice in terms of reducing post-harvest crop lose by 2.4 quintals. Net income of farmers increased from 31, 375 birr to 37,530 birr for wheat and 10,125 birr to 12,310 birr for sorghum because of using multi crop thresher. Thus, OARI Model Multi crop thresher was recommended for further scaling.

Key words: *Demonstration, Multi crop thresher, Wheat, Labor, Sorghum and Threshing*

Introduction

In crop production, where traditional way of production is followed, the lion-share of labor requirement goes to threshing and harvesting which accounts for about 40% of its total man-day. Moreover, in traditional method (manual and animal trembling methods) of harvesting and threshing, huge amounts of harvest and post-harvest loss is recorded which was estimated to about 12.9%, 13.6% and 10.9% for teff, wheat and maize respectively per annum ((Derege *etal* 1989).

According to African Post Harvest Loss Information System (APHLIS) report by Hodges *et.al* in 2010, there is highest losses in agricultural outputs for small farms than large farms both during harvest and post-harvest period until consumption.

Ethiopian agriculture which is highly characterized by small-scale and subsistence farming system, faces great problem of post-harvest loss (Abebe H. Gabriel and Bekele Hundie, 2006). Most grain loss was also recorded during harvesting/field drying, platform drying, threshing shelling and winnowing (Hodges, *et.al*, 2010). Until recent days, the main reason for this was due to the proper utilization and/or absence of appropriate intermediate threshing technologies for small-scale farmers in Ethiopia.

Assela Agricultural Mechanization research center developed a cereal threshing machine with good and promising capacity. According to the report by the center's harvest and post-harvest research team, the currently modified and improved machine that has threshing capacity of 250kg to 1700kg per hour for different crops with optimum straw moisture content, rotation per minutes of the machine parts and feeding rate. The machine had cleaning efficiency, threshing efficiency and grain breakage percentage to be 98.97%, 99.50% and 0.05% respectively. The machine was found to be superior in all of its performance quality compared to other machines so far developed in the country and even those imported from abroad

Despite having much advantage over traditional practice, other intermediate and imported machine for crops like wheat, sorghum, barley and tef; the improved threshing machine was not introduced to farmers in Arsi zone. Therefore, this pre-extension demonstration work conducted to demonstrate the improved multi crop thresher to selected districts of Arsi zone.

Objectives of the study

The demonstration work was conducted to achieve the following objectives.

- To evaluate the profitability of the multi-crop thresher under farmers' management
- To create awareness on the importance of the technology
- To enhance farmers' knowledge and use of the technology

Methodology

Site and farmer selection

Demonstration of multi-crop threshers was held in two districts of Arsi zone namely Merti and Chole selected based on their representativeness and appropriateness for the study. Then experimental sites and representative farmers were selected based accessibility for more farmers to visit the demonstration site with DA and district experts. Farmers` training center (FTC) was used as experimental site to undertake demonstration of multi-crop thresher. The experiment was done on four experimental sites; two from each districts.

Technology evaluation and demonstration method/techniques

Evaluation of multi crop thresher was done in comparison with traditional way of threshing for wheat and sorghum.

Method of data collection

This study was employed both qualitative and quantitative method of data collection. 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 by gender, numbers of farmers become aware of the relative advantage of the technology by gender, role of farmers and other stakeholders in technology demonstration and skill of farmers and farmers' opinion was collected using field observation, household/participant interview and focus group discussion.

Method of data analysis

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

Data related to farmer's perception towards technology was analyzed using five scale likert scale method and data related to economics of technology was analyzed by using partial budget analysis.

Results and discusion

Training of farmers and stakeholders

The implementation of this research activity use training on knowledge, skill and attitude was the main methods that used to create awareness on OARI-Assela Model-3 Multi Crop Thresher technology among farmers, to enable farmers', DAs' and experts' knowledge and skill on OARI-Assela Model-3 Multi Crop Thresher technology. Thus, multidisciplinary team consists of Engineers`, Extensionist and Socio-economist were organized to deliver the training in capacity building and facilitating extension efforts of OARI-Assela Model-3 Multi Crop Thresher technology.

On the training organized on OARI-Assela Model-3 Multi Crop Thresher technology; a total of 92 participant of which 67 (73%) were male and 25 (27%) female from two districts participated on both theoretical and practical training on OARI-Assela Model-3 Multi Crop Thresher technology. The training was mainly focused on how to operate technology, relative advantage of technology over local practice.

Table 1. Training to stakeholders on OARI-Assela Model-3 Multi Crop Thresher

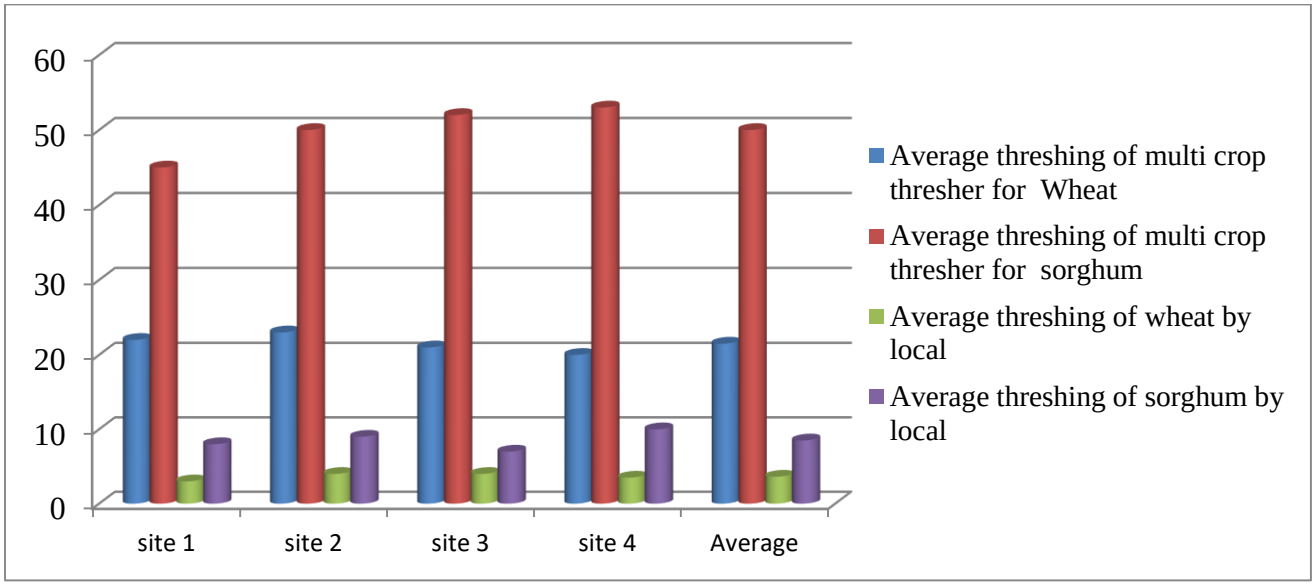
Disticts	**Description of participants**	**Male**	**Female**	**Total**
Merti	Farmers	30	10	40
	Agricultural Experts	2	-	2
	Development agents	2	-	2
	Supervisor	2	-	2
Chole	Farmers	25	15	40
	Agricultural Experts	2	-	2
	Development agents	3	-	3
	Supervisor	1	-	1
Grand total		**67**	**25**	**92**

Threshing capacity of technology

The most important factors influencing threshing capacity of OARI-Assela Model-3 Multi Crop thresher were; crop moisture content, feeding rate, grain straw ratio, crop sheaf length, performance of the operator and others. As indicated in the graph below the average threshing capacity of multi crop thresher for wheat and sorghum were twenty one point one (21.5) and fifty

(50) quintals eight working hours. Whereas the average threshing capacity of wheat and sorghum for local practice which were rounding/trampling animals on the heaped crop was three point six quintals (3.6) and eight point five (8.5) quintals in eight working hours.

Graph1. Mean comparison of multi crop thresher for wheat and sorghum



Profitability analysis of the machine

The profitability analysis of the machine was done by comparing two crop threshing mechanisms which were traditional animal trampling and stationary engine driven machine threshing. As it was indicated in the table below, the engine driven machine thresher had relative advantage over traditional practice in terms of reducing post-harvest crop lose by two point four (2.4) for wheat and one (1) quintals for sorghum. It also reduced the cost of human labor and animal labor which were calculated to be five thousand three hundred seventy fifty (5,375) birr and three thousand three hundred seventy five (3,375) for wheat and sorghum respectively. Whereas total cost incurred for human labor force both for machine operation and re-cleaning of two crops were three thousand seventy (3,070) birr for wheat and two thousand ninety (2,090) birr for sorghum. From the result shown in the following table net income of farmers increased from thirty one thousand three hundred seventy five (31, 375) birr to thirty seven thousand five hundred thirty (37,530) birr for wheat and ten thousand one hundred twenty five (10,125) birr to twelve thousand three hundred ten (12,310) birr for sorghum because of using multi crop thresher. The other quality of multi crop thresher that adored by farmer`s was straw chopping capacity of the machine for their livestock feed which was serious problem in the study area.

Table 2:- profitability analysis of machine

Variables	Traditional threshing for wheat	Multi crop thresher threshing for wheat	Traditional threshing for sorghum	Multi crop thresher threshing for sorghum
Average yield in quintal per hectare	25.6	28	15	16
Gross return[a]	37,120	40,600	13,500	14,400
Labor for transportation[b]	125	140	75	80
Labor for threshing[c]	2,250	-	1,800	-
Labor for winnowing[d]	900	-	300	-
Animal labor[e]	2100	-	1,200	-
Labor for operation[f]	-	750	-	750
Labor for re-cleaning[g]	-	500	-	300
Machine cost[h]	-	1,680	-	960
Total cost that vary	5,375	3,070	3,375	2,090
Net income	31,745	37,530	10,125	12,310

Farmer perception

A five point Llikert scale method was used to measure respondent's opinion/views towards the new technology with respect to traditional way of threshing crops. Among the farmer interviewed about 37.5%, 22.5%, & 15% of participant farmers were responded that the operation of machine was very simple, simple and medium to operate the multi crop thresher. Whereas about 18.75% and 6.25% of the respondents were responded that it was difficult and very difficult to operate and it requires some modification on the technology. As far as maintenance of the technology concerned; about 35.25%, 17.5% & 18.75% of respondent farmers were responded that the maintenance of technology was very simple, simple and medium respectively to maintain multi crop thresher. Whereas about 20% and 12.5% of the respondents were responded that it was difficult and very difficult to maintain technology. In addition to that about 43.75%, 28.75% and 20% of the respondent farmers also indicated that the affordability of the technology was very high, high and medium respectively. Whereas only 7. 5% of respondents were responded that it was low to afford technology.

Table 3.Farmer's response towards the technology

No	Criteria	Attributes	No of respondent	Percentage (%)
1	Ease of operation	Very simple	30	37.5
		Simple	18	22.5
		Medium	12	15
		Difficult	15	18.75
		Very difficult	5	6.25

2	Maintenance	Very simple	25	31.25
		Simple	14	17.5
		Medium	15	18.75
		Difficult	16	20
		Very difficult	10	12.5
3	Price to afford technology	Very high	35	43.75
		High	23	28.75
		Medium	16	20
		Low	6	7.5
		Very low	-	-

Conclusion and recommendation

The demonstration of OARI-Asella Model-3 multi crop thresher was conducted to evaluate and demonstrate the machine. The demonstration result indicated that the demonstrated machine had much advantage over the traditional threshing system interims of threshing capacity and reducing labor costs required for threshing and cleaning. Feedbacks obtained from participant farmers, DAs and experts also asserted that the threshing machine has additional advantages of reducing post-harvest losses grain and straw quality. Thus, based on these evidences the OARI Asella Model-3 multi crop thresher technology was recommended for further scaling up in wheat and sorghum producing areas.

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Pre-Scaling up of Integrated Fish – Poultry-Horticulture-Production System in East Wollega Zone and Buno Bedele Zone, Oromia Region, Ethiopia

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Abstract

Integrated poultry-fish-horticulture farming system is rarely practiced in Ethiopia but potential method of food production to mitigate problems facing vulnerable farmers in the country. The current research activities were aimed to pre-scaling up and test the feasibility of the integrated farming system in East Wollega and Buno Badele Zone of Oromia region at a small-scale farmer's level. The farm was implemented at selected site based on basic research information. Productivity of the farm was compared against productivity reported in the basic research and the farmers practice. Potential to produce diversified food and generate income at small scale farmers' level was evaluated. Productivity of the three components was found to be comparable to or better than the productivity obtained at basic research and farmers practice. Moreover, diversified products were produced on small area at a lower input cost in sustainable base. The local community accepted the practice as a technology. Government and other stakeholders have to support extension of the practice at applicable areas. Since the integrated technology have positive feedback from farmers we recommend to Livestock and Fishery Offices at district and zonal level in collaboration with other stakeholder should work on the wider scaling up of this technology.

Keywords: *Integration; Fish; Poultry; Vegetable; Waste Recycle; East Wollega; Buno Bedele.*

Introduction

Fish raised in semi-intensive, freshwater systems provide the major proportion of farmed, global production (FAO, 1995). Global fish production peaked at about 171 million tonnes in 2016, with aquaculture representing 47 percent of the total and 53 percent if non-food uses (including reduction to fishmeal and fish oil) are excluded. The African aquaculture production has only contributed less than 2 million tonnes, around 2.5 percent of the global aquaculture (98.7% from inland aquaculture and 1.3% from marine and coastal aquaculture (excluding aquatic plants). The per capita aquaculture production (excluding aquatic plants) in Africa is still inferior the global standards with the highest figure in northern Africa was 5.3 kg/capita, 0.5 – 1.0 kg/capita in western and southern Africa with the minimum figure 0.2 kg/capita in middle

Fish production is mainly by wild capture of tilapia (Oreochromisniloticus), followed by catfish (Clarias. gariepinus), Nile perch (Latesniloticus) and Barbus species. The total fish production potential is estimated to be 51,481tonnes/year. Of these, approximately, 50% of this is currently

exploited annually. Stock depletion in some lakes has been reported. The demand for fish has increased recently. The total expected demand for fish in 2025 is estimated to be 118,000 tonnes, which is greater than the capture production potential. This calls for an increased focus on stocking and enhancement of water bodies based on sound genetic principles and development of aquaculture to produce fish to meet future demand (Gopalakrishnan, 2019).

Fish-poultry-horticulture integrated productions plays an important role in the diet of the people of developing nations. When fish farm integrated with other agricultural sectors it diversifies farmers' income, create job opportunity, contributes for household food security and meeting future diets like protein, carbohydrate, vitamins and minerals demand. Integrated horticulture-fish production system is maximizing productivity and economic efficiency of smallholders' fish farmers through enhancing the productivity per acreage of land where fish production remained as the most important activity (Mukherjee, 1995).

This type of integration can increase overall production intensity and economies on land, labor and water requirements for poultry, fish and horticulture. For example, one hectare of static water fish ponds can 'process' the wastes of up to 1500 poultry, producing fish in quantities of up to 10 MT/ha without other feeds or fertilizers. Also, since effluents are few, environmental impacts are minimal. The importance of poultry wastes in aquaculture is relatively recent. In areas of traditional fish culture, ruminant and pig manure have predominated as pond fertilizers in some part of the country. Poultry manure was not used to any extent probably because small flock size and extensive management precluded collection. Vertical integration of the poultry industry by agribusiness has been stimulated by the biology and widespread acceptability of poultry, particularly chickens. Global trends in livestock production indicate that poultry, particularly layer and broiler chickens, are increasing faster than any other (FAO, 1989, 1990, 1991, 1993).

Poultry production wastes have inherent qualities that make them particularly valuable for fish production compared to other livestock wastes. The small individual size of poultry also allows their confinement and production directly over fish ponds that implementing production boosting waste recycling technology which replaces fish feed and chemical fertilizer for fish ponds and vegetables. Most published data concern integration of fish culture with modern poultry systems which are typically inappropriate for resource-poor farmers. Village or backyard poultry systems predominate in areas where modern breeds and systems are absent, or co-exist in competition with them. Recent research indicates that integration of such poultry and backyard fish culture can also bring benefits at little extra cost. Farmers in Oromia regional state practiced extensive fish farming in small ponds using Nile tilapia since 2008 and fish farms were interested but not supported with a package to attain the potential production level (Tugie, 2010).

One of the many major constraints of fish farming in Ethiopia is feed supply whereas many farmers rearing depending on grazing native pasture and use crop residues, animals like cattle, sheep, poultry, goat and equines (Endabu *et al.,* 2016). Integrated pond management with

poultry, fish and vegetables was proofed to be excellent approach for sustainable production, income generation and employment opportunity of the resource poor rural households (Alam *et al.,* 2009). As previous study confirmed that fish integration farming system is profitable, it needs to more demonstrate as one strategy that can be adopted by small farmers in the country to increase farm returns from per unit area of land (Lamma, 2017). Therefore, this integrated farming was conducted for further scaling up at East Wollega and Buno Bedele Zone.

