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PREFACE

Agricultural Growth Program (AGP-II) is one and perhaps the biggest World Bank and other donor partners supported project with significant achievements in generating demand driven agricultural technologies, demonstrating proven technologies to farmers and end users, producing ample early generation seeds and other source technologies, and enabling the implementing research institutions/centres through physical & human capacity building.

With the financial support of AGP-II, Oromia Agricultural Research Institute (IQQO) conducted 642 different research activities during the last four years (2016/17 – 2019/20) through its 17 implementing research centers and one food science laboratory based at head quarter. Among those, 214 were pre-extension demonstration research activities. About 161 improved agricultural technologies (148 % of five years project plan) were fully approved by 516 completed Farmers Research Extension Groups (FREGs) involving 8157 direct beneficiary farmers (29.1% female) and recommended for further dissemination into public extension system. Classification of these 161 technologies promoted to public extensions into cross cutting issues revealed that 48 were gender sensitive, 34 nutrition sensitive, 36 Climate Smart Agriculture and 43 multipurpose. Besides, those technologies were from multidisciplinary directorates such as crops (76), livestock (35), natural resource (21) and Agricultural engineering (29).

In 2019/20, a total of 118 different research activities were conducted following the different extension approaches. Among those, 94 research activities were demonstrated on 175 completed farmers research extension group (FREG) involving 2652 farmers (33.11% female). Accordingly, 48 improved agricultural technologies that fitted farmers' technology selection criteria were chosen. Out of these selected technologies, 15 (31.25%) were from crops, 13 (27.08%) livestock, 6 (12.5%) natural resource, and 14 (29.17%) agricultural engineering technologies. Those technologies are ready to be promoted to public extension service. Besides, 33 technologies were demonstrated on larger scale using 81 clusters involving 1537 (24.3% female) smallholder farmers. Furthermore, three technology villages were established to intensively demonstrate a set of technologies to 60 farmers (10% female). Therefore, this workshop is organized with the purpose of critically reviewing research findings related to pre-extension demonstration of agricultural technologies and large scale demonstrations conducted during 2019/20 (2012 EFY). I am fully confident that the technical quality of the research conducted and proceeding paper will be enriched with this forum and the forthcoming peer reviewing program. The workshop participates includes researchers from different disciplines, research directorate directors, director general, deputy director generals, other relevant stakeholders from Oromia bureau of Agriculture and natural resource and the national AGP-II research coordination unit.

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CROP TECHNOLOGY

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

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ABSTRACT

Pre-extension demonstration of improved Malt barley varieties was conducted in Sinana and Agarfa districts of Bale Zone and Dodola district of West Arsi Zone. The main objective of the study was to demonstrate and evaluate recently released (Moata) variety along with standard check. The demonstration was under taken on single plot of 10mx10m area for each variety with row planting, recommended seed rate of 120kgha^{-1}and fertilizer rate of 100/50kgha^{-1} NPS/UREA. Mini-field day involving different stakeholders was organized at each respective site. Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the demonstrated varieties was identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Moata variety performed better than the standard check (IBON 174/03 variety) with an average yield of 34.23qtha^{-1} and 27.96qtha^{-1}respectively. Moata variety had 22.42% yield advantage over the standard check. Furthermore, this variety was selected by farmers. Thus, Moata variety was recommended for further scaling up.

Key words: Demonstration, Farmers' preference, malt barley, Moata, Selection criteria

INTRODUCTION

In Ethiopia, barley is one of the top five cultivated cereal crops after tef, maize, wheat and sorghum. Among 10,358,890.13ha of land covered by cereal crops in 2018/2019 cropping season barley shares 951,993.15ha of land. A total of 17,675,184.47quintals were produced with averageyield of 21.77 quintals per hectare. In Oromiya 386,569.22 ha of land was covered by barley and 9,325,076.44 quintals were produced with an average yield of 24.12 quintals per hectare (CSA, 2019).Similarly, in Bale and West Arsi zones during the 2016/17 main production season, 44,929.97 and 63,085.81 ha of land was covered by barley, respectively. The average productivity of the crop was 24.66 and 29.84 quintals per hectare in Bale and West Arsi, respectively (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. However, until the recent time the 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 (Assela Malt Factory, 2015).

Malt barley supply in Ethiopia is characterized by continued scarcity. To overcome the problem, Sinana Agricultural Research Center (SARC) released the new variety of malt barley (Moata) which has relatively moderate resistance to crop pests. Moata has yield potential of 25-51quintal per hectare and the yield advantage of Moata over standard and local checks is 13.3% and 16.7% respectively. Thus, it is a paramount important to demonstrate and evaluate recently released malt barley variety (Moata) under farmers' management condition.

METHODOLOGY

Description of the study area

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

Site and farmers' selection

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

Materials used and Field design

Improved variety, Moata was demonstrated with IBON 174/03 (standard check). Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full packages were applied in which, row planting with 20 cm b/n rows, seed rate of 120 kg per hectare and fertilizer rate of 100/50kg of NPS/UREA per hectare was applied. Twice hand weeding was done.

Data collection

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

Data analysis

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

Farmers' variety evaluation and selection

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

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

Focused Group Discussion (FGD)
Before leading the participant farmers and experts to focus group discussion, brief orientation was given to the evaluators on why variety/technology evaluation and selection is necessary in research process. Then evaluators were grouped in to small manageable groups (by selecting one group leader) and encouraged to set their own criteria to select the demonstrated varieties in order of their preference, how to carefully assess each variety by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their respective group leaders.
Table 1: participants of variety selection

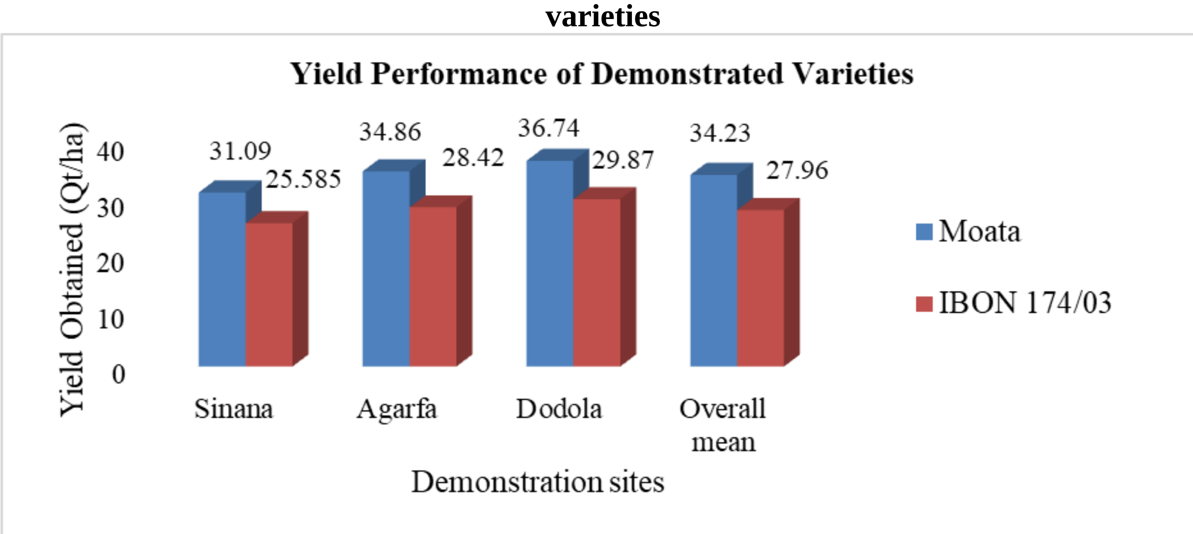
	Farmers					
Districts	Men	Women	Youth	Total	Others	Total
Sinana	12	-	9	21	6	27
Agarfa	15	-	8	23	6	29
Dodola	16	4	12	32	6	38
Total	43	4	29	76	18	94

RESULTS AND DISCUSSIONS

Yield performance of Demonstrated varieties

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

Chart 1: Yield performance of the demonstrated varieties



The demonstration result revealed that, the new variety (Moata) performed better than the standard check (IBON 174/03 variety) all over the demonstration sites. It gave higher yield at all locations. The mean yield of Moata variety was 31.09qt/ha, 34.86qt/ha, and36.74qt/ha at Sinana, Agarfa and Dodola, respectively with all over mean yield of 34.23qt/ha. Similarly, the mean yield of IBON 174/03 variety was25.585qt/ha, 28.42qt/ha, and 29.87qt/ha at Sinana, Agarfa and Dodola respectively with all over mean yield of 27.96qt/ha (Chart 1). The yield advantage of Moata over IBON 174/03 is 22.42%.