Objective

- To scaling up integrated Fish-poultry-horticulture farming systems in the study area.
- To create awareness and enhance knowledge of farmers in integrated farm technologies
- To enhance better linkage with Farmers, Researcher, Development Agent and others stakeholder.

Materials and methods

Descriptions of the study area

The pre-scale up of integrated Fish-poultry-horticulture farming systems were conducted in Wayou Tuka district of East Wollega zone and Chora district of Buno Badele Zone of Oromia Region, Ethiopia. Wayou Tuka district is 298 km far from the capital Addis Ababa to the West on the way to Nekemt, situated in Farmers' Training Center (FTC) of Warababo Migna peasant association at 902'N and 36040'E, at an altitude of 1910 m.a.s.l. The area is categorized in to mid altitude (locally known as Badda daree) agro-ecology, receiving bi-modal type of rainfall with main rain from June to August. Production system of the area is mixed agriculture where the farmers produce field crops such as maize, wheat, barley and rear livestock such as cattle, goat, sheep and chicken all in traditional methods (data at local district offices).

Buno Badale Zone is one of Oromia Regional States that newly established since 2009 E.C. This area is under Ilu Aba Bora Zone before the area is categorized in two Zones. The large number of populations in the area is engaged in Agriculture as primary economic sector. In addition to this cash crop coffee take a large proportion in the local market. The activity was conducted in Chora Districts Tulu Mute Peasant Association. The area is 12km far from Chora Districts asphalt road in the direction of Ilu Aba Bora Zone and 28km far from Badele Town. Chora district found at 8 23'N and 36 07'E, at an altitude of 2,000 m.a.s.l (CDBOA, 2018). The farming system of Chora district was characterized by mixed farming system, comprising both cropping and livestock production. It is mostly known for its vegetation coverage, suitability for coffee, crop livestock and bee production (CSA.2015).

Site selection for the technology

The major factors considered in site selection were availability of year-round water with the quality required by fish (optimum temperature and pH), site suitability for pond construction,

horticulture and poultry management and accessibility of the site for majority of farmers to share knowledge for the communities. After checking the site to qualify the required criteria for the technology, discussions were made with government officials, community administrative, experts and farmers.

In East Wollega Zone the site within Farmers Training Center (FTC) was selected for the technology transfer based on the interest of local community to learn the management of integrated fish-poultry-horticulture farming. In other case from Buno Bedele Zone, Tulu Mute Passant Association was selected for the technology transfer based on the interest of local community to learn the management of integrated fish-poultry-horticulture farming. As the technology is aimed to solve nutritional insecurity, the selected site was accessible for women, vulnerable households, youth and other local societies to easily learn the technology.

Fish pond construction and fish production

The three farming components, fish, poultry and vegetable were conducted in integration simultaneously by communities' participation. To establish the integrated farm one rectangular shaped earthen pond was constructed in each selected research areas with water inlet, outlet and overflow was excavated on a gentle slope land near to water source to secure the permanent water supply through gravity flow. The pond has an area of $150m^2$ (15m X 10m) and $225m^2$ (15m X 15m) in East Wollega Zone and Buno Bedele Zone, respectively.

In both research site before stocking the pond with the fishes, the bottom and the walls of the pond was treated with lime to kill potentially harmful microorganisms especially parasites. The lime also helps to increase the alkaline reserve in water and mud which prevents extreme changes in pH, neutralizes the harmful action of certain substances like sulfides and acids and promote biological productivity. Two weeks after liming, the pond was filled with water from the irrigation system via the supply canal. Poultry house in each the integration were also stocked with pullets.

A total of 290 fishes fingerlings Stocked in East Wollega Zone and a total of 463 was stocked in Buno Bedele zone with three fish species (Oreochromis niloticus, Cyprinus carpio and Claries gariepinus) were collected from Batu Fishery and other Aquatic Life Research Center and Koka reservoir using beach seine hauls and stocked in to the pond under integration. In East Wollega Zone the fishes were composed of 240 O. niloticus, 18 C. carpio and 32 C.gariepinus fingerlings.

In other case in Buno Bedele Zone the fishes were composed of 315 Oreochromis niloticus (68.03% stocking density), 120 Cyprinus carpio (25.92% stocking density) and 28 Clariesgariepinus (6.05% stocking density). Tilapias were considered as the major product in the fish component of the integration whereby mixed sex tilapias of the best performing Chamo among the local strains were used in these pre-scaling activities. The fishes were managed properly by exchanging water regularly, removing impurities, protecting fish from predators and maintaining inlet and outlet pipes up to the end of harvesting period.

Poultry house construction and production

Poultry farming is one of the three major components of the integration. Poultry house construction is one of the main activities for establishing this integrated farm. In both research areas the house having an area of 4m X 3m ($12m^2$), partitioned into two classes were constructed using locally prepared raw materials. The first class, half part of the house, 4m X 1.50m, was open to air enclosed by mesh wire around the poles and hanging over the pond while the second half part with sealed wall footing on the ground (Figure 1). The hanging class was used for the poultry to stay during day time where they eat and drink from hanged feeders and watering containers. Bottom of this class supporting the chicken was covered by stronger mesh wire protecting chicken against predators and competitors, allows poultry droppings passing down to the underneath pond water.

The second class of the house footing on the ground serves for resting, night time stay and has nests for egg laying. In this integrated farm 30 pullets of Lohmann Brown breed were purchased from a commercial poultry producing company called Alema and stocked into the house and managed according to the company's recommendation. Commercial feed was provided to the chicken depending on their age, 80-110g pullets feed per day for 9-20 weeks pullet and 110-120g layers feed per day for the layers above 20weeks of age. All management including regular provision of feed and water, egg collection and health care were accomplished according to the recommendation of the company.

Vegetable production

Horticulture is the third component of the integrated farm. The plot selected for onion plantation was unfortunately degraded fallow plot. An area of $260m^2$and $150m^2$were cleared, ploughed .and prepared for plantation in East Wollega and Buno Badele zone respectively. Before transplanting the seedlings of vegetable to the site, the plots were flood irrigated twice by water coming out of the fish pond in order to enhance the fertility of the plot. Onion (*Allium cepa*) variety called "Adama red" was used in the integration based on its higher market demand, higher yielding performance and better adaptation to the site was planted at wayu Tuka East Wollega Zone. Whereas improved varieties of onion, cabbage and Tomato were planted at Chora district of Buno Bedele Zone with size of 5x10 m for each crop.

Seedlings of the onion, cabbage and tomato were transplanted to the plot according to the local farmers' practice, with the recommended spacing. However, chemical fertilizers were not applied to the vegetable at all. Instead, the vegetable plots were irrigated regularly every 5-7 days by the fertile water coming out of the fish pond under the integration. Weed removing and hoeing and all agronomic practice were carried out every 2 weeks at earlier stages and by observing the weed appearance and intensity in later age.

Management of the integrated farm (poultry, fish and horticulture) were carried out by selected individuals from the local farmers after they received training on the component management. Local farmers participated in pond preparation; poultry house construction, land preparation for horticulture, and also attended the theoretical trainings. Besides, farmers attended fish harvesting practice and food preparation from fish on the final demonstration at both selected site.

Method of data collection

Both primary and secondary data were collected. The primary data was collected from the research site during the implementation of the technology. In addition to this, the primary data was collected by oral interview and product record sheet. The secondary data was collected from agricultural offices, related research results, books, journals and CSA.

Method of data analysis

Both qualitative and quantitative methods of data analysis were used. The qualitative data were presented by organized Tables and narrations. The quantitative data were analyzed by using appropriate descriptive statistics like mean and percentages. Financial analysis was also carried out. Data generated from the various sources were presented as tables, figures or graphs.

Fish data for the parameters such as fish growth rate and survival rate (%) are calculated from initial number and weight (g) of stocked fishes, and final number and live-weight (g) of fish using the following formulas.

$$Daily\ Growth\ Rate\ (DGR\ g/day) = \frac{Final\ weight\ (g) - initial\ weight\ (g)}{Expermental\ Days}$$

$$Survival\ Rate\ (\%) = \frac{(Number\ of\ harvested\ fish)}{Number\ of\ stocked\ fish} x100$$

The survival rate of the O. niloticus, C. carpio and C. gariepinus was analyzed from the date of stocking to harvesting, during 381 culturing period at Wayou Tuka district East Wollega and 305 Chora district of Buno Badele Zone.

Results and discussions

Training

Fish-poultry-horticulture integrated farming looks a simple and applicable candidate technology in all potential areas. Initially, awareness was created to the local farmers on the benefit and use of the integrated farming system. Training was given to the beneficiary farmers, Experts and Development Agents on the technology before its implementation in both research areas. The farmers then attended and participated in every activity of the farm during the component preparation; pond, poultry house and horticulture plot preparations. The integrated farm became the communal property of the beneficiary farmers where they learn the practice in the farming

system and use the products for their own consumption and sell but keep every record as data. Besides training FREG member, DAs and experts participated on regular pre-scaling up of Fish-Poultry-Horticulture farming system.

The training covered for the total of 111 farmers, 16 development agents (DAs) and 21 fishery experts from selected districts in East Wollega zone and Buno Bedele Zone on current status of fishery production with special focus to aquaculture development, criteria to be considered during site selection for aquaculture, pond design and construction, poultry house and vegetable land preparation, fish and pond management. In addition to this, trainings were given on how to harvest fish from pond, and how to process gutted and filleted fish and how to prepare food from fish in the form of soup, fried and boiled fish. Extension agent and participant fishermen disseminate information shared from training to non-participant fishermen. Participatory training method was followed during implementation of training program for sharing knowledge's, skills and experience on integrated farm.

Generally, subsequent trainings were given for the beneficiaries at each stage of production starting from the farm preparation up to the harvest and consumption of the products.

Table 1: Training participants on integrated fish-poultry-horticulture farming system

Year G.C	Site	Farmers		Development Agent		Experts		Total
		Male	Female	Male	Female	Male	Female	
2016-2017	Wayou Tuka District of East Wollega Zone	40	18	6	2	4	0	70
2017-2018	Chora District of Buno Badele Zone	44	9	6	2	15	2	78
	Total	84	27	12	4	19	2	148

Source: Own results, 2016-2018/19.

Field day

Field day was jointly organized in collaboration with Zone and Districts level Livestock and Fishery offices. Farmers, experts and development Agents participated on field day to create opportunities for stakeholders to see and learn from the demonstration promotions and evaluation the performance of technology and to get farmers feedback for better improvement. In two research site a total of 249 participants participated on field day. At each site one FREG having a members from 12-18 farmers and a total of two FREGs were established to popularize the technology.

Table 2: Participants of mini field day in four years

Year	Site	Farmers	*Das*	Experts	Researcher	Total participant
2015	Wayu Tuka district of East Wollega	49	*2*	8	2	61
2018	Chora district of Buno Badele	112	*20*	53	3	188
Total		161	22	61	5	249

Source: Own results, 2016-2018/19.

Brief explanation was given for the participants at each site on the objective of integrated farming system. Members of FREGs and non FREG members participated and evaluated the technology during the study periods. On the field work Fishermen, Administrators, Researchers, Experts, Development Agents and other stakeholders were invited to give feedbacks. All participants gave a positive response about the technology at each site.

Fish Production

In both research areas there were three fish species, the Nile tilapia (Oreochromis niloticus), African catfish (Clarias gariepinus) and common carp (Cyprinus carpio) stocked into one pond as a poly culture under the integration system. In Wayu Tuka district the number at stocking were 240 tilapia, 32 catfish and 18 carps into a pond area of 150m^2 making a total fish density of 1.93fish/m2. The sizes of the fish at stocking were 29.13g, 44.69g and 53.86g for the tilapia, catfish and carp, respectively (Table 3). At Chora district of Buno Badele Zone the number at stocking were 315 tilapia, 120 catfish and 28 carps into a pond area of 225m^2 making a total fish density of 2.06fish/m^2. The sizes of the fish at stocking were 8.5g, 7.95g and 28.3g for the tilapia, catfish and carp, respectively (Table 3). In pond there is no supplementary feed was provided to the fish under integration throughout the culturing period. The fish was feeding upon the planktons and other organisms harbored in the integrated pond by the aid of poultry waste (Endabu *et al.*, 2016). Waste recycling in the integration system was the nobel idea concept. Poultry waste is either eaten directly by fish or fertilizes pond water to support the plankton community used by fish as natural organic feed (Endabu*et al.*, 2016). Nutrient rich water from fish pond is used to grow horticulture being an organic fertilizer (Hirpo, 2017) and by-products from horticulture and fish offal being used as poultry feed to complete the loop in recycling.

At the end of the trial in 381 days, the Nile Tilapia - attained a mean body weight of 275.3 with mean daily growth rate of (DGR) 0.65g.day-1 in case of Wayu Tuka district. While in case of Chora district at the end of 305 days average body weight and daily growth rate (DGR) were 176.61g and 0.55g/day, respectively (Table 3). Different results on tilapia growth performance were reported by many authors. Negisho et al. [10] reported DGR of 0.57±0.01g with supplementary feed, which was less than the present study. In our current trial, the fish were depending on the recycling waste in the integration with minimal cost without providing any

supplementary feed and chemical fertilizer. The fish growth rate in this trial (0.65g/day) and (0.55g/day) is close to the previous result of DGR 0.75g.d-1 reported by Endebu, et al. (2016) in the integrated ponds.

C. gariepinus and C. carpio attained mean body weight of 1283.6 with DGR of 3.25g/d and 1305.7 with DGR of 4.01g/d in 381 days, respectively. Whereas at Chora district C. gariepinus and C. carpio attained mean body weight of 552 with DGR of 1.62g/d and 389.6g with DGR of 1.25g/d in 305 days, respectively. The DGR of 4.01g/d attained by C. carpio in this trial was relatively on a better level compared to the 1.7g/d reported by Endebu et.al.(2016) in fish-poultry integrated farm. The difference was attributed perhaps due to higher initial weight and longer culture period in the current trial. The current result recorded for the DGR of carp is comparable with 4.04g.d-1 reported by Abdelghany and Ahmad (2002). Integration of poultry with fish farm enhances plankton's production and productivity in the ponds for the fish feed thereby increased fish productivity in ponds. Supplementary feed was not provided for the fishes cultured in the pond integrated with poultry throughout the culture period. The fishes used the phytoplankton, zooplankton, direct feeding of poultry manure and spilled off poultry feed. The survival rates of the fishes, O. niloticus, C. gariepinus and C. carpio were 98.75%, 100% and 72.22%, respectively in case of Wayu Tuka district. Whereas in case of Chora district survival rates of the fishes, O. niloticus, C. gariepinus and C. carpio were 95.24, 92.85 and 96.67, respectively. Generally, a total of 123 and 112.5 kg fish were produced in the trial pond during the culture period at calculated yield rate of 8 and 12.84 tonnes of fish per hector per year in case of Wayu Tuka and Chora districts, respectively. The contribution of fish as a protein source in securing nutritional balance of small-scale farmers is valued.

Table 3: Summary of fish data in the integration at selected site

Wayu Tuka district of East Wollega Zone				
Parameters	O. niloticus (N.Tilapia)	C. gariepinus (African catfish)	C. carpio (Common Carp)	Total
Number stocked	240	32	18	290
Average weight at stocking (g/fish)	29.13	44.69	53.86	32.38
Culture period	381	381	312	-
Average weight at harvest (g/fish)	275.3	1283.6	1305.7	-
DGR ($g.d^{-1}$)	0.65	3.25	4.01	-
Number harvested	237	32	13	282
Survival rate (%)	98.75	100	72.2	97.2
Actual Yield/pond/culture periods (kg/pond)	65.25	41.08	16.97	123
Converted yield/ha/yr (kg)	4,167	2,623	1,323	8,113

Chora district of Buno Badele Zone				
Number stocked	315	28	120	463
Average weight at stocking (g/fish)	8.5	28.3	7.95	-
Culture period	305	305	305	-
Average weight at harvest (g/fish)	176.61	552	389.6	-
DGR ($g.d^{-1}$)	0.55	1.62	1.25	-
Number harvested	300	26	116	442
Survival rate (%)	95.24	92.85	96.67	95.46
Actual Yield/pond/culture periods(kg)	52.98	14.35	45.19	112.52
Converted yield/ha/yr (kg)	2817.88	7619.13	2403.54	12840.55

Source: Own computation from data results, 2016-2018/19.

Egg Production

The Lohmann brown pullets in the integrated farm started laying eggs two months after stocking in June 2016, at age of 22 weeks at Wayu Tuka district. After the egg production reached the peak in August 2016, it gradually decreased associated with age factor (Fig. 4a). This result was similar to the result reported by (Hirpo, 2017). The production of egg decreases in later ages and becomes uneconomical after chickens reach the age of 18 months due to change in their physiology. Some irregularities and decline in egg production observed when the chicken was fed with homemade cracked grains during shortage of commercial feed supply. Availability of commercial feed for poultry at rural areas was limited that the government has to support feed producers to avail the feed at all areas demanding the feed. Generally, 7,005 eggs were collected from the 30 layers in 12 months (Fig. 4a).