Comparison of yield advantage of improved varieties

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

Yield Advantage of Moata over IBON 174/03: 34.23-27.96= 22.42%
27.96

Table 2: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties	
		Moata	IBON 174/03
1.	Yield obtained (qt/ha)	34.23	27.96
2.	Sale price (ETB/qt)	1800	1800
3.	Gross Returns (Price X Qt) TR	61614	50328
4.	Land preparation	4200	4200
	Seed purchase	2160	2160
	Fertilizers purchase (NPS)	1400	1400
	Fertilizers purchase (UREA)	600	600
	Herbicide purchase	1100	1100
	Labor for spray	400	400
	Insecticide purchase	600	600
	Labor for spray	400	400
	Fungicide purchase	800	800
	Labor for spray	200	200
	Combiner rent	4140	3360
	Packing, Loading and store	350	350
	Store (bag purchase)	350	280
	Total Variable Costs TVC (ETB/ha)	16700	15850
5.	Fixed cost	8000	8000
6.	Total cost (TC)	24700	23850
7.	Net Return (GR-TC)	36914	26478
8.	Benefit cost ratio (NR/TC)	1.49	1.11

As shown in the above table (table 2) the cost benefit ratio analysis showed that, the net return gained from Moata and IBON 174/03 varieties was 36914 birr and 26478 birr per hectare, respectively. Moata variety had higher cost benefit ratio (1.49) than IBON 174/03 variety (1.11). This means, Moata variety is more profitable than IBON 174/03 variety with the same cost expenditure for both varieties per unit area.

Farmers' preference to demonstrated varieties

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

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

Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, suitability for mechanization and lodging resistance were the top three priority concern given by farmers (Table 3).

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

A=Seed size, B= disease tolerance, C=Crop stand, D=resistant to lodging, E=Seed/spike, F=Yield, G= suitable for mechanization.

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

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

No	Variety	Rank	Reason
1	Moata	1st	Seed/spike, good crop stand, resistant to lodging, more suitable for mechanization because of its stand and late maturity, high yielder, bigger seed size.
2	IBON 174/03	2nd	Susceptible to lodging, poor crop stand, less suitable for mechanization due to its poor stand and early maturity.

CONCLUSIONS AND RECOMMENDATIONS

Pre extension demonstration and evaluation of malt barley varieties was carried out on eight (8) representative trial farmers' fields. Improved variety viz. Moata was demonstrated along with IBON 174/03 variety which is the standard check. Accordingly, Moata gave higher yield than IBON 174/03 variety. Moreover, Moata was selected by participant farmers in all districts due to it is has higher number of seed/spike, good crop stand, resistant to lodging, more suitable for mechanization because of its stand and late maturity, high yielder and bigger seed size. Based on these facts, Moata variety was recommended for further scaling up.

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Cluster Based pre-scaling up of Bread wheat (Triticum aestivum L) Varieties at Dugda district East Shoa Zone.

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ABSTRACT

Cluster based pre-scaling up of bread wheat varieties was conducted at Dugda district of East Shoa zone, Oromia National Regional State, Ethiopia in 2019 production season with objective of demonstrating farmers preferred bread wheat varieties in a large-scale cluster approach. A total of 13 farmers from Tephochoroke kebele of the district contributed a total of 10ha for the activity. The farmers were organized using cluster approach into two clusters, each with 5ha of land. Before planting, class room trainings and inception workshop were conducted to all involved pertinent stakeholders' parties on the overall activity implementation approach as well as bread wheat production and management packages. Accordingly, a total of 148 participants including follower farmers attended the training. Two varieties namely Ogolcho and Kingbird were sown on the two clusters separately. Proper agronomic management practices were applied by the farmers. Yield data was collected and the result indicated that Ogolcho gave higher yield 44.25 ± 3.90 compared to king bird variety 34.11 ± 1.98. In terms of profitability 45,939.00 ETB and 31,743.00ETB per hectare was found for Ogolcho and Kingbird at the time of harvesting using farm gate price, respectively. Generally, both varieties performed better in-terms of yield and profitability in large scales. Thus, further promotion and wider extension works are recommended on these varieties at Dugda and similar agro ecologies.

Key words: Large scale demonstration, Pre-scaling up, Ogolcho, Kingbird, Farmers feedback

INTRODUCTION

Ethiopia is the largest wheat producer in sub Saharan Africa and has a favorable climatic condition. Wheat is the fourth important cereal crop in the country produced majorly in places at an altitude ranging from 1500 to 3200m.a.s.l (Wuletaw et.al., 2019). Within the country the top wheat producing districts are primarily located in Oromia, Amhara, and Tigray National regional states. Oromia accounts for the largest of all. CSA, 2017/18 report shows that Oromia region accounts 53% of the area allocated for wheat production in the country in the production season of 2017/18.

Within Oromia, the top wheat producing districts are located in the Arsi-Bale areas of the region (Warner et.al, 2015). East shoa zone is also among the top 25 wheat producing zones in the country, major producing districts within the zone being Dugda and Gimbichu (CSA, 2017/18). Although the country in general and the region in particular is the major producer of wheat in sub Saharan Africa it is still reliant on foreign wheat import to satisfy its demands. The country imported average 1.2 million metric tons of wheat commercially on 2018/19 (excluding the informal import of significant wheat product) which accounted about 30 percent of the domestic consumption. (USDA,2020).

To solve this challenge and improve production and productivity efforts were made by the national and regional research and extension systems of the country by releasing improved varieties along with their management practices. As part of its effort to improve production and productivity of bread wheat ATARC has also conducted adaptability and demonstrations trails in the past two years at Dugda and Lume districts with support from Agricultural Growth Programme (AGP II). In these two districts participatory variety evaluation and selection and pre-extension demonstration was conducted. As a result, two varieties were preferred by participant farmers namely Ogolcho and Kingbird. Their yield results also indicated that these varieties have 69.42% yield advantage over the farmers' variety (Hawi) and farmers have become interested in them. Therefore, this activity is initiated to pre-scale up these improved varieties (Ogolcho and kingbird) using cluster approaches at Dugda district.

METHODOLOGY

Description of the study areas

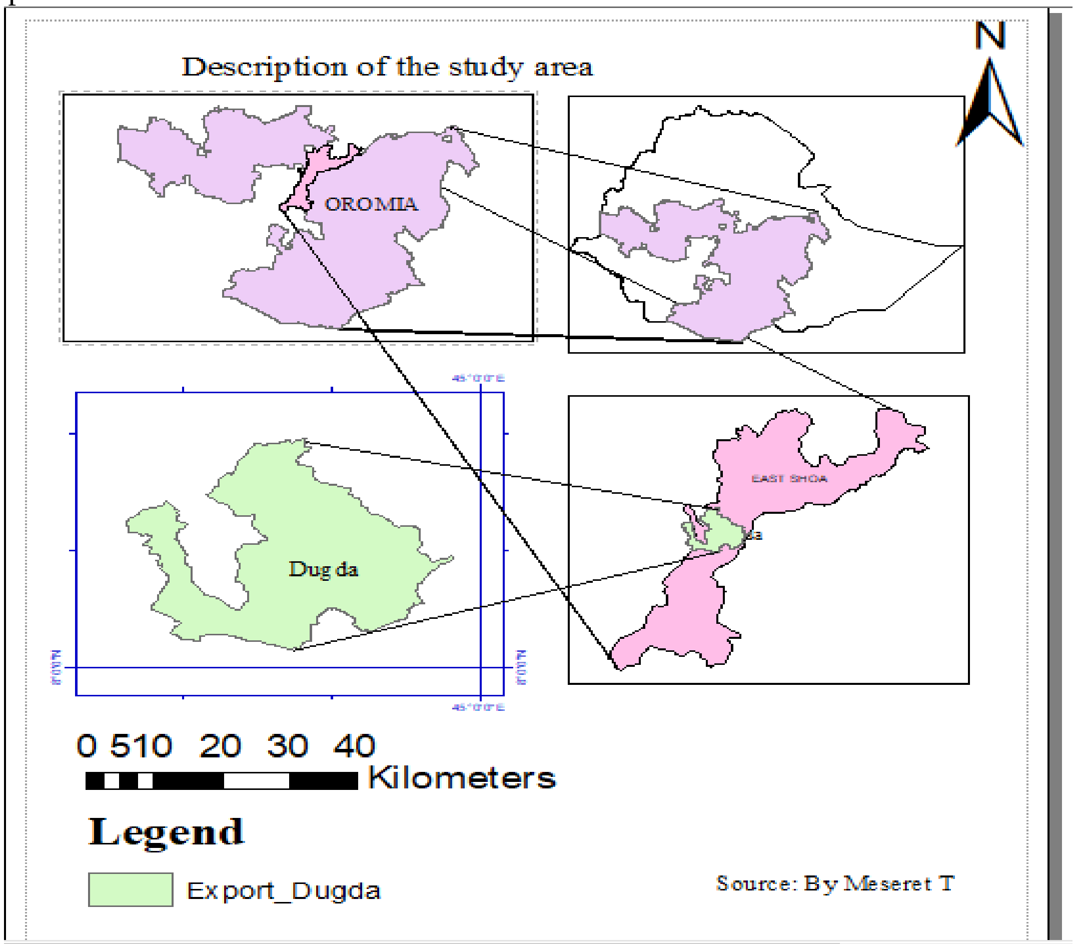
The pre-scaling activity was conducted in one district of East shoa zone Oromia national regional state. East shoa zone is among the 20 administrative zones of the Oromia region. One district was purposively selected for the activity. The district is selected basing its wheat production performance. The district is also one of the districts where previous participatory varieties evaluation and selection and a follow up pre-extension demonstration of the selected varieties has been conducted.

Dugda district is located at 135km from the capital city of Oromia national regional state, Finfinnee and 100km from East shoa's zonal capital Adama. The district covers 5.2% of East shoa zone with area of 751km^2. Dugda has 18 Kebele's among which one kebele was used for this study. The district has an average 636mm annual rainfall and 26 ^{o}c average annual temperature with a total cultivated land of 60,769 ha. The major crops produced are wheat, teff and maize.

Site and farmers selection

One kebele (Tephochoroke) was selected for the implementation of the activity. The study used cluster approach to group and plant the varieties. The farmers were neighboring farmers' having adjacent farms in two villages (settlement zones) within the selected one Kebele. A total of 13 farmers were selected and grouped with two clusters each having 5ha of land. The selection, cluster formation and organization of farmers was done in collaboration with district experts and Development agents. Moreover, through discussions, the district office of agriculture specifically assigned two experts as a focal person for this and other cluster-based activities of Adami Tulu agricultural research center contributing for the successful implementation of the activity as well as stakeholder's collaboration.

Map of the district



After reaching at concusses, agreement was made with the participant farmers based on the mentioned points. Generally, the following criteria were considered to select participating farmers

- Willingness to accept the technology,
- Willingness to allocate land
- Willingness to fully cover cost of labor starting from land preparation up to harvesting
- Willingness to work in groups
- Willingness to keep appropriate records and share experiences
- Implement all the recommendations forwarded by researchers and district focal persons and Development agents by incorporating their own indigenous knowledge.
- Willingness to participate on meeting, field visits and training events
- Willingness to participate on group member meeting

MATERIAL USED AND FIELD DESIGN

Planting materials

Previously demonstrated bread wheat varieties namely Ogolcho and kingbird were used. A total of Sixteen (16) quintals of certified seed was purchased from Oromia seed enterprise (OSE) and distributed to participating farmers.

Field design and agronomic practices used

The approach used was cluster farming. The varieties were planted on a total of 10ha each variety on 5ha. The participant farmers who allocated the land are neighboring farmers grouped based on cluster farming system. Each farmer in a cluster allocated a minimum land size of 0.25ha. All farm operations such as land preparation, planting, weeding, agro-chemical spray, harvesting, threshing was carried out by this hosting farmers with close supervision of researchers and district level agricultural experts. The host farmers as well other group member farmers were also organized using FREG approach. A seed rate of 150kg/ha, fertilizer rate of 150kg UREA and 100kg NPS were used. UREA was applied using split application where 1/3 was applied during planting and 2/3 at tillering stage. Recommended packaged production and management technologies and practices (seed rate, spacing, fertilizer management and weed management) for bread wheat production were used to establish the trials.

Capacity development

Training about bread wheat production and management was provided before commencing the activity. The farmers were given class room training and practical orientation prior to planting. The training covered issues from input preparation until harvesting and post-harvest handling of the bread wheat. Promotional/Extension events such as field visits, experience sharing field days were also conducted for farmers and other stake holders to observe and share their knowledge and experience about the varieties, cluster approach as well as bread wheat production and management.

Stakeholder analysis and Signing of Memorandum of Understanding (MoU)

Before commencing on the actual implementation three important stakeholders were identified (Research center, office of agriculture at district level and farmers) and sensitized. The sensitization took place during the initial training session. All the three stakeholders agreed upon set of roles and responsibilities serving for efficient allocation of resources and successful implementation of the activity.

Data collection

Amount of inputs distributed, grain yield, costs incurred and income gained, total number of farmers by gender participated in trainings, field days and visits, and feedbacks will be collected.

Data analysis:

The collected yield data is analyzed using descriptive statistics mainly mean was used to analyze the grain yield. The gross financial performance analysis was done using the current market price data in ETB considering all the produced grain is sold.

RESULT AND DISCUSSION

Cluster formation and training

Two clusters were formed for large scale demonstration of two varieties of bread wheat at Dugda district, East shoa zone (Ogolcho and King Bird. Both varieties were planted on a total of 10ha land (each on 5ha). Before planting, training was provided for all participating farmers including host and non-host/ follower farmers, Development agent and district experts. A total of 120 farmers, 4DA's, 4 Experts and 16 other stakeholders including researchers were participants of the training. The training was provided once covering issues from input preparation up to post-harvest handling of bread wheat. The following table describes the number of training participants and other aspects of the organized cluster.

Table 1: Number of clusters formed and farmers and other participants trained.

Cluster Name	No of clusters	Land size/cluster	Total land size covered	Total no of farmers	No of training participants									
					Farmers		DA's		SMS		Others		Total	
					M	F	M	F	M	F	M	F	M	F
Bread wheat cluster	2	5ha	10ha	13	95	31	1	1	4	0	15	1	115	33

Stakeholder's role and responsibility

A sensitization session was conducted at the initial stage of the activity. During the session the following roles and responsibilities were raised and agreed upon by the participating bodies. The following table shows each role and the assigned stakeholder to it as agreed upon by the stakeholders.

Input distribution

As per the initial agreements made with participating farmers during the initial phases of the activity, the items listed in the following table were provided to the farmers. The farmers were also aware on the expectations from the activities as well as on how to utilize each item they were provided by the project (e.g. agro chemicals).

Yield performance of the varieties

The following table describes the yield performance of the two varieties during this pre-scaling up phase. The yield data was collected from different randomly selected seven sample places in each cluster. A total of 14 samples were taken from the total 10ha, 7 per each variety. Accordingly, Ogolcho gave higher yield compared to king bird variety. This mean yield is higher when compared to previous year's demonstration works in the same district for Ogolcho and kingbird varieties respectively. (Tesfaye and Fiseha 2018, Tesfaye et.al 2019). The increment in yield could be associated with the better rainfall pattern in the production season compared to the previous year.

Table 2: Stakeholder roles and responsibilities in implementing the activity

Stakeholders	Roles and responsibilities
Research (ATARC)	➢ Coordination and facilitation ➢ Provision of inputs (Seed, fertilizer and agro-chemicals ➢ Provision of training ➢ Organizing field days and visits ➢ Supervising, monitoring and Evaluation ➢ Helping farmers in revolving seed among them selves ➢ Collecting feedback for future technology promotion
Office of Agriculture and Natural resource of the district through Development Agent and assigned Focal persons	➢ Organize farmers into clusters and assist in site and farmers' selection ➢ Monitoring of activities of farmers in each cluster ➢ Support in providing training, field days and visits ➢ Assist during input distributions ➢ Helping farmers in revolving seed among them selves
Farmers	➢ Organize themselves in cluster ➢ Share costs ➢ Allocate land as per the requirement ➢ Prepare land for sowing and conduct required management practice (Agronomic practice) as per researchers and experts' advices ➢ Participate in the training and field days ➢ Share skills and experiences to neighboring farmers

Table 3. Inputs distributed

Item distributed		Unit	Amount	Remark
Seed (Certified C1)		Quintal	16	C1 seed was purchased from Oromia seed enterprise
Fertilizer	UREA	Quintal	15	
	DAP	Quintal	10	
Agro-chemicals	Weedicides	Lit	15	2-4-D for broadleaf weeds and Pallace for grass weeds were used
	Rust controlling chemicals	Lit	15	Both stem and leaf rusts were observed on both varieties

Table 4: Yield performance of ogolcho and kind bird varieties (2019 rainy season)

Variety	N	Mean GY (Qt/ha)	Min Qt/ha)	Max (Qt/ha)	Std. Deviation
Ogolcho	7	44.25 ± 3.90 ^{a}	30.25	62.50	10.34106
Kingbird	7	34.11 ± 1.98 ^{b}	25.00	43.00	5.24972

GY= grain yield

Financial analysis

To estimate the income gained through the varieties scaled up using the cluster approach a simple financial analysis has been done. The calculations were done on hectare bases taking the current market price of wheat. The variable costs were the prices during the input purchase at the early production (rainy) season of 2011. The calculations also considered price of land (4000 ETB/season) as a fixed cost considering the practice of renting land in the study area. Accordingly, the results indicate that a farmer can get an income of 45,939.00 through producing Ogolcho, while for kingbird an income of 31,743.00 was gained by allocating a ha of land. The difference in income among the varieties is as a result of the yield difference the varieties have. i.e the higher the yield the higher the income will be. The income can increase by 4000ETB if farmer used his/her own land; as there is no fixed cost. For this activity the farmers have allocated their own total of 5 ha for each variety. Thus, for a total of 5 ha the participating farmers have got a total of 233,695.00ETB birr by producing Ogolcho and 162,715.00 by producing kingbird variety using this cluster farming.