The collected eggs were sold by the beneficiary farmers to the local people at price rate of 2.75 Birr per egg. The contribution of eggs as a protein source for the local people and the income from the selling to the beneficiary farmers are also valued. In case of Chora district Lohmann brown pullets in the integrated farm started laying eggs after eleven week after stocking in January 2018. As indicated Figure 4b, the production of egg fluctuation was observed when the chicken was fed different source of commercial feed. Commercial feed supplied by Genesis L.P.C so poor compared to Alema poultry fed supplier. During August and September 2018 egg production were decreased due to usage of homemade cracked grains as a chicken fed during those months due to budget shortage to purchase of commercial feed supply. Generally, 2,811 eggs were collected from the 30 layers in 12 months (Figure 4b). The collected eggs were sold by the beneficiary farmers to the local people at price rate of 3.78 ETB per egg at Chora district.

Figure 3(a, b): Average egg production per hen per month in the integration farm

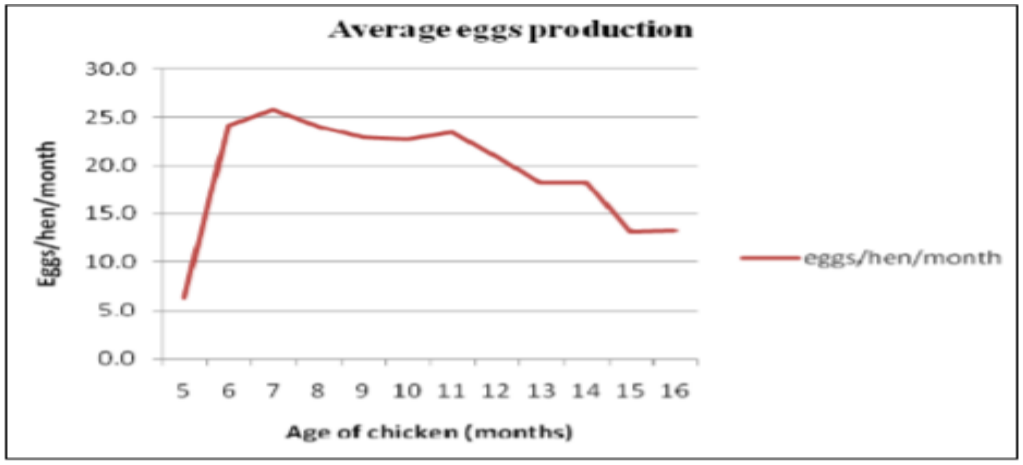
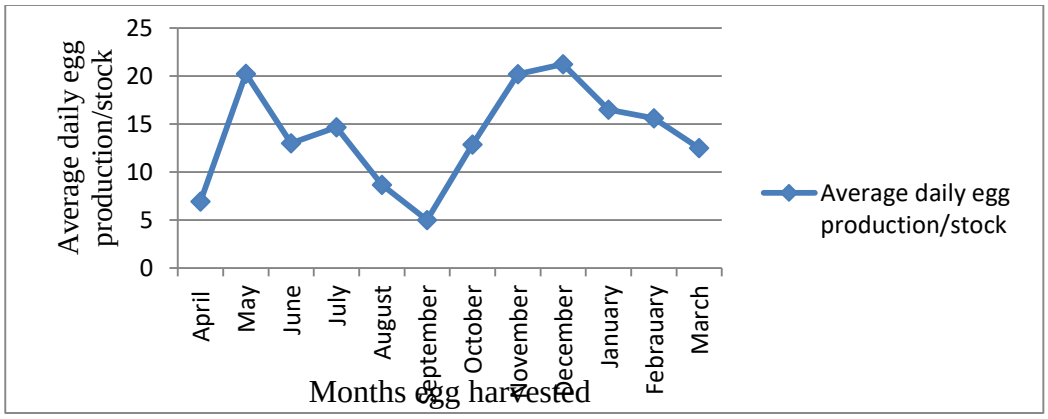


Fig 3: Average egg production per hen per month in the integration farm

(a)



(b)

Source : Own compution from data results,2016-2018/19.

Vegetable production

Adama red onion (Allium cepa) was grown in the plot (260m^2) and obtain 281kg from plot, estimated to 10,800kg/ha when extrapolated to hectare base at Wayu Tuka district. The obtained yield was ranked to a better production level when compared to the yield obtained using chemical fertilizers in some previous trials in Ethiopia (Desaleng and Aklilu, 2003)

In case of Chora district Adama red onion, tomato and cabbage were grown in the plot of each (50m^2) and yield obtained were 52, 29.5 and 10 kg, respectively. When converted to hectare yield obtained from onion, tomato and cabbage were 10,400, 5,900 and 2,000 kg respectively.

The advantage of having horticulture component in the integration can be seen as alternative way of vegetable production for home consumption and also as a source of income, minimizing input cost and environmental pollution. The vegetable crops yield were obtained by using waste water

from fish pond without purchasing the chemical fertilizer, which minimized input cost in the production system. The system also minimized environmental pollution caused by waste from poultry farm and fish pond, rather recycled the waste to produce food.

Partial budget analysis

Simple calculation was made to know the economic feasibility of the integrated farm comparing input costs against outputs in money value. Labor costs were estimated depending on local wage payment to workers. The poultry house and fish pond construction works were done by beneficiary farmers while they participate in all stages of the technology implementation, but the value was estimated in terms of money (Table 4). Depreciation values of the poultry house and fish pond were considered in production costs. The products from the integration were used for local consumption after they were estimated in terms of money. Revenue generated from the selling of eggs, fish and Vegetable (Table 4) was used. The hens and equipment's were also estimated for their current value in terms of money at the end of the trial for financial analysis.

As depicted in Table 4, integrated farming system, the total estimated cost of production in the fish, poultry and vegetable components were 2,470ETB, 14,030ETB and 1,290ETB, respectively with a total estimated production cost of 17,794ETB at Wayu Tuka district. The revenue obtained from all harvested fish was estimated to 7,050ETB while the revenue generated from poultry and onion production was 21,483.75 and 2,240ETB, respectively. A total of 30,774 ETB was generated as revenue. The profit obtained from the three components sum up to **12,984**ETB per season (Table 3).

Table 4: Partial economic analysis of fish, egg and onion production in Wayou Tuka district of East Wollega Zone

Fish			
Production cost	Amount(ETB)	Revenue generated from fish	Amount(ETB))
Fingerling purchase (variable)	870	Fish selling 25-birr x282	7,050
Estimated labor cost	600		
Annual fishing net depreciation	300		
Annual pond depreciation cost	400		
Opportunity cost of land (rent)	300		
Total cost in fish component	2470	Total profit (revenue-cost)	4,580
Poultry			
Production cost	Amount(ETB)	Revenue generate from poultry	Amount(ETB)
Pullets purchasing	2700	Revenue from egg production	19,263.75
Poultry feed purchase	8000	Estimated value of poultry at the end of the research	2,100
Poultry feeders and equipment's	480	Estimated value of equipment's	120
Estimated labor cost	1800		
Poultry house depreciation	800	Total revenue from poultry	21,483.75

cost			
opportunity cost of land(rent)	250		
Total cost in poultry	14,030	Total profit (revenue-cost)	7453.75
Vegetable			
Production cost	Amount(ETB)	Revenue generated	Amount(ETB))
Estimated cost for land preparation, weeding	600	Selling of onion (280*8ETB)	2,240
Purchased of onion seedling	400		
Purchased of pesticide	90		
Opportunity cost of land	200		
Total cost for vegetable production	1290	Profit from this component	950
Total cost of production	17790	Total revenue	30,774
Total profit in the system			12,984

Source: own computation from data, 2015-2018/19.

Similarly, in Buno Badele Zone, Chora district, Tulu Mute Peasant Association the economic feasibility of the integrated farm was calculated by comparing input costs against outputs in money value. The total estimated cost of production in the fish, poultry and vegetable components was 3,676ETB, 16,650ETB and 1,350ETB, respectively with a total estimated production cost of 21,376ETB. The revenue obtained from all harvested fish was estimated to 11,794ETB while the revenue generated from poultry and vegetable production was 18,245.58 and 1,422.5ETB, respectively. A total of 42,228ETB was generated as revenue. The highest profit was obtained from fish and egg production. The profit obtained from the three components sum up to **20,392** ETB (Table 4).

Table 4: Partial budget analysis of fish, egg and vegetable production in Chora district of Buno Badele Zone

Fish			
Production cost	Amount (ETB)	Revenue generated from fish	Amount(ETB)
Fingerling purchase (variable)	926	Fish selling 35-birr x442	22,100
Estimated labor cost	1000		
Annual fishing net depreciation	700		
Annual pond depreciation cost	700	Total profit (revenue-cost)	11,794
Opportunity cost of land	300		
Total cost in fish component	3676		
Poultry			
Production cost	Amount(ETB)	Revenue generate from poultry	Amount(ETB)
Pullets purchasing	3150	Revenue from egg production	10,625.58
Poultry feed purchase	10,000	Estimated value of poultry at the end of the research	7500
Poultry feeders and equipment's	500	Estimated value of equipment's	120

Estimated labor cost	2000	Total revenue from poultry	18,245.58
Poultry house depreciation	1000		
Opportunity cost of land	250	Total profit (revenue-cost)	1,595.58
Total cost in poultry	16,900		
Vegetable			
Production cost	Amount(ETB))	Revenue generated	Amount(ETB))
Estimated cost for land preparation, weeding and harvesting	350	Selling of vegetable(onion, tomato and cabbage respectively) (52*15+29.5*15+10*20ETB)	1,422.5
Purchased of seed vegetable	400		
Purchased of pesticide	300		
Opportunity cost of land	300		
Total cost for vegetable production	1350	Profit in vegetable	72.5
Total cost	21,376	Total Revenue	42,228
Total profit from the system			20,392

Source: Own computation from data results, 2017-2018/19.

In both research areas total land area occupied by the integration system was less than 500m^2 (0.05ha). This plot, according to information from the local farmers on their practice, can yield 250-500kg maize per year, which is estimated to a total amount in money of 1250-2,500ETB at current price. Though the farmers do not consider the labor of land preparation, cultivation, weeding and harvesting as a cost, it can be estimated to 1200ETB to produce maize in the plot. The profit farmers expect from that small plot of land according to their traditional practice do not exceed 1,300ETB per year under conducive weather conditions. This traditional way of production is efficient (about 52% return on their initial investment) but produce little product per unit area and risky as it depends on natural rain.

The integration of fish, poultry and horticulture farming is also promising technology to generate income for household on a small plot of land having access to water source. The technology was finally demonstrated to the local community and government officials at different administrative levels. The beneficiary farmers, local communities and administrative bodies understood the benefits of the integrated farming system in terms of its sustainability, contribution to income generation, poverty reduction, easiness of the farm to be managed by women, children, handicapped and old people. It was finally accepted as a technology to be scale out in all potential areas.

Farmers' feedback

Among 25 farmers respondents interviewed at Wayou Tuka district 96%, 92%, 72%, 72% and 88% had respond that integrated farm is effective due to need low cost, good for income generation and food security, time effective, easily managed and implemented and allow to utilize land and wastes efficiently, respectively(Table 5). In case of Chora district from total 22 farmers interviewed 54.55%, 90.91%, 68.18%, 45.45% and 95.45% had respond that integrated

farm is effective due to need low cost, good for income generation and food security, time effective, easily managed and implemented and allow to utilize land and wastes efficiently, respectively.

Table 3: Farmers feedback on the technology

Parameter	East Wollega(N=25)			Buno Bedele (N=22)		
	Item	Frequency	Percentage	Item	Frequency	Percentage
Low cost for establishment	Yes	24	96	Yes	12	54.55
	No	1	4	No	10	45.45
Good for income generation and food security	Yes	23	92	Yes	20	90.91
	No	2	8	No	2	9.10
Time effective	Yes	18	72	Yes	15	68.18
	No	7	28	No	7	31.82
Easily managed and implemented	Yes	21	72	Yes	10	45.45
	No	4	16	No	12	54.55
Efficiently utilized Land and wastes	Yes	22	88	Yes	21	95.45
	No	3	12	No	1	4.55

Source: Own results, 2015-2018/19.

In general, the result of assessment feedback revealed that integrated technology was highly preferred by farmers in the study area as the technology is not complicated, use locally available raw material and easy to implement. After pre-scaling up, the wider scaling up/out activities will be owned and huddled by respective Zones and districts office of livestock development in collaboration with different key actors in the area with close supervision by Batu Fish and Other Aquatic Life Research center.

Conclusions and recommendations

In the integrated poultry-fish-vegetable farming system, waste from one component is used as input for the other component in the system to produce income and food for people. The system worked at the around the same site with all the components (poultry, fish and vegetable) delivering the expected products at lower costs of inputs on relatively small plot of land as compared to the traditional farming system. Products obtained from the integration diversified the farmers' that help to generate income and used for consumption. Moreover, the system is cost effective and efficient enough to make money at small scale farmers' level on relatively small plot of land. The technology is also a very good resilience approach to produce sustainable food for victimized farmers of climate change in areas having access to water sources.

As the fish culture in general and the integration system in particular is new practice in Ethiopia, attention should be given by local administrative bodies, regional and federal governments and concerned institutions to extend the technology into potential areas. Generally, since integrated

farm technology have positive feedback from farmers and economically feasible in the study area, we recommend to Livestock and fishery offices at Districts and Zonal level in collaboration with other stakeholder should work on the wider scaling up of this technology.

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Pre-extension Demonstration and Evaluation of Fababean Varieties in Eastern Hararghe, Jarso and Kersa districts

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Abstract

The study was conducted at Jarso and Kersa districts of East Hararghe Zone. Introducing improved technologies fababean (Hachalu and Dosha) varieties are an option and have great advantages for the producers to minimize risks associated with it and maximizes their benefits. The activity was undertaken for the consecutive two yeras (2017-2018) of main crop season. In the process, a mutual learning among farmers, as well as among researchers and developments has been enhanced. As a result, fababean varieties have been demonstrated among FRG (Farmer Research Group) members. The result indicated that demonstrations of improved fababean variety of Dosha and Hachalu recorded similar grain yield (28.6 qt/ha) and (27.2 qt/ha) at afgug and 21.6qt/ha and 21.1qt/ha at Tola respectively. Awareness on advantage of fababean technology of farmers was increased through promotion of this technology. Therefore, both varieties were recommended for more promotion in the area and other similar agro-ecologies

Key Words: Fababean, Demonstration, FRGs , Dosha and Hacalu

Introduction

Faba bean (*Vicia faba* L.) is also referred to as broad bean, horse bean and field bean and it is the fourth most important pulse crop in the world (Sainte, 2011).Faba beans, one of the oldest domesticated food legumes have been cultivated for at least 5,000 years. According to the United Nations Food and Agriculture Organization (FAO, 2014), China is currently the world's leading producer, accounting for approximately 60% of the total. Fababean is an annual herbaceous plant with coarse hollow stems that can reach heights of two meters. It has large pinnate leaves, consisting of two to six leaflets.

Faba bean ranks first in pulse crop in the total area coverage and the total production of Ethiopia. It accounts about 36% of the country's pulse production (IFPRI, 2010). The crop has a multipurpose use and is consumed as dry seeds, green vegetable, or as processed food. Its products are a rich source of high-quality protein in the human diet, while its dry seeds, green haulm and dry straw are used as animal feeds (Sainte, 2011). Faba bean seeds are used for human nutrition. The grain of faba bean contains a high protein content of 24-33% (Winch,

2006).Due to its nitrogen fixing capacity, it is used in crop rotation with important cereal crops like wheat, teff, barley and other crops (IFPRI, 2010).Crop rotations which include faba bean in sequence with winter cereals and summer cereals, or cotton, are more productive and profitable than those in which legume phases are excluded. The benefits arise because yields and quality of cereal grain and cotton fiber are usually higher after faba bean. Nitrogen fixation in the root system of the faba bean makes more soil N available to the next crop, reducing the need for fertiliser-N, and in some cases adding to soil organic N.

It is known that East Hararghe is predominated by cereal crops (particularly sorghum and rarely maize) production and chat. This monoculture makes the soil degradation and erosion. Rotation of cereals with legume crops is not practiced. Although faba bean rarely grown on small scale lands around highlands of East Hararghe zone. The faba bean in the hands of farmers is unknown sources and inferior agronomic quality and low yield. Therefore, it is very important to demonstrate improved varieties for their wider promotion to highlands of East Hararghe areas with the objective of pre-extension demonstration of improved faba bean varieties (disease resistant and high yielder) for their wider promotion in the study areas.