Table 5. Financial analysis on bread wheat production 2011 rainy season, Dugda district

Parameters		**Varieties**	
		Ogolcho	Kingbird
Yield (Y) qt/ha		44.25	34.11
Price (P) per quintal		1500	1500
Total Revenue (TR)= TR= YxP		66375	51165
	Seed cost	2075	2075
Variable costs	Fertilizer cost	3425	3425
	Chemicals	3511	3511
	labor cost	3000	3000
	Combiner harvesting	4425	3411
Total variable costs (TVC)		16436	15422
Fixed costs	Cost of land	4000	4000
Total fixed costs (TFC)		4000	4000
Total Cost (TC) = TVC+TFC		20436	19422
Gross Margin (GM) = TR-TVC		49939	35743
Profit= GM-TFC		**45,939.00**	**31,743.00**

Field days

Field days are means of communicating out-put and creating awareness about improved technologies or practices leaving participants specially farmers with new interests and new concepts of what is possible after seeing what their neighbors have been able to accomplish in their line of work. To this end, in this large-scale demonstration activity field day was used as a means to create awareness about the varieties sown, method of production as well as the clustering approach. Thus, a total of 224 Participants attended field day in the course of implementing the activity.

Table 6: number of field day participants and their role

No of participants												
Farmers			DA'S			SMS			Others		Total	Overall
M	F	Total	M	F	Total	M	F	Total	M	F		total
34	7	41	3	1	4	9	2	11	141	27	168	224

Farmer's feedback

The FREG member farmers were let to observe the performance of both varieties at different growth phases different visits. The varieties demonstrated were compared based on farmers' preferences, qualities and their drawbacks raised by farmers and presented in the following table. The participant farmers preferred ogolcho variety as their first choice when compared to King bird. This selection of farmers has been consistent with previous participatory variety selection as well as demonstrations as reported by Tesfaye and Fiseha 2017, Dagnachew et.al 2018 and Tesfaye et.al 2019. Apart from good qualities farmers also raised drawbacks of the varieties, the following table describes the results

Table 7: Farmers feedback on good qualities and drawbacks observed during the scaling up phase

Variety	Good qualities	Drawbacks
Ogolcho	Very good yield compared to farmers variety, Good plant height with good biomass to be used as a crop residue, uniformity on heading and maturity, good tillering capacity	The yield may not be as expected when there is no enough rainfall, not disease resistant (rust),
Kingbird	Good yield, Early maturing, disease tolerant, uniformity in maturing	The yield may not be as expected when there is no enough rainfall, not disease resistant, smaller seed size, seed shape not attractive,

Challenges and solutions given

The following table describes the challenges encountered and solutions given during the implementation of the activity.

Table 8: Challenge encountered and solutions given in the process of implementing the activity

Challenges	Solutions given
All Participant farmers not working with equal pace	Motivating, setting different agreed up on abiding rules by FREG members according to the situation (e.g. a farmer who lagged behind during weeding was finned with 100 ETB)
Accessibility of inputs (agro-chemicals, seed, fertilizer)	Early preparation of inputs, purchasing from central market if not available at district level, Seed was purchased from Oromia seed enterprise)
Effective collaboration among stakeholders	Clearly defining role and responsibility of the participating stakeholders (what is expected from research, office of agriculture, participating farmers and development agents) were defined and agreed upon at early implementation stages of the activity. At later stage efforts were made to remind those roles.

Exit strategy

In this large-scale demonstration activity field day was used as a means to create awareness about the varieties sown, method of production as well as the clustering approach. Apart from this the field day was also a means of exit strategy where the involved stakeholders from the office of agriculture were let to observe the performance so that the variety can be part of the wider extension system. Furthermore, the farmers were linked with cooperative and union operating in the study area, so that the produce is used as a revolving seed in the next production season.

CONCLUSION AND RECOMMENDATIONS

The activity focused on promoting previously evaluated, demonstrated and farmers preferred two bread wheat varieties (Ogolcho and Kingbird) planted on large scale using cluster approach. A total of 13 farmers were organized into two clusters with a total of 10ha; each variety sown on 5ha of land. Apart from participating (Host farmers) a total of 50 farmers were organized into two FREGs in both clusters, out of which 15 were female farmers.

The results indicate that the varieties gave improved yield than local varieties; as well as improved yield than previous year demonstrations. Through the cluster approach the participating farmers have improved their collaboration and working together culture. Furthermore, the group approach contributed for collective action, bulk production and ease for mechanization. Moreover, the trainings, field visits and days conducted provided a room in creating awareness about the varieties as well as wheat production in the study areas in general to different stakeholders. Generally, the varieties were also found to be important in enhancing the participating farmers' productivity and income. Therefore, further wider scaling up works through participation of stakeholders is recommended.

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Pre-Extension Demonstration and Evaluation of Soybean Technologies (Glycine max L. Merrill) in West and Kellem Wollega Zones

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ABSTRACT

Soybean (Glycine max L. Merrill) is the most important legume worldwide due to its versatile uses as a human food, animal feed and its role in soil amelioration. By considering the importance of the crop, the study was designed to create awareness on soybean technologies, to evaluate yield performance of soya bean technologies and to enhance the skill and knowledge of farmers in soya bean production and management practices. The trial was carried out during 2019 cropping seasons in one kebele from both Dale Sedi and Seyo districts of Kelem Wollega and two kebeles of Lalo Asabi district of West Wollega zone. One improved variety of soybean (Nyala) and Didesa (standard check) were evaluated and the best fit variety was selected with the participation of FREG members. To conduct this study, Four (4) FRG which consists of sixty nine (69) member farmers (48 male and 21 female) were established/strengthened. The spacing of 40cm and 10cm between plants and rows were used, respectively. The trial was conducted on gross area of 625 m^2. Plant height, number of pods per plant, number of seed per plant, biomass yield, seed size, early maturity and grain yield was recorded to evaluate the performance of the varieties. Analysis of variance was done to see the variation among varieties across districts and the combined analysis of the four districts was done. The mean grain yield of Didesa was 2780 kg ha^{-1} which is relatively higher than the mean grain yield of Nyala (2367 kg ha^{-1}). That means, Didesa showed 17.44% yield advantage over Nyala variety. Farmers were enhanced to evaluate the technology using their own criteria, accordingly they selected Didesa variety as their first choice by its grain yield, number of pods per plant, biomass yield and Nyala variety secondly by its merits of seed size (large) and early maturity. Therefore, the newly introduced and evaluated Nyala variety failed to be disseminated and popularized in larger scale.

Key words: Demonstration, Farmer's preference, Participation Soybean

BACKGROUND AND JUSTIFICATION

Soybean (Glycine max L. Merrill) is the most important legume worldwide due to its versatile uses as a human food, animal feed and its role in soil amelioration. Among food legumes grown in Ethiopia, soybean is gaining more importance in recent years (Zinaw et al., 2013). Producing and consuming more soybeans improves the situation as it can provide a nutritious combination of both calorie and protein. It is also cheap and rich source of protein for poor farmers, who have less access to animal source protein, because of their low purchasing capacity. Besides better nutritional status, the crop has a great significance in improving the status of soil nutrients and farming system when grown solely and in combination with cereal crops (CDI, 2010).

Soya bean can grow in mid-highland and lowland, areas of the country. Depending on its varieties, the crop grows in an altitude ranging from 700-1800, rain fall 450-1500 mm. Day temperatures ranging from 23-25 °C are ideal for growing the crop. Although soybean is largely grown in Ethiopia, its national average yield is low (19.98 quintal per hectare) which is below the global average, 23.1 quintal per hectare (CSA, 2014).
The low national yield could be attributed to low adoption of improved soybean production technologies, lack of improved varieties and poor cultural practice (PARC, 2010). By considering this, adaptation trial of improved varieties of Soya bean was done by HSARC and released the top promising and adopted Soya bean varieties. Accordingly, varieties Niyala yielded 32.18qt/ha was the high yielder varieties than that previously adopted varieties i.e. Ethioyogoslavia, Boshe and Dedesa varieties. HSARC Soya bean adaptation trial result reveal that, the yield advantage of Niyla variety over Dedesa (standard check in our case) was 7.12%.

More over this, since it is paramount important to test technology under farmers' management condition, participatory on farmers' field evaluation and demonstration of the technology was done in order to taste the feasibility, relative advantage and compatibility of the technology in line with the existing local condition. This will in turn hasten the adoption rate and dissemination of the technology. Accordingly, the two-way feedback between farmers and researchers is indeed vital component of high yielder and disease and pest resistant varietal development. The activity was intended to create awareness on Soya bean technologies, to evaluate yield performance of Soya bean technologies, to assess farmers' and other stakeholders' feedbacks for further technology development/improvement

METHODOLOGY

Description of the study area

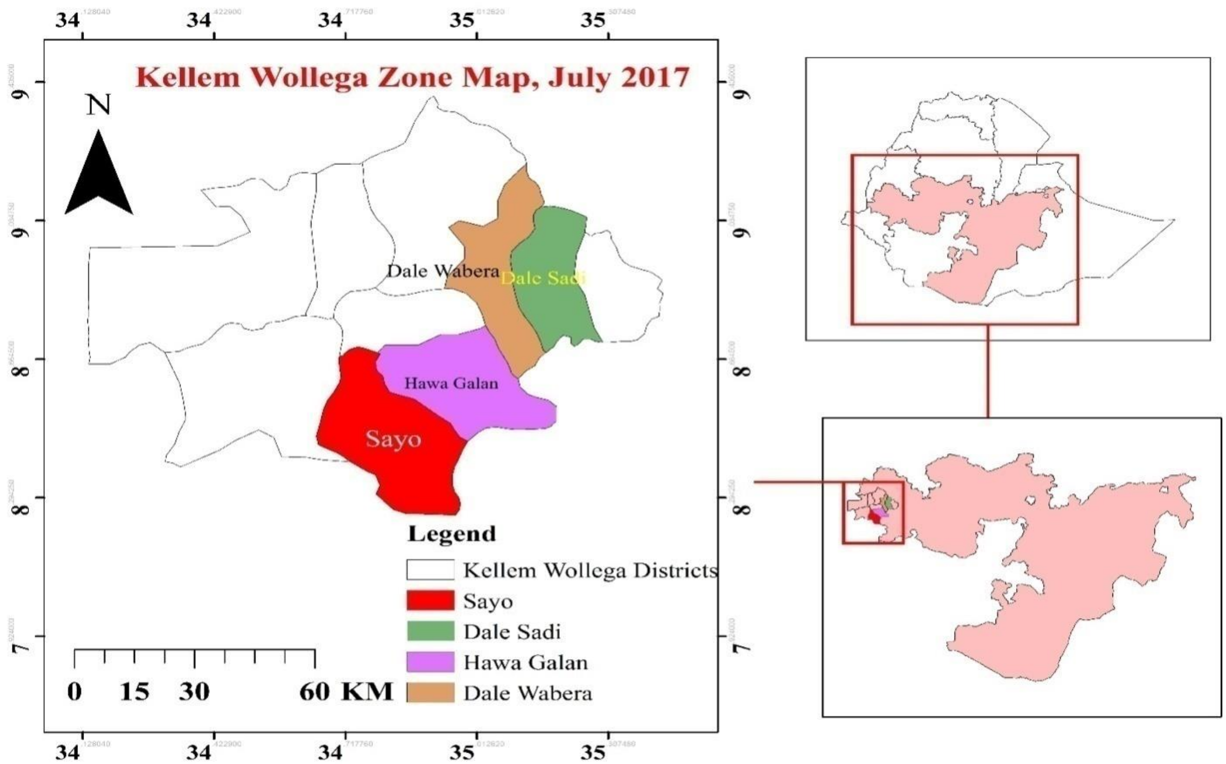
Kellam Wollega Zone
Kelam Wollega is one of the zones of the Oromia Region in Ethiopia. This zone is named after the former province of Wollega, whose western part lay in the area Kelam Wollega now occupies. Kelam Wollega was formed of woredas which included to West Wollega Zone, from Kellam Wollega zone project locations were Dale Sedi, and Seyo districts

Dale sadi district
Dale sadi is situated at about550 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 to February) with mean annual rain fall of 1200mm.

Sayo
Sayo District is located in the south western part of Kellam Wollega Zone & the zonal capital was found in it (Sayo district). Astronomically the district is located between $8^0 12'$-$8^0 44'$ north

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

Map of D/sadi and Sayo districts with in Kellam wollega zone.



L/Asabi district

Lalo Asabi is one of the 21 Districts of West wollega zone. It is bordered on the south by Yubdo, on the west by Aira and Guliso, on the north by Boji, on the east by the Benishangul Gumuz, and on the southeast by Gimbi. The administrative center of this woreda 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. Coffee is an important cash crop of this woreda. Over 50 square kilometers are planted with this crop.

Site and Farmers Selection

Three potential Districts, two Districts from Kellem wollega zone and one district from West wollega zone were selected purposively based on access to transport service, agro-ecology suitability and Soybean production potential. These Districts Were D/Sedi and Seyo of Kellem wollega and L/Asabi district of West wollega. From D/Sedi and Seyo Districts one each kebeles and from L/asabi district two representative model kebeles were selected based on their potential for Soybean production and accessibility.

The FREG (Farmer Research Extension Group) was established in each operational kebeles. The FREG formed was gender inclusive (the participation of male, female and the youth group as well). Before starting the field work, selection of experimental farmers was done in collaboration with researchers, extension agents and the FREG members by taking in to consideration the farmers' interests and motivation, land ownership, and other important socio-economic aspects

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

No	District	Kebeles	Number of FRGs	Member of FRGs		Trial farmers	
				Male	Female	Male	Female
1	Sayo	A/Mika'el	1	13	4	2	1
2	D/Sadi	Camo	1	11	6	2	0
2	L/Asabi	K/Birbir	1	9	6	2	1
		D/Disi	1	15	5	3	0
Total			4	48	21	9	2
Percentage				69.5%	30.5%	81.8%	18.2%

Materials used

One improved variety of Soybean namely; Nyala with standard check namely; Dedesa were tested for their yield performance and other important parameters with full participation of farmers in the study areas. The recommended fertilizer rate of NPS 100Kg/ha was used. The spacing between plant and rows were 10cm and 40cm respectively. Each experimental plot had 25m x 25m with a gross area of 625 m^2.

Technology evaluation and demonstration methods

Partial Training (only orientation training on role and responsibility of FREG members and very important agronomic practices like spacing between row and plant, seed and fertilizer rate and management practice) and Participatory technology evaluation and selection methods were employed to demonstrate and evaluate Soybean technologies. The demonstrated technology was evaluated using PRA tools like Pair wise ranking, focused group discussion & Direct matrix ranking.

Data type and Method of data collection and analysis

Grain yield, Farmers selection criteria 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. Data was collected both by the researcher and development agents of host peasant association. Development agents were provided with data recording sheet and orientation on how to record data since they were nearby to the trial and can frequently supervise the trial. The collected data were analyzed using simple description statistics like mean and table using SPPS software.

RESULT AND DISCUSSION

Training

Before the trial establishment, orientation on roles of farmers and experts and development agent as well as importance of FREG approach and during trial establishment, practical training on very important agronomic practice such as spacing between row and plant, seed and fertilizer rate and management practice was given to 69 member farmers out of which 48 of them are male and 21 of them are female and also 9(nine) DAs were trained out of which 6(six) of them are male and 3(three) of them are female. But training that planned to be given to farmers and other stake holders on Necessary packages for Soybean production, marketing and utilization was not given due to severe security problem, limited logistic and occurrence of Corona virus.

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

Districts	Participants	Male	Female	Total
Sayo	Farmers	13	4	17
	DA'S	2	1	3
D/Sedi	Farmers	11	6	17
	DA'S	2	1	3
L/Asabi	Farmers	24	11	35
	DA'S	5	1	6
Sum		57	24	81
Percentage		70.37	29.63	100

Yield performance of Demonstrated Soybean varieties

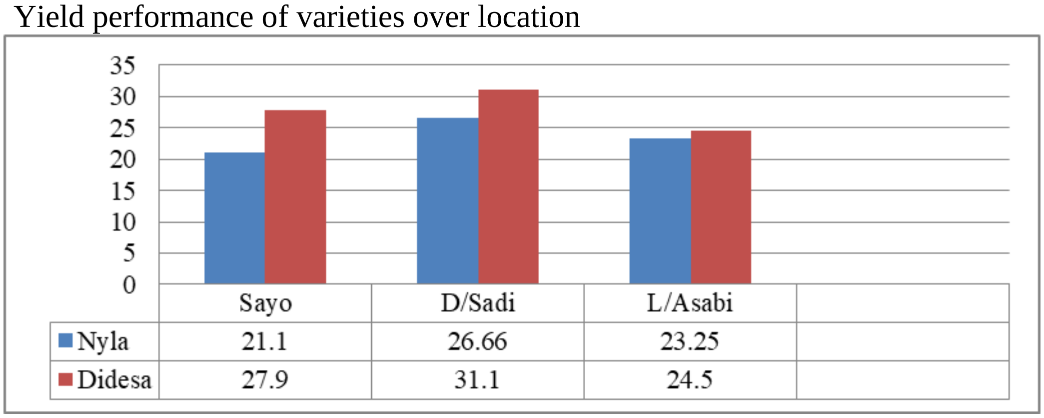
The yield results of the demonstration manifested that Didesa variety superiority over the newly demonstrated Nyala variety of Soybean with magnitude of 27.8 qt/ha and 23.67qt/ha, respectively. The yield advantages of Didesa over Nyala variety were 17.44%.