Objectives of the study

- ✓ To evaluate the productivity of technology under farmers condition.
- ✓ To create awareness on improved fababean varieties production technologies.
- ✓ To build farmers' knowledge and skill of production and management of the technology
- ✓ To strengthen linkage among stakeholders

Methodology

Description of the study area

Kersa is one of the woredas in the East Hararghe Zone of the Oromia Region of Ethiopia. It is named after a river that flows through it, the Kersa. The woreda is bordered on the south by Bedeno, on the west by Meta, on the north by Dire Dawa, on the northeast by Haro Maya, and on the southeast by Kurfa Chele. The administrative center of the woreda is Kersa; other towns include Lange. The altitude of this woreda ranges from 1400 to 3200 meters above sea level. Rivers include the Weter, Lange and Goro; other bodies of water include the seasonal Lake Adele. A survey of the land in Kersa (released in 2017) shows that 42.3 % is arable or cultivable, 1.4 % pasture, 4.3 % forest, and the remaining 52.3% is considered built-up, degraded or otherwise unusable. Khat, fruits and vegetables are important cash crops. Coffee is also an important cash crop; over 50 square kilometers are planted with this crop.

Jarso is bordered on the south by the Harari Region, on the west by Kombolcha, on the north by the city of Dire Dawa, on the east by the Somali Region, and on the southeast by Gursum. The administrative center of this woreda is Ejersa Goro. The altitude of this woreda ranges from 1050 to 3030 meters above sea level; Mount Gara Sirirta, Aybera, Kilisa and Bekekalu are amongst the highest peaks. Rivers include the Gideya. A survey of the land in Jarso (reported in 2017)

shows that 26.3% is arable or cultivable, 1.3% pasture, 15.7 % forest, and the remaining 56.7% is considered degraded or otherwise unusable. Khat, fruits and vegetables are important cash crops.

Site and farmers selection

The activity was conducted in selected district of East Hararghe Zone for the consecutive two years of the cropping season. Jarso and Karsa district were selected based on potentiality of pulse and oil crop production and accessibility for close monitoring. Also from selected districts, two representative potential kebeles were selected purposively in collaboration with Experts and Development Agents of Office of Agriculture and Natural resource based on accessibility and potentiality for pulse and oil crop production.

From each kebeles, 2FRG (Farmer Research Group) member considering gender and youth consists of 15 farmers were established. Member of FRG farmers were selected based on; their interest on technology, willingness to cost sharing like land provision, labor work and willingness innovative experience sharing for the members as well as non-members of target farmers. In Each FRG member; ten representative trial farmers from each kebele were selected. Moreover, 1 FTC (Farmer Training Center) in each kebeles was involved in technology promotion.

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

District	PAs	No. of trial farmers	FTCs	Area covered
Jarso	Afgug	10	1	10mx10m for each experiment plots
Karsa	Tola	10	**1**	
Total		20	2	

Source: Own computation 2017/18

Technology evaluation and demonstration methods/technique

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

Research Design

Two improved varieties of fababean (Dosha and Hachalu) and one local check were replicated across ten trial farmers per kebeles. Two improved and one local check were sown on 20 farmers land. Simple plot designs (10m*10m) of land from individual trial farmer for each experiments/ varieties were used. Spacing 40cm*20cm (Between row and plant) respectively. Ten trial farmers per kebele's were used as replication of the varieties. Seed rate134 kg/ha and fertilizer rate DAP 100kg/ha and no need of Urea.

Method of Data Collection

Both quantitative and qualitative data were collected through personal field observation, individual interview by using checklist and data sheet .Quantitative data such as number of farmers participated, yield performance, number of stakeholders participated in training and field days were collected. Qualitative data such as farmers' feedback and perception toward the new technology were also collected.

Data analysis

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

Results and Discussion

Training provided to farmers, DAs and experts

Training is the most important component of extension approach. The training was given to farmers, DAs and district experts by multidisciplinary team of researchers on improved fababean production, market information and technology transfer approaches. Among the training participants, 83.3% were farmers of which 26.7% were female farmers.

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

		Jarso		
No.	Participants	Male	Female	Total
1	Farmers	22	8	30
2	DAs	3	0	3
3	District experts	2	1	3
	Total	27	9	36

Source: Own computation 2017/18

Mini-Field day organized

During mini- field days and farm visit, different questions, opinions and suggestion were raised and reacted from the concerned bodies. Different extension materials (60 leaflets and 35 small manuals) prepared in Afaan Oromoo and English languages were distributed for the participants. Most farmers showed high interest towards improved fababean technology production because of better grain yield and earned better income by selling seeds for different stakeholders (neighbors' farmers and Non-Government Organizations) as compared to the local seeds. Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Table 2: Type of profession and number of participants on the mini-field day at Jarso

No.	Participants	Jarso		
		Male	Female	Total
1	Farmers	47	27	64
2	DAs	8	0	8
3	District experts	9	2	11
	Total	64	29	93

Source: Own computation 2017/18

Agronomic and Yield performance

The performances of the fababean varieties during their growing season were collected and analyzed. The result showed that grain yield of fababean Dosha, Hacalu and local ranges from 28.6,27.2 and 16.98 at Afgug PA respectively. Hacalu variety gave high grain yield (21.6 qt/ha) followed by Dosha (21.1 qt/ha) and local check (13.20 qt/ha) at Tola PA. Both improved varieties used for the experiment showed better mean grain yield at both districts.Dosha and Hacalu varieties showed statistically significant yield difference at 1% probability level at both location over local check but no significant yield difference between two improved varieties was observed

Table: Yield performance of early maturing Fababean varieties across districts.

PA	Varieties	Mean	Maximum	Minimum
Afgug	Dosha	28.6	30	24.2
	Hacalu	27.2	30	22.4
	Local	16.98	18.3	15.5
Tola	Dosha	21.1	23.7	13.5
	Hacalu	21.6	22.4	20
	Local	13.2	14.1	12
Total	Dosha	24.9	30	13.5
	Hacalu	24.4	30	20
	Local	15.1	15.1	12.6

Yield advantage of demonstrated varieties the local check

The yield advantage of Dosha and Hacalu varieties over the local check was calculated and presented in table 4 below. According to the result, Dosha variety had 64.9 % yield advantage over the local check while Hacalu had 61.58 % Hacalu yield advantage over the local check. This showed that improved fababean varieties had advantages over the local check.

Table 4: Yield advantage of demonstrated varieties the local check

Varieties	Average yield qt/ha	Yield difference	Yield advantage over the local check (%)
Dosha	24.9	9.8	64.9
Hacalu	24.4	9.3	61.58
Local check	15.10	-	-

Source: Own computation 2017/18

Farmers' Opinion/Perception

Farmers' selection of the best performing improved fababean varieties. Farmers selected the varieties based on the criteria like Maturity, grain yield, disease tolerance, pod number, Seed per pod, seed size. Based on the above criteria; farmers evaluated the varieties and ranked Dosha first and followed by Hacalu variety.

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

Crop varieties	Farmers rank	Reasons
Dosha	1st	Maturity, High grain yield, Good disease tolerance, Pod per plant, Seed per pod Performance at growing stage and Large seed size
Hacalu	2nd	Maturity, High grain yield, Disease tolerance, Pod per plant, Seed per pod, Performance at growing stage and Large seed size
Local check	3rd	Maturity, Low grain yield, Disease tolerance, Pod per plant, Seed per pod, Performance at growing stage and Small seed size

Conclusions and Recommendations

From the result of the study, Dosha variety had 64.9 % and Hacalu had 61.58% more yield advantage over the local variety. Moreover, Dosha variety was ranked as first in variety rankings. Therefore, Dosha variety was recommended for further scaling up and popularization in the study area and similar agro ecology.

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Pre-Extension Demonstration and Evaluation of Improved Hot pepper Varieties in Eastern Haraghe Zone, Babile District

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Abstract

The study was conducted at Gursum District of East Hararghe Zone. The objectives of this activity were to demonstrate and evaluate the productivity of adapted, high yielding hot pepper varieties on farmers' field at the target areas. The activity was undertaken for two consecutive years (2017-2018) of main cropping season. A total of 30 farmers were involved. Two improved hot pepper (Mareko fana and Melka awaze) and local check varieties were used on plot size of 10mx10m for. The targert farmers, Dvelopment Agents and Experts of the districts were trained before starting the activity. Awareness creation was done through different extesion approaches and extension materials (Field day, Field visit, manuals and leaflet).The result showed that Marako fana variety gave high grain yield (23.73 qt/ha) followed by Melka awaze (22.82 qt/ha) and local check (15.38 qt/ha). The result obtained from demonstration plot was very encouraging. Moreover, the varieties were identified and ranked based on the criteria set by farmers (Early maturity, yield, Disease tolerance, pod size, pod diameter. As a result, both Mareko fana and Melka Awaze varieties were recommended for more promotion in the area and other similar agro-ecology.

Key Words: Hot pepper, FRGs, Demonstration, Marekofana and Melka awaze

Introduction

Vegetables are sources of vitamins, minerals and income for those involved in production and marketing. Having first-hand information about vegetable production and marketing system is essential to devise appropriate strategies aimed at enhancing vegetable extension development.
Commercial vegetable production is concentrated in the Rift Valley areas of Ethiopia, primarily due to availability of irrigation facility, accessibility and closeness to agro-processing industries

(Alemayehu et al., 2010).Hot pepper is one of the major vegetable crops produced in Ethiopia and the country is one of a few developing countries that have been producing paprika and *capsicum* oleoresins for export market. Because of its wide use in a diet, the hot pepper is an important traditional crop mainly valued for its pungency and color. The crop is also one of the important spices that serve as the source of income for smallholder producers in many parts of rural Ethiopia.

According to the EEPA (2003), in the major pepper producing regions in the country, that is, Oromia, Southern Nations and Nationality People's Regional State (SNNP) and Amhara, pepper generated an income of 122.80 million Birr for farmers' in2000/01. In Ethiopia particularly in western Oromia, Hot Pepper **(***Capsicum annum***)** grows in well drained, fertile silt loam or sandy loam texture, warm and humid weather conditions and the best fruit is obtained with Rainfall 900-1300 mm. It is extensively grown in most parts of the country, with the major production areas concentrated at altitude of 1000 to 1800m.s.l. (MoARD, 2009).

Hot pepper adaptation trial was conducted at Fadis agricultural research center in the year 2010 during main season (rain fed) on station. Four improved hot pepper varieties (Melka fana, Melka awaze, Melka zala, andMelka shote and with one local check variety were evaluated for productivity, adaptability and for drought tolerance. Statistically significant variation was observed between varieties for all vegetative parameter except fruit length that shows no significant difference. The parameters were evaluated such as, plant height, average number of main branch per plant, canopy width, average number of pods per plant and stand count at harvest. Among the five varieties on the bases of their productivity, adaptability, resistance/tolerance to pests and diseases and farmer's preference Marako fana and Melka awaze were recommended for further production (FARC, 2010).

The goals of FARC are to alleviate farmers' problem through providing improved and adapting technologies and varieties that perform best with their full package. These varieties were used as standard check for two years and perform well at Fadis. Thus hot pepper varieties are one of contributing factors toward, disseminating demand driven technologies that are high yielding, insect pest tolerant and adaptable varieties with good quality traits and agronomic characters are very crucial. This project aimed Demonstrating and evaluating improved hot pepper varieties at farmers' field there by expanding (scaling up) of the adapted technologies to the end users based. These in turn increase the dissemination of improved hot pepper varieties, increase household income and contribute more to production of the crop that has high market demand.

Objectives of the study

- To evaluate the production and productivity of hot pepper varieties under farmers' management.
- To create awareness on the importance of hot pepper varieties.

- To improve farmers' knowledge and skill of application/use of the hot pepper technology.
- To strengthen linkage among stakeholders

Methodology

Description of the study area

Babile is located on distance of 31 kms from Harar in the direction of county's Eastern part. It is bordered by Gursum in Northern, Fedis in south, sumale region in eastern, Harari region and Fedis in western and Jarso in North West district. Erer ibada and Ibada Gemechu are located on distance of 33 km from Harari region and Erer Ibada located at 09° 10' 41.5'' north of latitude, 042° 15' 27.3'' east of longitude and elevation 1274m a.s.l. The physical property of soil in the study area is sandy loam (majority of the soil in the study area is sandy and equal proportion of silt and clay known as sandy loam).The climatic condition of this area is almost dry land. It has bimodal nature of rain fall. The socio-economic character of the population in the study area depends on subsistence agriculture. These study area are potential for production of horticultural crops both at main (rainy) season and off season (Belg).

Site and farmer selection

The activity was conducted in selected districts of East Hararghe Zone for the consecutive two years of the cropping season. Babile district was selected based on potentiality of hot pepper production and accessibility for close monitoring. Also from selected districts, 1 representative potential kebele was selected purposively in collaboration with Experts and Development Agents of Agriculture Office and Livestock Production based on accessibility and potentiality for hot pepper production. From kebeles, two FRG (Farmer Research Group) members considering gender and youth consists of 15 farmers were established. From selected district, representative potential kebeles, 1 FTC from each kebele and 5 representative trial farmers from two FRG were selected purposively.

Farmers Selection

Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in the form of Farmers Research Group (FRG) with the member of 15 farmers per PAs in consideration of gender issues (women, men and youth). Two FRG were established in the study area a total of 30 farmers were grouped in 2 FRGs. In the FRG 5 farmers (3 male and 2 female) trial farmers and 10 farmers worked with trial farmers.

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

District	PAs	No. of trial farmers	FTCs	Area covered
Babile	Erer	10	1	10mx10m for each plots
Total		10	1	

Source: Own computation 2017/18

Research Design

Two improved treatments (Marako fana and Melka awaze) hot pepper varieties and one local check were planted on adjacent plots and the treatments were replicated on 10 trial farmers. The varities were planted on a plot sized 10m*10m. The recommended spacing of 80cm between rows and 40 Cm between plants, seed rate of 1.2 kg/ha and fertilizer rate of 200 kg/ha DAP and 100 kg/ha Urea was used.

Data Collection

Both quantitative and qualitative data was collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. Types of collected quantitative data were number of farmers participated in FRG, yield performance, number of stakeholders participated in training and field days while qualitative data were farmers' perception toward the new technology, awareness created and farmers' technology selection criteria.

Data analysis

Quantitative data was summarized using simple descriptive statistics (Mean, Frequency and Percentage).While the qualitative data collected using group discussion and field observation and oral histories was analyzed using narrative explanation tools and argument. Finally, data from different sources was triangulated to get reliable information.

Results and Discussion

Agronomic and Yield performance

The performances of the hot pepper varieties during their growing season were recorded and analyzed. The result showed that Marako fana variety gave high grain yield (23.73 qt/ha) followed by Melka awaze (22.82 qt/ha) and local check (15.38 qt/ha). Both improved varieties used for the experiment showed better mean yield and statistically significant yield difference at 5% probability level over local check.

Table 2: Yield performance of early maturing Hot pepper varieties across districts

PA	Varieties	Mean	Maximum	Minimum
Erer	Mareko fana	23.73	24.90	22.80
	Melka awaze	22.82	23.93	21.77
	Local	15.38	16.35	14.39

	Mareko fana	23.73	24.90	22.80
Total	Melka awaze	22.82	23.92	21.77
	Local	15.38	16.35	14.39

Yield advantage of the demonstrated varieties

The yield advantage of Melka Awaze and Mareko fana varieties over the local check was calculated and presented in table 3 below. According to the result, Melka Awaze variety had 54.42 % yield advantage over the local check while Mareko fana had 48.37 % yield advantage over the local check. This showed that the improved hot pepper varieties had advantages over the local check.

Table 3: Yield advantage of the demonstrated varieties

Varieties	Average yield qt/ha	Yield difference	Yield advantage over the local check (%)
Melka Awaze	23.75	18.37	54.42
Mareko fana	22.82	7.44	48.37
Local check	15.38	-	-

Source: Own computation 2017/18

Farmers' Opinion/Perception

Participant farmers have identified variety evaluation and ranking criteria such as fruit yield, fruit length, fruit diameter disease tolerance, fruit number per plant and maturity. Based on the these criteria; farmers evaluated the varieties and ranked Melka Awaze first and ranked Marako fana second.

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

Crop varieties	Farmers rank	Reasons
Melka awaze	1st	Good Fruit yield, medium Fruit length, medium fruit diameter, good disease tolerance, Good fruit number per plant and Early maturing
Marako fana	2nd	Good Fruit yield, Fruit length, high fruit diameter disease tolerance, fruit number per plant and Early maturing
Local check	3rd	Lower Fruit yield, lower Fruit length, Lower fruit diameter disease tolerance, Lower fruit number per plant and late Maturing

Conclusions and Recommendations

Based on this result, it can be concluded that Melka awaze and Marako fana variety has yield advantage 54.42 and 48.37% respectively early maturing and gave higher yield than local variety. However, farmers preferred Melka awaze variety for its are the outstanding, disease tolerance, fruit number, yield and the local one preferred by its repeatable harvesting which leads to high yield per hectare, but with small fruit size. Therefore, Melka awaze was well performed agronomical and was recommended for production by growers in the study area

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Pre-Extension Demonstration and Evaluation of Improved Faba bean (Vicia faba L.) Technology in Selected Districts of Kellem and West Wollega Zones.