Table 4 Yield performance of demonstrated Soybean varieties

NO	Variety	Mean yield(Qt/hac)	Yield advantage over local
1	Didesa	27.8	17.44%
2	Nyala	23.67	

Source: On Farm Demonstration Data

Yield performance of varieties over location



The results of demonstration trials indicated that; in all study area Didesa variety (Standard check) gave high yield than the newly demonstrated Nyala variety of soybean. In all study area the already introduced variety of soybean, which is used as standard check in the study (Didesa) gave better yield than the newly introduced and demonstrated Nyala variety.

Economic cost of production was collected. But since there is no difference in cost of production we took yield advantage of varieties.

Yield advantage of Nyala = Yield of Nyala –yield Standard check(Didesa) *100

Yield of local= 23.67-27.8/27.8*100 = -14.85%

Based on the result of this demonstration trial farmers get yield advantage of 17.44% when they produce Didesa variety (standard check) rather than producing the improved variety (Nyala). Depending on this it is recommended Nyala variety not to be scaled up and popularized.

Participatory Varietal Selection, Preference and Ranking of varieties

Another important part of this research was participatory evaluation of the technology by the farmers. Farmers evaluated technology by setting their own criteria, and shown their own way of selecting a variety for their localities. Accordingly, different stakeholders (mainly farmers, development agents, and agricultural experts) participated on participatory evaluation and selection. Thus, at maturity stage a total of 72 (20 Female and 52male) farmers participated. During the assessment farmers were assisted to list their own selection criteria which may help them to identify best varieties/variety that can fit their demand. These parameters include grain yield, plant height, and number of pods per plant, number of seed per plant, biomass yield, early maturity and grain size. Accordingly, farmers selected Didesa variety first by more of criteria they set (for its grain yield, biomass yield, number of pods per plant, number of seed per plant and plant height) and Nyala variety secondly by its quality of seed size and Early maturity. Hence, it is a paramount important to include farmers' preferences in a variety selection process. Therefore, based on objectively measured traits and farmers' preferences, Nyala variety of soybean was not selected to be scaled up and disseminated for the target community in the study areas.

Table 4 Pair wise ranking of varieties by farmers

Traits	**GY**	**PP**	**SS**	**SP**	**BY**	**EM**	**Frequency**	**Rank**
GY	X	GY	GY	GY	GY	GY	5	1
PP		X	SS	PP	BY	EM	1	5
GS			x	SS	BY	EM	2	4
SP				X	BY	EM	0	6
BY					x	EM	3	3
EM						x	4	2

GY=Grain yield, PP=Pod per plant, SP=Seed per pod, EM=Early maturity, GS=grain size, BY=Biomass yield

As shown in above table the most important trait among farmers' criteria was grain yield, Early maturity, biomass yield, grain size, number of pod per plant and number of seed per pod of the demonstrated Soybean variety respectively.

Table 5. Direct Voting ranking of varieties

No	Criteria (N=72)	Farmers Preference and ranking of Soybean Varieties	
		Nyala	Didesa
1	Grain yield		72
2	Early maturity	72	0
3	Biomass yield	0	72
4	Grain size	72	0
5	No of pod per plant	0	72
6	No of seed per pod	0	72
	Total	144	288
	Percentage	33.3%	66.7%
	Rank	2	1

As shown in the above table farmers preferred and selected Didesa variety as their first choice when compiled by all criteria of their choice followed by Nyala (improved variety). Generally farmers preferred and ranked variety Didesa first with the total percentage of 66.7 %, Nyala second with 33.3%

Lessons learned

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

CONCLUSION

One improved variety of Soybean (Nyala) including Standard check was evaluated with the objective of identifying the best performing Soybean variety with full participation of farmers. It was carried out on 11 farmers' field during 2011/12 E.C cropping season in Dale Sedi and Sayo districts of Kellem wollega and Lalo Asabi district of West wollega zone. Grain yield of the two varieties of soybean was collected and analyzed by researcher. Ensues the already demonstrated and used as standard check, Didesa variety gave higher yield relative to the newly introduced and demonstrated Soybean variety(Nyala) in all three districts. Different participatory technology evaluations were used to evaluate the technologies. Among them PVES, Pair wise ranking and direct matrix ranking were used. Farmers evaluated the technology by setting their own parameters which include grain yield, grain size, days to maturity, biomass yield, number of seed per pod and numbers of pods per plant were major evaluation criteria's farmers used. Accordingly, a total of 72(20 Female and 50 male) stakeholders evaluated and selected varieties based on their selection criteria. Generally, farmers ranked Didesa variety first with the total of 66.7% and Nyala second with total of 33.3% based on the above listed criteria. Accordingly, the newly introduced Nyala variety has no yield advantage and quality to be preferred than standard check.

RECOMMENDATION

The trial farmers have now developed a better capacity in identifying best fit varieties and management practices of Soybean technology, thus they should be given the opportunity to share their experience to other farmers thereby strengthen farmers to farmers extension. It will be productive if extension service considers the identified farmers' preferences in varietal promotion activity. Generally, Didesa variety which is used as standard check was better performed and preferred by more farmers (66.7% of participant) than the newly introduced Nyala variety of Soybean. Ensues based on both yield advantage and farmers' preference, it is not recommended to popularize the newly introduced improved variety (Nyala) on large scale.

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

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ABSTRACT

Pre-extension demonstration of improved Common Bean varieties was conducted in Ginnir and Goro districts of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Wabero) variety along with standard check. The demonstration was under taken on single plot of 10mx10m area for each variety with row planting, recommended seed rate of 100kg/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 identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Wabero variety performed better than the standard check (Awash 2 variety) with an average yield of20.375qt/ha and17.695qt/ha respectively. Wabero variety had 15.15% yield advantage over the standard check. Furthermore, this variety was selected by farmers. Thus, Wabero variety was recommended for further scaling up.

Key words: Common bean, Demonstration, Farmers' preference, Wabero

INTRODUCTION

Phaseolus vulgaris L. (Leguminosae) is a crop widely distributed in all parts of the world. In Ethiopia, common bean is cultivated as a source of protein for local consumption and for export. Mostly**,** it grows in the warm and lowland areas of the country (TeameGereziher et al, 2017). Common beans are among the most important grain legumes produced by small-scale farmers for both subsistence and cash, mainly in the lowlands and in the rift valley areas of Ethiopia. They are high in starch, protein, and dietary fibre, and are an excellent source of minerals and vitamins. (FAO, 2015).

Among 1,620,497.30 ha pulse crops produced in Ethiopia88,302.71 hectare of land was covered by white common bean and a total of 1,508,230.37 quintals were produced with average productivity of 17.08 quintal per hectare. In Oromiya 30,502.27 hectare of land was covered by white common bean and a total of 509,614.93 quintals were produced with average productivity of 16.71 quintal per hectare in 2018/2019 (2011) production season (CSA, 2019).

In Bale Zone a total of 30,502.27ha of land was covered by white common bean and 55,116.24 quintals were produced with an average productivity of 13.69quintals per hectare during 2016/2017 (2009) production season (CSA, 2017). However, local varieties are becoming low yielding and less profitable to subsistence farmers. To overcome this problem, researchers from Sinana Agricultural Research Center released Wabero, variety of common bean. Wabero has yield advantage of 17.9 % over standard check. Hence, participatory on farm demonstration of this variety with standard check and enhancing farmers to select variety/ies of their interest to their locality is a vital task.

METHODOLOGY

Description of the study area

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

Site and farmers selection

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

.

Materials used and Field design

Improved variety, Wabero was demonstrated with Awash 2 (standard check). Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full packages were applied in which, row planting with 40 cm b/n rows, seed rate of 100 kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. Twice hand weeding was done.