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Abstract

This demonstration trial was conducted on farmer's field on area of 100m^2 using participatory approaches in 2017/18 cropping season. Two districts from each zone namely Lalo Asabi and Bodji Dirmaji of West Wollega and Sayo and Anfilo districts of Kellem Wollega Zones were selected in collaboration with experts from office of agriculture at district levels. Two improved varieties of Faba bean (Walki and Hacalu) were sown and evaluated along with a local variety for comparison and selection of best variety using participatory approaches. Accordingly, the combined yield analysis results indicate that walki was the best yielder with yield of 2,051kg/ha followed by Hacalu (1,715kg/ha) and local variety (1,420 kg/ha). The yield advantage ranges from 44.4% (walki variety) to 20.77% (Hacalu variety) over the local variety. In terms of

profitability analysis, Walki variety has shown more net benefit to farmers over Hacalu and Local by 30.2 % and 62.4% respectively. Furthermore, the demonstration incorporated a participatory variety selection. In this participatory approach, participant farmers used different criteria to assess Faba bean varieties sown at the flowering, maturity and harvest stages. Major selection criteria used were grain yield, disease tolerance, seed size, seed color, lodging resistance, and marketability. According to the results, farmers preferred Faba bean variety Walki for its high yielding, lodging tolerance, early maturity and disease tolerance. Generally, farmers mostly preferred variety which provided higher combined yield, disease tolerance, early maturity and tolerance to lodging. Thus, the selected variety (Walki) needs to be multiplied and distributed to farmers in order to improve adoption and varietal diversity.

Key words: *Faba bean, Demonstration, Farmer's Preference, Participation.*

Introduction

Faba bean (*Vicia faba* L.) is grown in temperate and sub-tropical region of the world (Tores et al, 2006). The world foremost producing countries of faba bean are China, Ethiopia, Egypt, and United Kingdom. Ethiopia is the leading producer of faba bean in Africa accounting 56% of the total production (FAOSTAT, 2014).Faba bean is among the most important pulse crop in the highlands and mid-highlands of Ethiopia. It was the first crop among the pulses grown in the country both in terms of area coverage and volume of annual production (CSA, 2016). However, the low-yield potential of the indigenous cultivars is one of the most important production constraints.

As a result, adaptation trial of improved varieties of Faba bean varieties was conducted at on station and sub sites by Haro Sabu Agricultural Research center (HSARC) researchers and recommended two top promising and adaptable faba bean varieties (Walki and Hacalu) for West and Kellem Wollega zones.Thus, this activity was initiated to demonstrate and evaluate this recommended faba bean varieties with participation of farmers using participatory approaches. Such, participatory technology demonstration and evaluations are important to identify the best variety fitting to the local farmers condition. This also helps to have better adoption as the farmers are the key actors for selecting technologies based on their own criteria. Furthermore, testing of improved Faba bean technologies with farmers before further recommendations is paramount important in incorporating farmers' perception in to technology generation processes; which will in turn hasten the adoption rate and dissemination of the technology.

Objectives of the study

- To demonstrate and evaluate the productivity of Faba bean technologies under farmers management conditions
- To analyze the cost and benefits of faba bean production under farmers situation

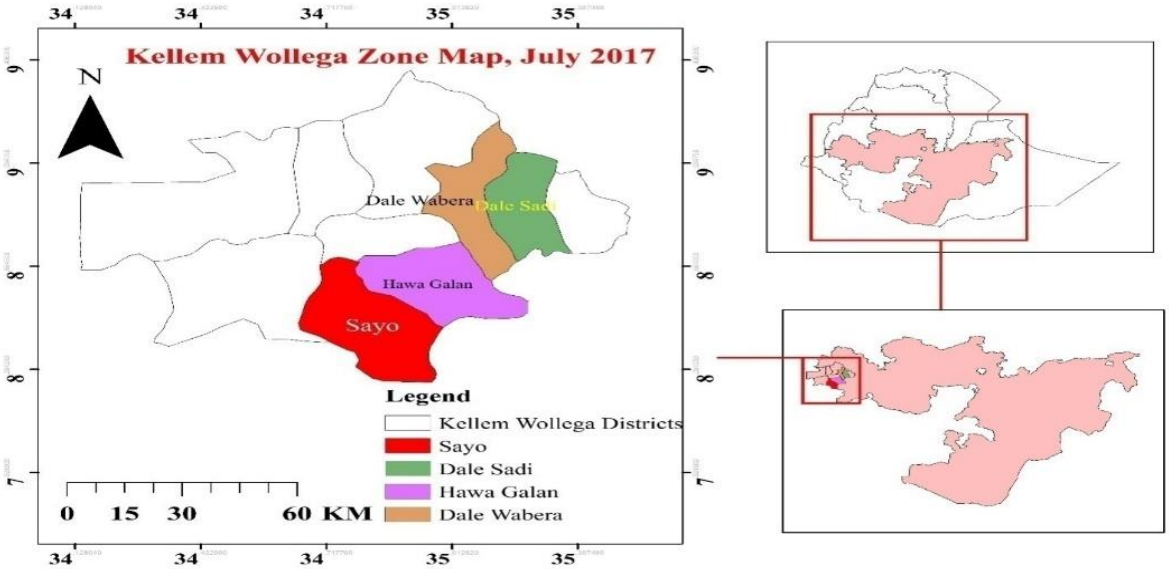
- To strengthen linkage among farmers, researchers, development agents and other stakeholders

Materials and Methods

Description of the study area

Sayo district

Seyo district is located in the south western part of Kellem Wollega Zone & the zonal capital Dambi Dolo was found here (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, Ilubabor Zone in the south east, Hawa Galan &Yemalogi Walal districts in the north and north east and Anfilo district in the west and North West directions. The district has a total area of 127,800 km^2. Generally the district lies within an altitudinal range of 1300-2000 m.a.s.l. The major rainy season in the district include spring (April-May), summer (June-August) and autumn (September-November).



Anfilo district

Anfilo district is located in the western part of Oromia regional state.Mugi is theadministrative center of this district. 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.

Lalo Asabi district

Lalo Asabi is one of the 21 districts of West Wollega Zone. The administrative center of this District is Inango. A survey of the land in Lalo Asabi shows that 80.39% is cultivated or arable, 5.26% pasture, 9.08% forest, and 5.26% infrastructure or other uses. Lalo Asabi is bordered on the south by Yubdo, on the west by Ayra Guliso, on the north by Boji, on the east by the Benishangul-Gumuz Region, and on the southeast by Gimbi.

Boojjii Dirmaji district

Boji dirmaji is one of the woredas in West Wollega Zone and a part of the 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

Two districts, Sayo and Anfilo from Kellam wollega and two districts, Lalo Asabiand Boji dirmaji was selected from west wollega Zone purposively based on Faba bean production potentialand accessibility. From Lalo Asabi and Sayo two representative peasant associations (kebeles) were selected, whereas from Bodgi Dirmaji and Anfilo Woredas one representative peasant association (kebele) was selected. 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, roughing, harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio-economic variables. Thus, a total of six FRG's were organized with 120members among which16 of them were trial farmers (Table 1).

Table 1. Demonstration trial districts and number of participant farmers

No.	District	Kebeles	Num of FRGs	Member of FRGs		Trial farmers		No of FTC's
				Male	Female	Male	Female	
1	Bodji Dirmaji	Gidano King	1	15	5	1	1	1
2	Lalo Asabi	Aroji Serdo	1	14	6	2	1	1
		Garjo Siban	1	14	5	2	1	
3	Sayo	Humbi Karo	1	15	4	3		
		Tabor	1	12	8	1	2	
4	Anfilo	Sudi	1	14	6	2		1
Total			6	84	34	11	5	3

Materials Used

Two improved varieties of Faba bean, namely Walki and Hacalu along with a local check were used for this demonstration trial with full participation of farmers. The recommended fertilizer rate of NPS of 100 Kg/ha was used for this demonstration. During the implementation of the activity the land was ploughed three to four times before sowing, row spacing of 40cm and plant to plant spacing of 10cm were used. During the implementation this activity, no chemical was applied for disease management.

Field Design

The trial was carried out on selected farmer's fields in such a way that two improved varieties and a local check were planted side by side on equal and non replicated plot size of 10 m x 10 m with a gross area of 100 m^2 for each variety. Sowing was done with spacing of 40 cm between rows and 10cm between plants replicated by the number of participant farmers.

Technology Evaluation and Demonstration Methods

Training was given for farmers and other stakeholders and participatory technology evaluation and selection methods were employed to demonstrate and evaluate Faba bean technologies. The technology was evaluated using participatory research approach (PRA) tools like pair wise ranking, focused group discussion & direct matrix ranking

Data Type and Method of Data Analysis

Grain yield, Farmers selection criteria, economic cost and return data and number of stakeholders participated on promotional event like training were objectively measured and analyzed to see the performance of varieties under farmer's management condition. The collected data were analyzed using simple descriptive statistics like mean and presented using tables and graphs and also profitability analysis was used to analyze cost-return data.

Results and Discussion

Training

Before the trial established, orientation trainings on roles and responsibility of farmers, experts and development agent as well as on the importance of FRG approaches was given to 117 farmers out of which 80 of them are male and 27 of them are female and total of Ten (10) DAs out of which five (5) of them are males and Five (5) of them are females.

Table-3: Training given for farmers, DA's and Experts

Districts	Participants	Male	Female	Total
Sayo	Farmers	27	10	37
	DA'S	1	2	3
Lalo Asabi	Farmers	25	8	33
	DA'S	1	2	3
Bodji	Farmers	15	5	20
Dirmaji	DA'S	2	0	2
Anfilo	Farmers	13	4	17
	DA'S	1	1	2
Total		85	32	117

Yield performance of Demonstrated Faba bean varieties

The yield results of the demonstration indicated that Walki variety showed superiority over Hacalu and local varieties. It gave 20.51 Qt/ha followed by Hacalu 17.15qt/ha and Local 14.2qt/ha. The yield advantages of Walki and Hacalu varieties over local were 44.4% and 20.77% respectively. Walki variety consistently shown superiority over Hacalu and Hacalu variety over Local in all study areas with similar management practices applied.

Table 4. Yield performance of demonstrated Faba bean varieties

No	Variety	Mean yield(Qt/ha)	Yield advantage over local
1	Walki	20.51	44.4%
2	Hacalu	17.15	20.77%
3	Local	14.2	-

Source: On Farm Demonstration Data of 2010/11

Participatory Varietal Selection and Preference Ranking

Different stakeholders (mainly farmers, development agents, and agricultural experts) were participated on participatory evaluation and selection. A total of 98 (24 Female and 74male) participant farmers were participated on the process at the crop maturity stage. During participatory varietal selection, there were a few varietal traits that the farmers used to select the variety. Earlier studies by Gurumu (2013) working on common bean and Wondimu (2016) on faba beans reported similar findings of farmers using a combination of a few traits when evaluating new genotypes. 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. Accordingly, they selected criteria such as grain yield, disease tolerance, seed size, seed color, lodging tolerance, marketability (reflection of the combination of preferences) and early maturity of the variety(Table 5). As shown in the table, the most important trait among farmers' criteria was grain yield, followed by lodging tolerance and seed size. Seed color,

disease tolerance and early maturity come respectively as fourth, fifth and six ranks in the selection process of Faba bean varieties.

Based on farmers' most important traits, a follow-up direct voting ranking was also conducted to select among the demonstrated varieties (Table 6). Thus, Walki was selected in the first place followed by Hacalu. The following table describes the result. Generally, farmers preferred and ranked variety Walki as their first choice with the total percentage of 52.9%, Hacalu second with 27.9% and Local third with total percentage of 19.2%.

Table 5. Pair wise ranking of varieties by farmers

Traits	GY	DT	SS	SC	LT	EM	Frequency	Rank
GY	x	GY	GY	GY	GY	GY	5	1
DT		x	SS	SC	LR	DT	1	5
SS			x	SS	LR	SS	3	3
SC				x	LR	SC	2	4
LR					x	SC	4	2
EM						X	0	6

GY=Grain Yield, SC=Seed Color, DT=Disease Tolerance, EM=Early Maturity, SS=Seed Size, LR=Lodging Tolerance.

Table 6. Direct Voting for Ranking Faba Bean Varieties in West and Kellem wellega zones

No	Criteria (N=98)	Farmers Preference and Ranking of Faba Rean Varieties		
		Walki	Hacalu	Local
1	Grain yield	98	0	0
2	Lodging resistance	60	0	38
3	Seed size	0	75	23
4	Seed color	0	89	9
5	Disease tolerance	83	0	15
6	Early Maturity	70	0	28
	Total	311	164	113
	Percentage	52.9%	27.9%	19.2%
	Rank	1	2	3

Financial evaluation

As shown in table 7, the net benefit obtained from Walki is higher with 47,923 ETB followed by Hacalu with net benefit of 36,802 ETB and local 29,509 ETB. Using walki would increase the net benefit of farmers by 30.2 % and 62.4 %_over Hacalu and local variety, respectively. The use of Hacalu would increase the net benefit to farmers by 24.7 %_over local variety.

Table 7. Profitability analysis

Items	Description	Quantity	Variety		
			Walki	Hacalu	Local
Average yield(Qt)		-	20.51	17.15	14.2
Adjusted yield (-10%)			18.46	15.44	12.78
Selling price Qt/birr			3,300	3,300	3,300
Total revenue(gain)			60,918	50,952	42,174
Seed cost		165,200,155 respectively in kg	5,445	6,600	5115
Fertilizer cost in Kg	NPS	100Kg	1600	1600	1600
Land preparation	Oxen/ha		2200	2200	2200
Labor cost per day	Sowing	25(labor)	1250	1250	1250
	Weeding	30(labor)	1500	1500	1500
	Harvesting and transportation	10	1000	1000	1000
Total Cost			12,995	14,150	12665
Net benefit	**TR-TC**		**47,923**	**36,802**	**29,509**

Source own demonstration data

Conclusions and Recommendations

In this on farm demonstration, two varieties of improved Faba bean (Walki and Hacalu) and the local check were demonstrated on the farmers' field. Grain yield, farmer's selection criteria's, economic cost-return data, number of stake holders participated on promotional events were collected and objectively measured and analyzed. The yield performances of varieties were 20.51 qt/ha,17.15qt/ha and 14.2qt/ha for Walki, Hacalu and Local respectively. Farmers used their own selection criteria to prefer and select variety of their choice. Accordingly walki variety was selected as first for its high yielding, Lodging tolerance, Early maturity and disease tolerance with the total percentage of 52.9%. Hacalu variety was the second and the local was third with total percentage of 27.9% and 19.2% respectively.

It is undeniable fact that farmers do have best indigenous knowledge of their environment and farming practice. Thus, demonstration of these Faba bean varieties gave farmers, researchers and agricultural expert's considerable knowledge of Faba bean production in different ways. Farmers were aware on the traits of varieties as well as identified the varieties which fit their demand. Furthermore, participant farmers developed better capacity in identifying best fit varieties and management practices for Faba bean technology while researchers got farmers preference criteria to different traits of Varieties/technologies which will provide the base for future technology generation as well as extension works. Thus, farmers should be given the opportunity to share their experience to other farmers thereby strengthening farmer to farmer extension. Moreover, it will be productive if extension service considers the identified farmers preferences in varietal promotion activity. Generally based on farmer's preference and objectively measured trait Walki variety is recommended for further scaling up/out to similar agro-ecology with that of demonstration districts found in both west and Kellem Wollega zones.

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Pre-scaling up of Ground nut Varieties in Selected Districts of West and Kellem Wollega Zones

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Abstract

The study was conducted in Dale sadi, Dale wabera and Sayo districts of Kellem wollega Zone and Gimbi districts of west Wollega zone for two consecutive production years(2016/17 and 2017/18 G.C) on farmers' field. The objective of the study was to pre-scale up and popularize the best performing and preferred groundnut variety in the study area. The study addressed a total of 90 farmers in the two years of the project life span. From a total of 90 farmers male farmers represented 73 and females 17. During farmers' selection process both female and male farmers had been incorporated so as to avoid gender bias. Training was given for the selected farmers, development agents and Woreda experts about improved groundnut technologies production and management. Full packages of the technologies were provided. Variety Manipinter was planted on plot area of 0.25haon respective farmers' field in the study area. The recommended rate of NPS 100kg/ha and Row planting method with the spacing of 60cm between rows and 10cm between plants were used respectively. To enhance farmer's knowledge on Groundnut, training was given for target community on agronomic practice of Groundnut production. During training a total of 117 target communities were participated on training out of which84 were male and 33 were male. An average production of 14.935 qt/ha and a total of336 qt quintal of groundnut yield was harvested during project life span. Finally, farmers feedback concerning technology was collected and incorporated, accordingly the farmers have observed as the manipinter have relatively high yield, good seed quality (Grain size,color),disease tolerant than previously used varieties. Generally, since it is impossible to address all farmers only by the effort of the centre, Woreda agriculture and natural resource bureau in collaboration with zonal agricultural and natural resource office and input supplying NGO's should hold the turn to scale up the technology in wider scale.

Key words: *-Farmers Feedback, FREG, Groundnut, Pre scaling up, Manipinter*

Introduction

Groundnut (*Archis hypogea*) is one of the most important oil crops grown by small holder farmers. It is an excellent source of oil which thrive under hot, semi-arid conditions and as a legume; groundnuts improve soil fertility by fixing nitrogen. Groundnut is usually grown at altitudes ranging from sea level to 1600 m above sea level. It requires fewer inputs than many

other crops, giving a high return per unit of land, and hence is appropriate for small-scale farmers (Okello *et al* , 2010).

Groundnut is an important food and feed crop, which also serve as a significant source of cash in developing countries that contribute significantly to food security and alleviate poverty (Pande et al., 2003; Upadhyaya et al., 2006). Groundnuts have several uses. In many countries, groundnut cake and haulms (straw stems) are used as livestock feed.

In Ethiopia, groundnut is a high value crop that can be marketed with little processing; however, it is extremely versatile and can be used in a wide range of products. Processed groundnut is used in diversified ways including groundnut butter which is used as spread for bread or biscuits, in cookies, sandwiches, candies and frostings or icings. Moreover, it is also used as a substitute for milk in the preparation of *"maciyato"* during fasting days in Ethiopia. Groundnut is also used to prepare children's food ("fafa") and used daily as roasted "ocholonie" or "Kolo". It is a good source of calcium, iron and vitamins (Aldominantly cultivated cereal crop than other cereal crops by the farmers of these zones. It is a major source of food and an important cash crop for farmers of these zones. However, farmers found in these areas only grow the local varieties. Hence, this may be due to inaccessibility of the farmers to newly released improved groundnut varieties. For this reason, Haro Sabu Agricultural Research Center has evaluated and recommended top performed varieties for demonstration. During the demonstration, Manipinter variety had performed better and recommended for further scaling up. Thus, this pre-scaling up study was conducted following the demonstration trial further popularize and disseminate the technology on large scale.

Objectives

- To disseminate already proved and verified productive groundnut varietyin selected districts of West and Kellem Wollega Zones
- To provide farmers with alternative improved high yielding groundnut varieties
- To increase farmers' income in the project areas

Methodology

Description of the study areas

The trial was carried out during 2016/17and 2017/18 cropping seasons in Dale Wabera, Dale Sedi, Sayo and Gimbi districts in collaboration with District Agricultural and natural resource office. Dale sadi, Dale Wabera and Sayo district are among districts found in kellam wollega zone, whereas Gimbi district is one of districts found in west wollega zone.

Dale Sadi District

Dale sadi is situated at about 552 km West of Addis Ababa. It is bordered by: Illubabor to the South, Dale wabera to the West, Aira to the North and Lalo kile to the East. The area lies between 08°N 25 56 to 08°N 58 05 and 034°E 33 41 to 035°E 28 48 and has average altitude of1150 meters above sea level. The area has temperature range of 33-35°C with more agricultural crops and people in rural of the country. The climatic condition alternates seasons from March to April. The winter dry seasons (November - February) with mean annual rain fall of 1200mm.

Sadi Chanka district

Sadi chanka district is located at a distance about 570 km west of the Ethiopian capital city, and the altitude of the area ranges from 1100 to 1800 m.a.s.l. The mean minimum and maximum temperature of the district ranges between 11.0–15.5°C and 26.1–34°C, respectively. The Agro ecology of the district 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.

Sayo district

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 8012'-8044' north latitude and 34041'-35000' east longitude. The district has a total area of 127,800 km2.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).

Gimbi district

Located in the West Wollega Zone of the Oromia Region, it has a latitude and longitude of 9°10′N 35°50′E with an elevation between 1845 and 1930 meters above sea level. It is the administrative center of Gimbi woreda. The 2007 national census reported a total population for Gimbi of 30,981, of whom 15,716 were men and 15,265 were women.

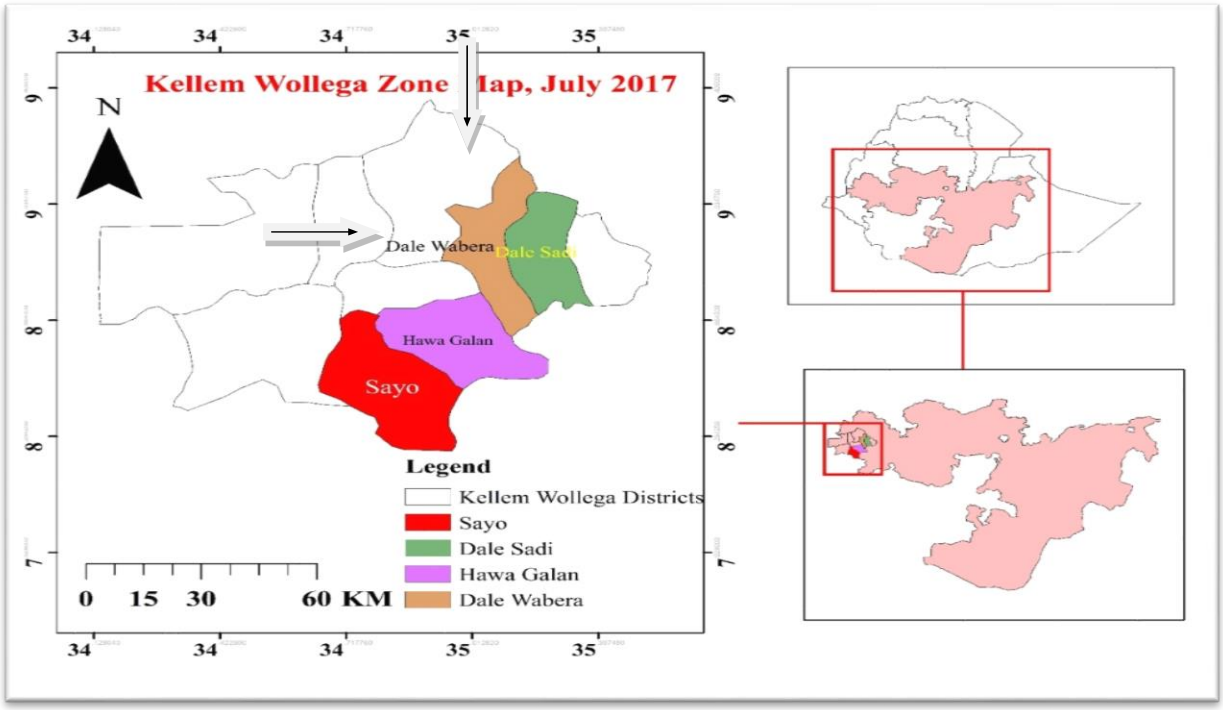

Fig 1. Map of the study districts

Site and Farmer Selection

Site selection was done in collaboration with district agricultural offices and DA's. The sites were selected purposively based on ground nut production potential. Before starting field work, strengthening of FREG (Farmers Research Extension Group) were made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices (timely weeding, roughing, harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables. The proposed technology was then scaled up on 43 representative farmers' field in the first year in the three selected districts. In 2018 year of production the scaling up was done on 47 farmers' felids in Sayo, Dale Sedi and Gimbi districts. Necessary management and monitoring were also performed properly.

Material Used

One variety of groundnut namely Manipinter that was preferred and selected by farmers was used with its full recommended practices. In organic fertilizer NPS was used with its recommendation rate of 100kg/ha.

Seed Distribution

After farmers selection had made by the researchers and DAs in respective Kebele's, each farmer was given seed which can cover 0.25 ha of land for consecutive two cropping calendar of production (i.e. 2017-2018). The study addressed a total of 90 farmers in the two years of the project span.

Stakeholder Analysis (SA)

Stakeholder analysis is very important for identifying the situation and informing stakeholders their responsibility (who does what?) before starting field work SA was undertaken to identify potential stakeholders. Who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing these activities? Finally, the roles, duties and responsibilities of each actor were clearly stated in implementing the activity

Table 1: Stakeholder roles and responsibilities in implementing the activity (2016/17, 2017/18)

Stakeholders	Roles and responsibilities
HSARC	➢ Coordination and facilitation ➢ Provision of Groundnut technologies ➢ Provision of training ➢ Organizing field days and ➢ Supervising, monitoring and Evaluation ➢ Helping farmers in revolving seed among them selves ➢ Collecting feedback for future technology promotion
ANR Bureau of district through Development Agent and SMS	➢ Assist in site and farmers' selection ➢ Monitoring and evaluating day to day activity of project ➢ Assist in providing training ➢ Facilitate seed distribution
Farmers	➢ Allocate land, Fertilizer and other inputs ➢ Conduct required management practice(Agronomic practice) ➢ participate in the training field days ➢ Share skills and experiences to neighboring farmers ➢ Transfer produced seed to surrounding farmers

Data Type, Method of Data Collection and Analysis

Amount of input distributed, harvested yield, total number of farmers participated on training, and field days were recorded by gender composition. Farmers' feed-back concerning technologies was identified. The data collection method employed were field observation and focus group discussion with experts, hosting and other farmers. Descriptive statistics was used to calculate the mean yield harvested.

Results and discussion

Seed distributed

A total of 22.5 Qt Manipinter variety of groundnut seed was distributed for a total of 90 farmers. The seed was used as initial seed for farmers to farmers seed dissemination mechanism in the selected Kebele (peasant association) based on the size of FREG members. Accordingly, the seed distributed during 2016/17 and 2017/18 G.C cropping seasons is summarized as follows.

Table 2. Seed Distributed Across Districts

No	District	Kebele	FREG Members	Amount of seed given	Total
1	Dale Sadi	Wara Wale Suchi and Awetu Birbir	29	25kg/farmer	7.25qt
2	Sadi Canka	Ganda-5	13	25kg/Farmer	3.25qt
3	Sayo	Karo Baha	18	25kg/farmer	4.5qt
4	Gimbi	Tole & Aba Sena	30	25kg/farmer	7.5qt
Grand total			**90**		22.5qt

Yield performance of Variety

The yield data of Manipinter variety was taken for consecutive two years of production to evaluate the performance of the variety under management of farmers with close supervision of development agents. The mean yield of the distributed variety over location is 14.935 qt/ha. The highest yield was recorded in Gimbi with magnitude of 16.77 qt/ha followed by Dale Wabera, Seyo and Dale Sadi with magnitude of 14.75, 15.44 and 12.77 qt/ha respectively.

Table-3 yield performance of the variety across location

Variety	Overall Mean Yield(qt/ha)	Mean yield across Districts			
		Sayo	Dale Sedi	Gimbi	Dale Wabera
Manipinter	14.935	15.44	12.77	16.77	14.76

Source own scaling up result

Training

Training was organized to introduce the available groundnut variety with their nature and management practices to both trial farmers and DA's in the trial sites. It is given for the target community on ground nut crop production techniques & management packages, post-harvest handling and commercialization of the new technology. Manuals were prepared and distributed

for farmers and Development Agents. The training given covered a total of 117 target communities out of which 84 them were male and 33 were female.

Table 4. Participants of the Training

District	Participant	Male	Female	Total
Sayo	Farmer	30	22	52
	Expert	8	1	8
	DA'S	3	1	4
	Others	8		8
Gimbi	Farmer	24	8	32
	Expert	5	1	6
	DA'S	2		2
	Others	4		4
Total		84	33	117

Field Day

Field day was among the means used to share experience among stakeholders. Accordingly, field day was organized during first year of project implementation in Dale Sedi district (Awetu Birbir Kebele) in order to share experience among agricultural stakeholders. During field day a total of 141 stakeholders out of whom 141 were male 24 female were attended.

Table 5 Participant of field day

No	PA	Participant	Male	Female	Total
	H/Birbir	Farmer	34	19	53
		SMS(DA'S +Expert)	80	5	85
		Other participants	3		
	Total		**117**	**24**	**141**

Farmer's feedback concerning Delivered Ground nut technology

Farmer's feedback about Manipinter variety as well as overall groundnut technology was collected and conceptually generalized. Accordingly,participant farmers appreciated the variety for giving relatively high yield than previously used varieties, for its good seed quality (large grain size and attractive grain color), disease tolerance, seed holding capacity of its root (no more seed is lost during harvest) and sweetness of its bi-products (such as the so called kolo).

However, the farmers criticized the Variety (Manipinter) for its upright nature compared to the local wgich is spreading type and for requiring more labor for earthling than local variety.

Economic return to farmers

Ground nut is produced in west and Kellam wollega zones mostly for hose hold consumption and marketing purpose. In achieving food security and diversifying house hold income it contributed huge for the stakeholders that produce Groundnut. Farmers those participated in scaling up of the variety achieved slight progress in ensuring their food security as well as income gained. During scaling up a total of 22.5quintal of improved Ground nut was distributed for farmers from which a mean total of 336qt was harvested.

Conclusions and Recomendations

Prescaling up of Manipinter variety of Groundnut was conducted in Dale Sedi, Sadi Chanka and Seyo districts of Kellam and Gimbi district of West Wollega zones.The Project covered a total of 22.5 ha of lands from which a total of 336 Qt was harvested with an average productivity of 14.935qt/ha. During project life span a total of 90 house holds where adressed and training was given for total of 117 target stakeholders to capacitate participants on groundnut production and management practices, post harvest handling and comercialization. The collected farmers feed back was mostly positive towards the distributed ground nut variety. Therefore, Manipinter ground nut variety is recommended for wider scaling up works. In addition it is recommended that the agricultural and natural resource bureaus at zone and district levels found in West and Kellam Wollega zones along with agricultural unions and input supplier which are found in these zones to supply this technology to farmers. To achieve this establishing & managing community-based seed production is crucially important. Thus, strengthening the linkages among actors and key potential stakeholders are indispensable to attain the desired goal in reaching number farmers with the variety and improve production and productivity of ground nut in West and Kellem Wollega zones.

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Per-scaling Up of Rope & Washer Pump for Small Scale Irrigation of Garden Practice in Jimma & 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 rope and washer pump technology at the farmer's condition. Thirteen hosting households were selected for the study as hosting households residing in two zones at different districts (Nada, Dedo, Kersa, Gechi and Chora). The result showed that it took 28, 34 and 38 seconds and 48,57and 61 seconds in average by using the pump and human labor to lift 25liters of water from 10, 12 and 14 meters depth respectively. Among the participant farmers, 81.54% had responded that lifting water from the distant water hole by rope and washer pump is easy in relation to using human energy. While only 18.46 % of the respondents stated that it requires some technical knowledge to use and make maintenances when it damages. The rope and washer pump operate with minimum force requirement. About 61.54% of the farmers responded that the constriction cost is medium that can be affordable by the average farmers compared to the engine driven pumps. Furthermore, 69.23*% of the respondent farmers also indicated to repair and maintain by local technicians or by themselves if the pump damages.*

Key words: *rope and washer, pump, respondents, maintenances, energy, technicians*

Introduction

The rope pump is based on an ancient Chinese technology, which was introduced in the 1990s to Central America. It was further developed in Nicaragua and now contributes significantly to rural water supply coverage (WSP 2008). Over the past decade efforts have been made to transfer the technology to various parts of Africa, often drawing upon the Central American experience (Sutton 2009).

Desertification and drought have been used as common identification for Ethiopia. To get out of these huge problem different personalities, intellectuals, institutions and foreign donors have been making different efforts. However, these efforts did not bring sustainable solution for desertification and drought. Some of the technologies used for irrigation to the purpose of horticulture and small farms like tree seedling growing etc, were engine, wind, solar power and manual driven pumps.

However, these pumps still did not solve the rural family household problems as the engines need trained operators whereas the rural societies lacked this ability and skilled man power. The solar wind and manual pumps usually fail to perform continuously after short period service. Similarly, the overflow pump and treadle pumps require much more human labor and are manipulated by adult and healthy men implying if there is no one to pump the pump, lifting water for drinking and garden irrigation is impossible.

In Ethiopia the water lifting technology transfer process started recently. Rope pumps were introduced to Ethiopia round 2006 by the Practical foundation and supported by organizations like IDE, JICA and Water Aid. During several years, local metal workshops have been trained in production and model. However, the pump became so popular that untrained workshops also started to produce and sell the pumps.