Data collection

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

Data analysis

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

Farmers' variety evaluation and selection

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

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

Focused Group Discussion (FGD)

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

Table 1: participants of variety selection

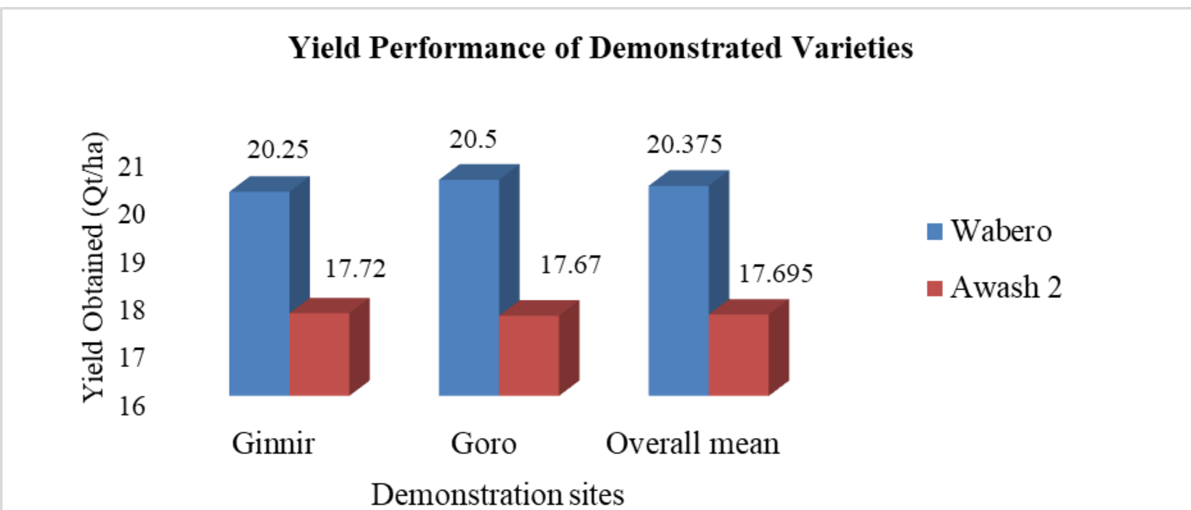
	Farmers					
Districts	**Men**	**Women**	**Youth**	**Total**	Others	Total
Ginnir	17	1	12	30	5	35
Goro	13	1	10	24	5	29
Total	30	2	22	54	10	64

RESULT AND DISCUSSION

Yield performance of Demonstrated varieties

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

Chart 1: Yield performance of the demonstrated varieties



The demonstration result revealed that, the new variety (Doyo) performed better than the standard check (Awash 2 variety) all over the demonstration sites. It gave higher yield at all locations. The mean yield of Wabero variety was 20.25qt/ha and 20.5qt/ha at Ginnir and Goro, respectively with all over mean yield of 20.375qt/ha. Similarly, the mean yield of Awash 2 variety was 17.72qt/ha and 17.67qt/ha at Ginnir and Goro respectively with all over mean yield of 17.695qt/ha (chart 1). The yield advantage of Wabero over Awash 2 is 15.15%.

Comparison of yield advantage of improved varieties

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

Yield Advantage of Wabero over Awash 2: 20.375-17.695=15.15%, 17.695

Table 2: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties	
		Wabero	Awash 2
1	Yield obtained (qt/ha)	20.375	17.695
2	Sale price (ETB/qt)	2800	2800
3	Gross Returns (Price X Qt) TR	57050	49546
4	Land preparation	3800	3800
	Seed purchase	2800	2800
	Fertilizers purchase (NPS)	1600	1600
	Labor for weeding	2000	2000
	Insecticide purchase	300	300
	Labor for spray	200	200
	Labor for harvesting	1600	1600
	Labor for threshing	800	800
	Packing, Loading and store	210	180
	Store (bag purchase)	210	180
	Total Variable Costs TVC (ETB/ha)	13520	13460
5	Fixed cost	7800	7800
6	Total cost (TC)	21320	21260
7	Net Return (GR-TC)	35730	28286
8	Benefit cost ratio (NR/TC)	1.68	1.33

As shown in the above table (table 2) the cost benefit ratio analysis showed that, the net return gained from Wabero and Awash 2 varieties was 35730 birr and 28286 birr per hectare, respectively. Wabero variety had higher cost benefit ratio (1.68) than Awash 2 variety (1.33). This means, Wabero variety is more profitable than Awash 2 variety with the same cost expenditure for both varieties per unit area.

Farmers' preference to demonstrated varieties

The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria. Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, pod/plant, seed/pod and disease tolerance were the top four priority concern given by farmers (Table 3).

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

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

6	**F**	A	F	C	D	E		2	5th
7	**G**	A	G	C	D	E	F	1	6th

A=yield, B= seed size, C=disease tolerance, D=seed/pod, E=Pod/plant, F=suitability for consumption, G=marketability.

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

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

No	Variety	Rank	Reason
1	Wabero	1st	High yielder , bigger seed size, more tolerance to disease, higher number of seed/pod, higher number of pod/plant, suitable for consumption, marketable due to its color
2	Awash 2	2nd	Low yielder, smaller seed size, less tolerance to disease, smaller number of seed/pod, smaller number of pod/plant, late mature, but marketable and suitable for consumption.

CONCLUSIONS AND RECOMMENDATIONS

Pre extension demonstration and evaluation of common bean varieties was carried out on six (6) representative trial farmers' fields. Improved variety viz. Wabero was demonstrated along with Awash 2 variety which is the standard check. Accordingly, Wabero gave higher yield than Awash 2 variety.

Moreover, Wabero was selected by participant farmers in all districts due to it is high yielder , bigger seed size, more tolerance to disease, seed/pod, pod/plant, suitable for consumption, marketable. Based on these facts, Wabero variety was recommended for further scaling up.

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Cluster based large scale demonstration of improved Agricultural Technologies in West and Kellem Zones

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ABSTRACT

Technologies that can truly solve farmers' problems and provide opportunities for productivity growth, improved food safety, and greater farm income may not stay long on the shelf (Lele et al., 2010). However, scaling out does not just happen by itself; it needs to be well planned and facilitated. Therefore, the study was designed to promote and disseminate improved varieties of Five (B/Wheat, Maize, Potato, Haricot bean and Finger millet) agricultural commodities in the study area. The operational sites of the study were Lalo Asabi and Guliso district from west Wollega zone whereas Dale Sedi, Dale Wabera and Seyo, districts from Kellem Wollega zone. Two major cluster approaches were implemented (Village cluster and Farm Cluster). Selection of farmers was made purposively based on their representativeness of the majority of farmers, their interest in carrying out the recommended management practices, land ownership and other important socio economic variables. After farmer's selection, each farmer was given the seed which can grow on 0.25ha of land. Three finger millet variety (Bako-09,Bonaya and Addis) has been distributed and sown on a total of 23.75 hectare of land, two Variety of Potato (Gudane and Balaxe) has been distributed and sown on a total of 2.1 hectare of land, two variety of Common bean (SER-119 and SER-125) has been distributed and sown on a total of 6 hectare of land, three variety of improved Bread wheat(Liban,Ogolcho and King bird) has been distributed and sown on a total of 10 hectare of land and one improved variety of Maize (BH-661) has been distributed and sown on a total of 21.15 hectare of land in both Kellem and west Wollega zones. Ensues total of 62.91 hectare of land was covered and total of 201 farmers (61 of them are Female and 140 of them are male) participated and benefited from the project. From total covered 49.16 hectare of land the total of 3050.73 qt of grain yield (671.28 qt of finger millet, 1466.3 qt of maize, 554.15 qt of potato, 117 qt of common bean and 242 qt of wheat) were harvested. Revolving seed system was used to sustain the availability of the distributed seed. Field day was organized to create wider interest and awareness and it was attended by woreda agriculture and natural resource office heads, experts, researchers, DAs and Farmers. During field day a total of 152 farmers out of whom 115 were male and 37 were female and a total of 56 experts including agriculture and natural resource office heads(out of whom 47 were male and 9 were female) have attended. Finally, farmer's feedback concerning technology was collected and incorporated. Accordingly, those popularized improved varieties of different agricultural commodities has its 'own positive and negative feedback and farmers feel that most of those newly introduced technologies are better than local practice in case of productivity and production system. However, it is difficult to address the wider community only by the effort of the center and hence it requires Woreda Agricultural and Natural resource offices in collaboration with Zonal Agricultural and Natural resource office and Agricultural Unions commitments to scale up the technologies in wider scale.

Key words: - Commodities, Cluster, Farmers Feedback, FREG, Pre scaling up.

INTRODUCTION

Agricultural technologies have the power to drive economic development and improve food and nutritional security around the globe (USAID, 2014). Advance in agriculture is contingent on the volume of technologies that is available for use in the sector. Apparently, the same condition was responsible for the agricultural transformation and food sufficiency in the advanced world. Every development in the history of mankind is orchestrated by technological revolutions; more specifically when technologies meet up with felt needs and social political will for change. To date efforts, gives ample attention to technology generations across a board, and series of technology testing actions in several pilots. Some of the technologies have potentials and a handful also stood at bay requiring further development to yield the desired outputs. Despite the efforts into technology generation, introduction, adaptation etc. the agricultural sector development only experiences a slight move and it seems to plateau suggesting that other actions are required to sustain the growth of the sector.