Currently some rope pumps have been produced in Ethiopia, but uptake and sustainability remain key areas which need much more popularization (Sally Sutton and Tsegaw Hailu, 2011). Adoption of the rope pump as an effective technology is being promoted not just by the water sector but also by the Ministry of Agriculture (MoA), with a focus on the expansion of small-scale irrigation. This is in line with the Growth and Transformation Plan (MoFED 2010) aims of developing community participation and labour intensive, low cost technologies.

The revised rope pump and washer puts considerable emphasis on the potential of the rope pump to provide safe and sustainable water supply for households (MOWE, 2009). It highlights the low cost technologies role, both within community and household contexts. Even as community low cost supplies (hand pumps on hand-dug wells and shallow boreholes) are household level low cost systems that can be paid for in full by themselves. Further introducing of the pump to the farmers is therefore a key aspect if uptake is to make a significant difference to rural water supply coverage. Training, promotion and monitoring is needed to encourage self-supply of the households as it is relatively low cost though it is not a cost-free.

Thus, the rope and washer pump is a solution for the mentioned water lifting problems for drink and garden small irrigation purpose as it is easily driven by human labor enabling to harness and use water from different depth both for drinking as well as for garden small irrigation sustainably. It has no additional cost except development and installation costs. To this end, previous demonstration of this pump has been conducted by JAERC at Jimma and Buno Bedelee zones which are potential areas. The technology was easily applicable, built with low maintenance rope and washer pump to offer water without the need for fuel. Accordingly, promising results have been found. Thus, a follow up pre-scaling activity for further popularization of the water lifting technology in selected districts of Jimma and Buno Bedele zones was initiated with the following objectives.

Objectives:

- To popularize rope and washer pump for awareness creation on small irrigation
- To develop farmers' knowledge and skill on water lifting technology
- To improve research-extension linkage for farther dispersion

Materials and Methods:

Materials

- Thirteen prototypes of rope and washer pump were manufactured in JAERC workshop as per its design for the demonstration purposes.
- Use water holes of different depths (9m to 15m), water size and supply duration were considered to carry out the pump popularization.
- The pumps were instilled at the identified sites for the scaling up purposes.

Methods

Description of the study area

The study was conducted in three districts of Jimma zone namely Nada, Dedo and Kersa districts and two districts of Buno Bedele zone; Gechi and Chora districts.

Farmer selection

Thirteen hosting households consist of 5 members were selected. The SMS of respective district Agriculture and natural resource office and DAs at Kebele level were involved in the implementation of this scaling up activity.

Approach followed

Participatory and multidisciplinary approach was used during the pre-scale up activity. A multidisciplinary team consisting of researchers from Soil and water, technology production workshops and agricultural research extension was established at Jimma Agricultural Engineering Research Centre (JAERC) for the implementation of activity. In addition, ensuring efficiency, effectiveness, integration and cooperation were institutional tool used for the realization of the strategy. Moreover, the approach followed included the following

- Joint planning**:** establishment of task force at district and Kebele and establishment of FRGs at each site were done
- Capacity building training on operation and maintenance**:** training the participant farmers, DAs, SMS and local microenterprises members
- Inputs supply for technology production, distribution and installation: The JAERC produced and supplied the technology for installation

- FREG members and other follower farmers were encouraged to participate in physical activities at all stages (from start to the end) of the pump pre-scaling up activities.
- Joint monitoring and evaluation: field visit and supervision were made regularly by extension agents at different study sites where the pump installation made. Field day organized at two sites in both Jimma and Buno Bedele zones. Discussion session and result communication forum were also organized
- Technology supply & maintenance mechanism: sustainable technology delivery and maintenance system was designed. Members from micro and small enterprises at district level were invited on mini-field day visit and information of other technology manufacturers like Salam Vocational Training Centre were provided to the farmers for maintenance aid and further technology supply.

Stakeholder Analysis (SA)

In promotion of rope and washer pump for garden production, the research center was closely working and has made frequent consultation with the respective stakeholder. As the pre-scaling up activities need different actors in partnership collective stakeholder analysis was made to identify potential stakeholders', their type, role, duties and responsibilities of each actors in activity implementation was identified and analyzed. The stakeholders were namely district office of agriculture and natural resource, Water and Irrigation offices, Micro enterprises and farmers identified as our stakeholders.

Communication method used

Extension teaching method mainly individual, group, and other mass contact methods were used in line with the situations during the pump pre-scaling up activity implementation.

Data collection

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 focused group discussion (FGD). The collected data was analyzed through descriptive statistics as well as quantitatively.

Results and Discussion

Pump discharge

It was observed that the average time taken to lift 25liters of water from 10m, 12m and 14m depth were 28, 34 and 38 seconds while it took 48,57and 61 seconds for the pump and human labor respectively from the respective depth of water sources.

Table1. Water lifting by the pump against local system (labor)

No.	Rep.	Depth (Meter)	Time taken (Second)		Discharge (Liter)		Remark
			Pump	Manual	Pump	Manual	
1	P1	10	28	49	25	25	
	P2	10	26	46	25	25	25 liter
	P3	10	30	49	25	25	Depth 10
	Av.		**28**	**48**	**25**	**25**	
2	P1	12	35	58	25	25	
	P2	12	31	54	25	25	25 liter
	P3	12	36	58	25	25	Depth 12
	Av.		**34**	**57**	**25**	**25**	
3	P1	14	38	62	25	25	
	P2	14	36	58	25	25	25 liter
	P3	14	40	63	25	25	Depth 14
	Av.		**38**	**61**	**25**	**25**	

P1, P2 & P3 indicate persons participated at three different sites.

Training

Both theoretical and practical trainings were given to 84 participants out of whom 65 were farmers 6 were district Subject Matter Specialists (SMS) and 13 were Development Agents (DAs). The training topics were on general aspects of operation and maintenance of the rope and washer pump technology with aim to improve the users' awareness, attitude and adoption behavior of the people. Participants from agricultural and irrigation offices of the two zones and technical micro enterprises were also invited and participated during consultation meeting and training.

Table 2. Training given to farmers, SMS & DAs

No	District	Training Participants				
		Farmers		Others		
		Adult	Youth	DAs	SMS	Total
1	Nada	8	7	3	1	19
2	Dedo	5	5	3	1	14
3	Kers	6	9	2	0	17
4	Chora	10	5	3	2	20
5	Gechi	6	4	2	2	14
	Total	35	30	13	6	84

Mini-Field days

A total of 285 farmers attended the field demonstration that conducted at different sites where the pump instillations have made at the thirteen hosting farmers' households. The twelve district level agricultural workers, eighteen development agents and fifteen stakeholders were participated in mini-field day demonstration as stated in table below

Table 3. 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	Chala	3	32	25	3	4	5	69
2	Dedo	Ofole	2	28	30	3	4	5	70
3	Kers	Girma	3	25	20	2	0	7	54
4	Chora	Yember	3	27	16	6	2	4	55
5	Gechi	Gechi	2	16	11	4	2	4	37
6	Total		13	128	102	18	12	25	285

Farmers' perception on the technology attributes

Assessment was made to know how farmer perceived the technology. Pump was liked by farmers for lifting water from lengthy hole using pump than only human labor. About 81.54% had responded it is simple to operate the pump for lifting water from hole compared to using only human energy. While only 18.46 % of the respondents stated that it requires some technical knowledge to use and make maintenances when it damages.

Table 4. Farmers response on nature of the rope and washer pump (no= 65)

No	Districts	Response level	No. of respondents	Percentage (%)
1	Ease of operation	Simple	53	81.54
		Not Simple	12	18.46
2	Maintenance	Easy	45	69.23
		Difficult	20	30.77
3	Affordability	High	11	16.92
	(Construction cost)	Medium	40	61.54
		Low	14	21.54

The Rope and Washer Pump operates with minimum force requirement. It has good discharge capacity (2litres/s). As far as its affordability is concerned, 61.54 % of the farmers responded that the constriction cost is medium that can be affordable by the average farmers compared to the engine driven pumps. About 69.23 % of the respondent farmers also indicate that it is possible to repair and maintain by local technicians or by themselves when the pump damages.

Success factors

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

Challenges encountered

Time shortage for frequent follow-up to further service after pumps installed as pump damage happens after sometimes mainly where the user farmers are technically incapable. Some spare parts like piston or plastic washer often lacked at local markets at rural areas.

Using the rope and washer pump on communal wells by different households fasten the rate of damage and easily loss of water from the well. So, functioning and life time of the pump will be increased when care is taken during operation of the pump.

Usually bushings need lubricating every 2 weeks when they running dry or start to make a shrieking noise, but the farmers usually fail to lubricate regularly. Likewise, a lot of damage frequently occurred on the rope that need be changed before it breaks.

Exit strategy

As the role of technology supply of the research center is very much limited, the wider scale dissemination is to be undertaken by bureau of agriculture in collaboration with manufacturer enterprises. Thus information was supplied to the respective district and zonal bureau of agriculture

Conclusions and Recommendations

Conclusions

The rope & washer pump was vital to rural draw backs of water lifting for drink as well as small scale irrigation purpose. It was served being easily driven by human labor enabling access to water for drinking as well as garden small irrigation sustainably.

Thus, farmers could harness and use water from different depth once installed. It was also observed that the well easily finished water when used intensively in places with low ground water sources. Training enabled farmers to easily operate but still needed capable enterprise to manufacture and maintain locally.

Recommendations

Though it is simple to produce the pump locally, it also requires precision to avoid bad copying, resulting in early break down and bad image on the further extension activities of the pump. The pumps can also be broken down unless the necessary care is taken to keep its production quality and proper installation.

The pumps efficiency and sustainability depends on frequent maintenance, otherwise, it leads to early wearing out and breakage of pump handle. When the pump is kept open to children, it can also be insecure especially for children in case of sudden return of the handle. So, it needs adjustment of blocking system on the handle to avoid unexpected return of the handle.

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Pre scaling up of Improved Faba Bean Variety in Tullo and Gemechis Districts of West Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

Faba bean (Vicia faba L.) is one of the highland leguminous crops and widely sowed in Ethiopia. The productivity of faba bean crop under traditional way of farming system and using local variety is found to be very less. To overcome the production constraint and seed dissemination process, pre scaling up of faba bean was conducted for two years in 2017 and 2018 in two districts of West Hararghe Zone Tullo (Gara kufa kebele) and Gemechis (Walenso Defo and Kuni segaria kebeles). The objectives of the activity were; to enhance production and productivity of faba bean on farmers` fields and to improve linkage among stakeholders and create awareness on improved faba bean varieties. Methodologically, site selection was undertaken by considering criteria like farmers proximity to road for supervision and monitoring purpose, gender balance, farmers which have willingness to technology and sufficient land for the activity and risk taker farmers were selected for the activity. The required data were collected through preparing data record sheet and checklist by interviewing and direct field observation. Data collected were analyzed through descriptive statistics and inferential statistics. Descriptive statistics were used to summarize the yield collected from three locations within two years. Inferential statistics were used to compare the mean yield difference among

location by using independent t-test and one way Anova. Concerning the activity extension and advisory services like training and field day were organized for the accomplishment of the objectives of the experiment. Generally, farmers of the study area appreciated accepted the variety to multiply and sow it widely on their farm land for the future. So, it is recommended that the technology should have to get great consideration by district agricultural office to widely distribute it and sustain the use of the improved faba bean technology.

Key words: Activity, faba bean,Tullo,Gemechis, and scaling up

Introduction

Faba bean (*Vicia faba* L.) is a cool season grain legume crop with the potential to be grown as multi-purpose crop in areas with short growing season. Faba bean is grown in many regions in the world due to its high nutritional value, medicinal effect, and effective biological nitrogen fixation. Diverse ecosystem benefits are expected from integrating faba bean in cropping systems (Etemadi et al., 2019). The largest faba bean producer in the world is China with 1.62 Mt. The Mediterranean Basin ranks second with an average in the last decade of 0.67 Mt, followed closely by Ethiopia with 0.62 Mt and at a further distance by France and Australia with0.30 Mt - 0.35 Mt (Rubiales and Fernadez, 2015).

Faba bean has multi-purpose advantage which can be produced for its nutritional and medicinal values. Faba bean grain, pods, and leaves are full of protein and almost all elements required for human diets (Osman *et al*., 2014; Etemadi *et al.*, 2019). It is cultivated for the purpose of both human food and animal feed (Migdadi et al., 2015). The crop contributes to the smallholder farmers as a source of protein in both rural and urban areas (Osman et al., 2014) and is an important source of income for farmers (Merkine and Teshome, 2016).

It is also known by N fixation crop which is considered as high among the grain legumes. Sowing of faba bean within various cropping systems such as crop rotations by cereal crops and intercropping with it improves natural soil fertility and reduce the consumption of commercial N fertilizer, to minimize the occurrence of cereal cyst nematode (*Heterdera avenae*) and soil-borne pathogens (Landry *et al*., 2016; Etemadi *et al.*, 2019).

Faba bean is partially a self-pollinating plant; however flowers attract various pollinators, specifically honey bees. Recent study indicated that honey bees and other natural pollinators can increase the pollination incident and thus grain yield in faba bean (Marzinzig *et al.*, 2018).

The production and productivity of faba bean are constrained due to soil fertility decline and soil acidity, among other factors (Endalkachew *et al*., 2018). The productivity and yield of the crop is still far below its potential due to lack of improved varieties and application of inadequate agronomic practices (Merkine and Teshome, 2016**)**. Even though there is challenge to production

of faba bean, about 437,106.04 hectares of land were covered by the crop which accounted that the distribution of 3.45 % in 2017/2018 cropping season (CSA, 2018).

The productivity of faba bean varieties under traditional way of farming system is found to be very less (Fekede et al, 2018). However there is an opportunity to use improved technology like improved seed, organic and inorganic fertilizer and appropriate agronomic practices in enhancing its production. Taking into account the scenario of the study area, Mechara Agricultural Research Center has conducted Participatory variety selection of different improved varieties which are developed by different research centers.

From the adapted varieties the center recommended two varieties namely, Hacalu and Tumsa for demonstration on farmers` fields. In 2015 to 2016 Hachalu and Tumsa varieties were evaluated with local variety with different parameters on farmer's field. The evaluation result indicated that Hachalu variety was performed well in considered parameters and recommended it for further scaling up in study area and with in similar agro ecology. Thus, this study was initiated with the objectives of enhancing production and productivity of improved variety of Faba bean in the study area, strengthening linkage among actors and partners by creating rate of dissemination and improves farmers' knowledge and skill on Faba bean production.

Objectives of the study

- To enhance production and productivity of faba bean on farmers` fields;
- To improve linkage among stakeholders and create awareness on improved faba bean varieties

Review of Faba Bean Production in Ethiopia

Ethiopia is one of the fundamental centers of faba bean diversification. There are some evidence which shows remarkable diversity in protein content, chocolate spot and leaf rust resistance (MoA, 2010). Faba bean production and productivity are affected mainly by biotic factors (diseases, insect pests, and parasitic weeds). Faba bean irritate disease, a new disease in Ethiopia, is the major and the most widespread and destructive disease in the faba bean growing area (Getnet and Yehizbalem, 2017).

The major faba bean producers in Ethiopia are Tigray, Gondar, Gojjam, Wollega, Wollo, Gamo, Gofa, and Shoa (MoA, 2010).There also so many released improved variety of faba bean in Ethiopia which are under production and newly recently released by research centers and at higher education. Despite the availability of improved varieties and associated crop management practices, availability and access to these technologies are limited resulting in low productivity. The yield gaps between research managed and national yield levels are still very high across all crops and agro-ecologies including faba bean (Spielman *et al*., 2010). Likewise, the performance

of formal seed sector also varies considerably by crop type and agro-ecology where legume seed supply in general and faba bean in particular is very weak.

Overview Production of Faba Bean in Western Hararghe Zone

Faba bean is one of the most known highland crops in West Hararghe zone. It is produced majorly in Tullo, Chiro, Gemechis and Guba Koricha. The farmers of area used majorly the local variety to produce it for both consumption and commercial purpose. But, after intervention was made by research the farmers gets the opportunity to use the improved variety released by research centers. In 2014, participatory variety selection (PVS) was done by Mechara Agricultural Research Center to select the best performed variety by different selection criteria with the full participation of farmers. The experiment was done on farmers land with some variety to evaluate and select for farmers and by farmers (Wondimu *et al.*, 2016).

Among the evaluated variety hachalu and tumsa varieties were selected by farmers and experts with the major parameters sated by researchers, experts and farmers. Following the PVS experiment the selected varieties of Hachalu and Tumsa were taken for demonstration by researchers in three location of West Hararghe Zone,namely Chiro,Gemechis and Tullo districts in 2016 to 2017. From the demonstrated and evaluated varieties hachalu were performed well and selected for further scaling up by researcher and farmers in similar agro ecologies to the study area (Fekede *et al*., 2018). Production and productivity as well as yield of the crop may be affected by drought and management practices (Asfaw *et al*, 2018; Fekede *et al.*, 2018). The yield overview of hachalu variety was shown by the figure 1.

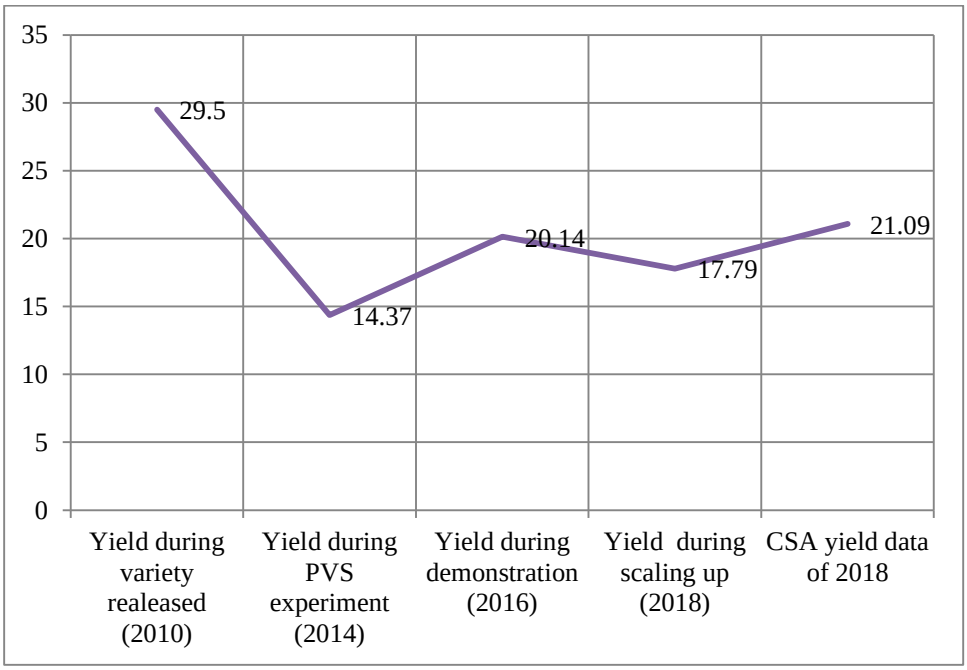

Figure 1: yield overview of hachalu variety in West Hararghe Zone

Research methodology

Description of the study area

Pre scaling up of faba bean was undertaken in 2017/2018 to 2018/2019 in Gemechis and Tulo districts of the West Hararghe zone of the Oromia National Regional StateGemechis district is one of the seventeen districts in West Hararghe zone, which is located at 343 km East of Addis Ababa and about 17 km South of Chiro, which is the capital town of the zone. The district is situated at the coordinate between 8^0 40'0" and 9 ^{0}04'0" N and 4^0 50'0" and 41^0 12'0" E. The soil of the study area was dominantly loamy soil (Desalegn *et al*., 2016). Gemechis town is located on the top of a hill and its climate is 70% cold and cloudy. The woreda has many small cities located 20–45 miles away from each other. Sogide, Sire, Metadhab, and Degaga are the major ones. Transportation for commuting is a major problem of the woreda.

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. The production system is mixed type in which extensive husbandry management of livestock have been practiced (Tulu D and Lelisa K, 2016).

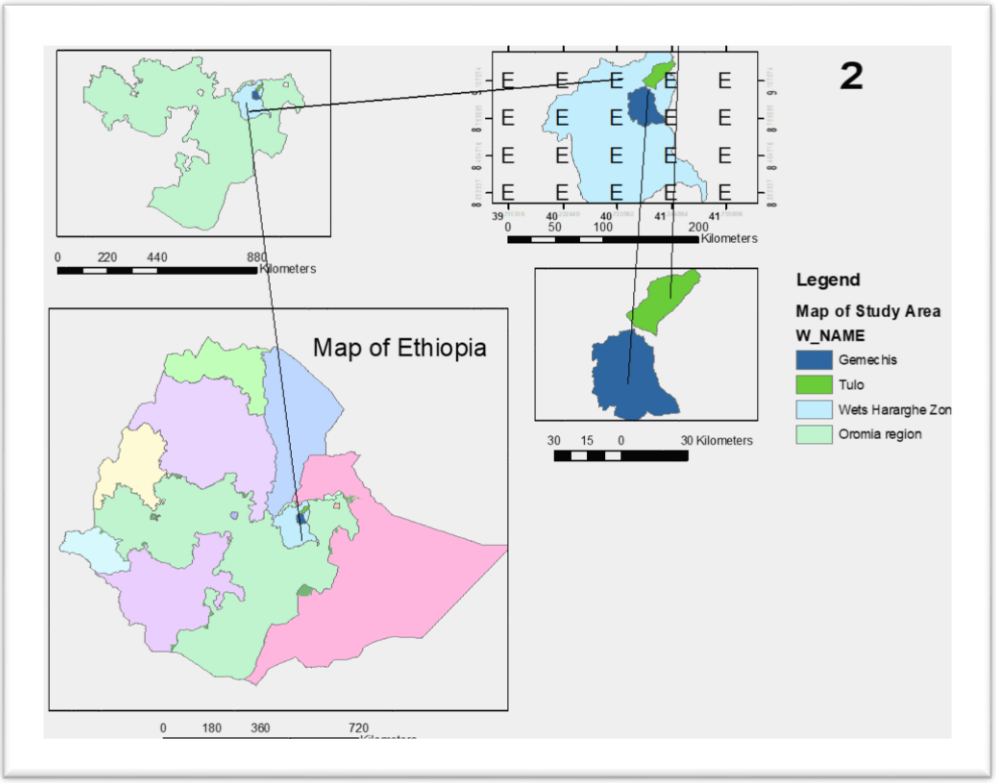

Figure 2: Map of the study area
Source: Own design from Arcgis data (2018)

Farmers and Site Selection

The activity was conducted for two consecutive years in Gemechis (2018/2019) and Tulo (2017/2018) districts of West Hararghe zone. Expert meeting and desk study were undertaken for site and farmer selection. Thus, major faba bean producing *kebeles* and farmers were selected in collaboration with district Agricultural Office. Accordingly, two *kebeles* from Gemechis district (Walenso Defo and Kuni segaria *kebeles)* and one kebele from Tullo district (Gara kufa kebele) selected purposively based on faba bean production potentials. The summary of selected participants for the activity was discussed by the table 1 with the area covered and amount of seed delivered.

Table 1.Summary of inputs procured to the farmers

District	*Kebeles*	Varieties	Farmers	Amount given (Qt)	Area covered (Ha)
Tulo	Gara kufa	Hacalu	18	1.8	2.25
Gemechis	Kuni segaria	Hacalu	28	2.8	3.5
	Walenso defo	Hacalu	26	2.6	3.25
Total			72	7.2	9

Source: Own field data (2018)

Agronomic Practices applied

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

Seed rate used

The optimum plant population of faba bean for maximum pod and grain yield as well as N fixation is not well documented (Etemadi *et al*, 2019). Kissi *et al*. (2016) showed that the seed rate of 250 kg/ha at onset of rain shower recorded maximum seed yield than the other seed rates. But, Ethiopian crop variety register recommended the seed rate of 275kg/ha for Hachalu variety (MoA, 2010).

Land preparation

Before preparing the land appropriate site for faba bean crop is needed to be selected. In addition the selected site and land is required to be cleared. Land clearance is important for avoiding the

emergence of weed in the land wanted to be cultivated on it. Land was required to prepare well by digging it two to three times before sowing the seed. Concerning the prescaling of faba bean activity the researcher has prepared the checklist during the supervision time to take some data like frequency of cultivation, land history/previously sowed crop and frequency of weeding. Thus, majority of farmers cultivated their land more than two to sow the seed of faba bean variety (hachalu).

Land history (previously) sowed crop

Crop rotation of faba bean with other crop especially with non-leguminous crop is very known to increase soil fertility (MoA, 2010). Sowing of faba bean within various cropping systems such as crop rotations by cereal crops and intercropping with it improves natural soil fertility (Landry *et al*., 2016; Etemadi *et al.,* 2019). It obtained from supervision data as the majority of farmers previously planted potato and onion in study area before sowing of faba bean. This shows that the farmers of the area rotate faba bean crop production with potato and onion especially in Gemechis district.

Sowing methods

After the land was prepared well, faba bean seeds should be sowed about 2.5 cm deep and the distance between plants on planting rows is 15 to 23 cm, depending on row spacing (Etemadi *et al*., 2015).

Weeding

One of the yield enhancements is undertaken through proper management of the crop like weeding and thinning out. As the data was taken from farmers during supervision, the beneficiary of the activity mean that the farmers participated on the activity managed their faba bean land by weeding at least two times to get the expected yield from it.

Types and Methods of Data Collection

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

Methods of Data Analysis

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

Method of communicating the result

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

Results and discussions

Yield Performance of Hacalu Variety

Prescaling up of faba bean was undertaken for two years in 2017 and 2018 in two districts of Tullo and Gemechis. Faba bean variety of hachalu was distributed to 18 farmers in Tullo district in 2017 at Gara kufa *kebele*. In 2018 the seed was distributed in Gemechis at two *kebeles* of Walenso Defo and Kuni Segaria besides 26 and 28 farmers respectively. The seed was sown by row sowing methods on the area recommended and managed by farmers to achieve the objectives of the activity. The combined mean of the crop collected in two years from both districts were discussed by Table 5. The combined mean of the grain collected from three locations Gara Kufa, Kuni Segaria, and Walensio Defo are 17.79 quintal/ha and with standard deviation of 10.27.The total grain yield collected from both districts from 268 ha was 1191quintal.The mean grain yield obtained in this study is less than the the mean yield (20.14 quintal/ha) reported by Fekede *et al* (2018) and better than the mean yield (14.37 quintal/ha) obtained from PVS by Wondimu *et al (*2016). The mean grain yield obtained in this study is also less than the national average (CSA, 2018).

Table 2: Mean yield of faba bean varieties in study area

Variety	No. of farmers	Mean yield from ha/Qt	Std. Deviation
Hacalu	67	17.79	10.27

Source: Own computation (2018)

The average yield obtained in this study was less than the yield (30.37 quintal/ha) reported by Tekle *et al* (2016). The observed yield gap was occurred might be due to management difference among farmers, rainfall pattern, disease occurrence, soil fertility status and so on. In 2018 when the activity was conducted in Gemechis district the rainfall was not sufficient especially at maturity stage. So, it is believed that the main reason that causes the occurrence of minimum yield is inadequacy of rainfall in study area during its critical stage.

Comparison of Yield Collected From District

Yield comparison across districts

Production and productivity of crops and yield difference occurred from place to place due to management practices (weeding and thinning out), input used like fertilizer, environmental conditions, farmer's indigenous knowledge on farming, soil characters, extension services, infrastructure and others factors (Asfaw *et al*.,2018). High mean yield were obtained from Tulo district in 2017 which is 24.37quintal/ha than Gemechis district that is 16.20 quintal/ha (Table

3). There is also significant difference between the yields obtained from the two district at 1% level of significance. There was also variations in mean grain yield among the kebeles with in the same district.

Table 3. Grain yield of the variety (Hacalu) across district by year.

Districts	N	Mean yield	Std. Deviation	t-value	Sig.
Tullo (2017)	13	24.37	9.10	2.694***	0.009
Gemechis (2018)	54	16.20	9.98		

***Sign shows that the study is significant at 1% significant level
Source: Own computation (2018)

Training

Besides advisory services, training is prepared for the farmers, extension agents and agricultural experts on faba bean agronomic practices, production and pre-harvest and post-harvest managements to improve knowledge, skills and attitudes of trainees (Asfaw *et al*., 2018). As indicated in Table 6, a total of 15 farmers, 9 extension agents and 7 agricultural experts were participating in training program. Due to budget shortage, all farmers did not participate in training program. Out of 72 faba bean producer farmers, 9 model farmers are selected by different criteria's such as role model, ability to transmit information, communicator and others. Extension agents and participant farmers are transmitted information shared from training to the non-participant farmers. Participatory training method is followed during implementation of training program for sharing knowledge's, skills and experiences own on faba bean productions.

Table 5: Training provided for participants on faba bean production and management

Districts	Farmers			Development Agents			Experts		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Gemechis	6	4	10	3	1	4	2	1	3
Tullo	3	2	5	2	1	3	2	1	3
Total	9	6	15	5	2	7	4	2	6

Source: Own field data (2018)

Field day

According to Asfaw *et al*. (2018) field day is one of the impotyant extension tool used to transfer information and to create awareness. Field day can be organized at different stages in crop production systems. It can be two or three times which the stages are at vegetative, flowering and maturity depending on crop type and nature produced. Field day is used as tool to address large number of farmers, even invited farmer who did not produce improved faba bean varieties to create massive awareness and large impacts on technologies for further production and scale up on farmers field. Not only farmers but also others stakeholder are also invited to participate on

the program. In addition, during field day mass extension methods e.g. leaflets, banner are used to reach large audience.

Accordingly, a total of 62 farmers, 9 development agents and 4 experts from district government offices and research office were participating on field day (Table 7). A total of 70 leaflets are distributed for the participants which describes the production, agronomic practices and overall managements of improved finger millet varieties.

Table 6: Participants of field day in Gemechis district

Location of field day	Types of varieties	Participants								
		Farmers			Development Agents			Experts		
		M	F	T	M	F	T	M	F	T
Gemechis		57	5	62	8	1	9	4	-	4

Note: M stands for Male, F stands for Female and T stands for Total
Source: Own field data, 2018

Farmer's feedback on the technology

Farmer's feedback on the technology was collected from its emergence to threshing. From farmers point of view hachalu variety of faba bean has good germination, disease resistant, has good stand, and has uniformity in stand, very attractive in eye & beauty on field. During demonstration stage hachalu variety were selected as first by different parameters like plant establishment, seed size, number of branches, disease resistant, plant height and grain yield (Fekede *et al*., 2018).

Finally, at the end of visit during field day, group discussion is conducted to grasp farmer's feedback on strength and weakness of improved faba bean varieties. Besides, constraints in agricultural production (weeds like straiga wilt on chickpea and climate change); needs and interest of farmers on others improved varieties such as early maturing sorghum and chickpea and timely distribution of seeds are points rose by participants on the program. Accordingly, Hachalu variety is more preferred than local variety due drought tolerance and yield advantages. Generally, majority of farmers appreciated the variety and has full willingness to sow it widely by giving more land for this crop separately.

Exit Strategy

It is obvious that technology dissemination has its own procedure starting from variety development to its extension. Improved variety of faba bean also developed by Holeta Agricultural Research Center in 2010 (MoA, 2010). Its adaptation (PVS) was done by Mechara Agricultural Research Center in 2014 (Wondimu, 2016). After PVS the experiment was taken to

on farm demonstration for evaluation purpose in 2016 (Fekede *et al*., 2018). Its scaling up was also done on sixty seven farmers (67) on two district in 2017 and 2018.

As exit strategy memorandum of understating were signed between farmers and development agent to sustain the production of this improved variety. Awareness creation was also made as the technology disseminated through farmer to farmer technology dissemination system. In addition the copy of signed memorandum of understanding were given to district agricultural office as they follow and monitor the status of the technology for full adoption purpose.

Conclusions and recommendations

Conclusions

Pre scaling up of faba bean was conducted for two years in 2017 and 2018 in two districts of Tullo (Gara kufa *kebele)* and Gemechis (Walenso Defo and Kuni segaria *kebeles*). Concerning the activity extension and advisory services like training and field day were organized for the accomplishment of the objectives of the experiment. In implementation of the activity the required inputs like seed rate, fertilizer and labor required were applied. Agronomic practices such as cultivation, sowing methods (row sowing) and weeding were done by farmers.

Yield summary of the three locations was also discussed from the results of the finding. From the activity high mean yield were gained from Tulo district in 2017 which is 24.37quintal/ha than Gemechis district that is 16.20 quintal/ha as it was revealed in the results of the finding. Yield comparison was also seen between district and among the *kebeles* by independent t-test and One-way Anova respectively. Thus, the result of the study shown that there is the significant mean yield deference between district and among *kebeles* at 1% significant level. So, it can be concluded that there is yield difference from place to place depending on different factors like human and non-human factors. The non-human (natural) factors like unevenly distributed rain fall, drought, heavy rain (ice) and heavy air condition (wind). Mean yield difference of the experiment can also occur due to human factors like inability to manage properly the experiment starting from land preparation to harvest. Generally, farmers of the study area appreciated accepted the variety to multiply and sow it widely on their farm land for the future.

Recommendations

From the result of the study, the following recommendations were given:

- To bridge the yield gap observed among different study and to get its potential yield the farmers should give proper management for improved technology of faba bean.
- To sustain the use of the improved variety of faba bean district agricultural office should follow and monitor its adoption status.
- Farmer to farmers seed dissemination pathway should also arranged by the concerning body to expand the technology widely.
- Market linkage should have to be made in enhancing the efficiency of the technology

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