One predominant assumption in the past is that if technologies or practices proved useful to farmers, then technology diffusion would occur naturally through peers (scale-out on its own), family and members or farmer associations. Sometimes good ideas that meet pressing needs spread on their own as they may be ground breaking. They therefore proliferate seamlessly from person to person, organization to organization and country to country. However, most good ideas do not spread with such ease. Rather, they require the backing and energies of committed individuals and organizations to design and carry out strategies for expansion that are carefully tailored to the realities of their settings. This is why agricultural researchers and scientists often face the problem of moving beyond testing technologies with farmers on a small scale, to enabling livelihood impacts across larger numbers of households, villages, and districts (Harrington et al., 2001). In practice, many technologies on the shelf are either not useful in real life or are not reaching enough farmers. Technologies that can truly solve farmers' problems and provide opportunities for productivity growth, improved food safety, and greater farm income may not stay long on the shelf (Lele et al., 2010). However, scaling out does not just happen by itself; it needs to be well planned and facilitated. Scaling up the impacts of agricultural research has become the center of recent debate; the debate is based on the recognition that many relevant technologies and approaches are not achieving their full impact because of low levels of adoption. Providing improved technologies to smallholders is essential, but their uptake is often limited by a number of factors. Conversely, there have been reports of some successful agricultural technology scaling projects within the continent and all over the world where learning of scaling of technologies can be used to adapt scaling knowledge. For example, the African Development Bank-funded Dissemination for New Agricultural Technologies in Africa (DONATA) program has been found to be a successful mechanism for adoption and scaling of technologies and innovations. In Ethiopia, the Operational Research Technology Dissemination project (ORTDP) is addressing key agricultural development challenges prioritized by both the Ethiopian and Irish governments: improved food security, poverty reduction and greater gender equity, better nutrition outcomes and more climate resilient food and farming systems through supporting of rural poor household by accessing for improved agricultural technologies. Southern Agricultural Research Institute (SARI) in collaboration with Irish-Aid had reported success in agricultural research and dissemination of improved agricultural technologies focusing on crops (Bassa et al., 2017).

MATERIALS AND METHODS

Description of the study areas

The trial was carried out during 2019/20 cropping seasons in Dale Wabera, Dale Sedi, Sayo ,Guliso and Lalo Asabi districts in collaboration with District Agricultural and natural resource office. Dale sadi, Dale Wabera and Sayo districts are among districts found in Kellam wollega zone, whereas Guliso and Lalo Asabi districts are among 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.

Dale Wabera District

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

Sayo

Sayo district is located in the south western part of Kellam Wollega Zone & the zonal capital was found in it (Sayo district). Astronomically the district is located between 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).

Guliso

Guliso is one of 19 districts of West Wollega Zone, with the capital located at 490 km West of Addis Ababa. It has an estimated area of 631.90 square km; it is bounded by Boji Chokorsa in the northeast, Gawo Dale in the west, Aira in the south and Lalo Asabi in the east. Total human population of the district is estimated at 91,471 of whom 45,525 were male and 45,946 were female. Of the total households 89.5 % is rural agricultural households (GWAO, 2016). The district has a total of 28 kebeles, of which 26 are rural based peasant associations and 2 are urban dwellers Associations Kebeles. From total rural passant associations 18 of them categorized to mid highland agro-ecology and 8 kebeles allocated to lowlands agro-ecology.

The altitude of the Woreda varies from 1650 meters to 1700 meters above sea level. It receives average annual rainfall of 720 mm and has an annual temperature range of 9^0c-18^0c. In terms of agro-ecology, the district is categorized as Mid highland (69%) and lowland (kola) (31%) (Fanos, 2012). The soils types in the district are predominantly red (58%), black (32%) and mixed (10%).

Lalo Asabi district

Lalo Asabi is one of the 21 Districts of West wollega zone. It is bordered on the south by Yubdo, on the west by Aira and Guliso, on the north by Boji, on the east by the Benishangul Gumuz, and on the southeast by Gimbi. The administrative center of this woreda 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.

Site and Farmer Selection

Site selection was done in collaboration with district agriculture and natural resource offices and DA's. The sites were selected purposively based on the proposed agricultural commodity production potential and suitability to be cluster (adjacent land with other farmers). 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 201 representative farmers' field in the five selected districts. In 2019/20 year of production the scaling up was done on 201 farmers' felids in Sayo, Dale Sedi, Dale Wabera, Guliso and Lalo Asabi districts. Necessary management and monitoring were also performed properly.

Materials Used

Three finger millet variety (Bako-09, Bonaya and Addis), two Variety of Potato (Gudane and Abdane), two variety of Common bean (SER-119 and SER-125), three variety of improved Bread wheat (Liban, Ogolcho and King bird) and one Improved variety of Maize (BH-661) those preferred and selected by farmers were used with their full recommended practices. In organic fertilizer NPS and UREA were used with their 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 at least 0.25 ha of land. The study addressed a total of 201 farmers.

Stakeholder platform

A multi-stakeholder platform was prepared to foster the interaction of stakeholders with a personal stake in the commodity of interest or the systems of production, promotion of organizational and institutional changes to enable cross disciplinary research and development and multi-institutional collaborations; capacity building for stakeholders on the innovation platform viz., farmers, and extension agents. Memorandum of understanding was signed in between clusters groups and implementing institution as well as stakeholders at different level.

Capacity building

Capacity building was delivered on how to adopt technology, its practical use, and associated impact. Regular feedback from monitoring and evaluation was collected and assessed.

Cluster Approach

Two major cluster approaches were implemented (Village cluster and Farm Cluster). Among the five selected commodities finger millet was the only commodity on which both approaches were implemented whereas the remaining commodities were mainly of farm cluster.

Selection of varieties

Before commence of the large-scale demonstration the farmers convey their interest on commodities and technologies, they prefer to ensure efficiency in production systems. Among selected commodities, improved varieties that best fit for the area was selected by researchers, depending on the previous research findings.

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.

RESULT AND DISCUSSION

Seed distributed

A total of 58 Qt of different varieties of different agricultural commodities were distributed for a total of 201 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. Ensues total of 62.91 hectare of land was covered and total of 201 farmers (61 of them are Female and 140 of them are Male) are participated and benefited from the project.

Yield performance of Varieties

The yield data of the popularized five agricultural commodities were to evaluate the performance of the varieties under management of farmers with close supervision of development agents. Accordingly, the mean yield of the distributed finger millet over location is 27.9 qt/ha, while, the mean yield of Maize, Potato, Common bean and Bread wheat over location were 68.2 qt/ha, 275.7 qt/ha, 19.5 and 24.25 qt/ha, respectively.

Table 1 Commodities included in cluster based large scale demonstration and Seed Distributed Across Districts

No	Commodities	Varieties	Zone	Woreda	Kebele	Area in hac	Total land coverage in hac	Seed given(Qt)
1	Finger millet	Bako-09	K/Wollega	Dale	Gandaso	6.5	10	4.7
		Boneya		Sedi	Camo	1.5		
		Addis-01	West Wollega	Lalo Asabi	Kelley Birbir	2		
2	Maize	BH-661	K/Wollega	Sayo	Mata	11.4	21.15	5.5
					Tabor	4.75		
			West Wollega	Lalo Asabi	Kelley Birbir	5		
3	Potato	Gudene	K/Wollega	Sayo	Tabor	1.01	2.01	35
		Belete	West Wollega	Lalo Asabi	H/sardo	1		
4	Common Bean	SER-125	K/Wollega	Dale	Gandaso	3	6	4.8
				Sedi	Camo	3		
5	B/Wheat	Liban Ogolcho Kingbird	K/Wollega	Sayo	Mata	10	10	8
Total							**49.16ha**	58

Table-2 yield performance of those popularized five agricultural commodities.

Commodities	Yield in qt	Total Coverage	Overall harvested yield
Finger Millet	27.9	10	279
Maize	68.2	21.5	1466.3
Potato	275.7	2.01	554.157
Common bean	19.5	6	117
Wheat	24.25	10	242
Over all total Yield		49.16	2658.457

Source: own scaling up result

The yields obtained across the location for the distributed varieties of those five commodities were varied from location to location. However, the yield obtained from those varieties of different commodities performed better than the local variety of each crop in all study area.
NB: the result of the popularized finger millet technology that mentioned on above table is only for farm clustered finger millet variety.

Village cluster of Bako-09 variety of Finger millet

Among the five selected commodities, finger millet was the only commodity on which both approaches were implemented. Accordingly, one improved finger millet variety (Bako-09) has been distributed on a total of fifty fife (55) farmers' fields. This pre-scaling up was implemented in Dale Sadi(Camo) and Dale Wabara (Dogano Bile) districts of Kellem Wollega and Guliso (Moga Kobara) district of West Wollega Zones. Ensures total of 13.75 ha of land was covered by Bako-09 variety of finger millet and total of 392.28 quintal of finger millet production was harvested during project life span. To share useful experience with stakeholders, field day was organized and total of 80 farmers out of whom 64 were male and 16 were female and a total of 59 experts out of whom 53 were male and 6 were female have attended. Finally, farmers feedback concerning technology (Both merits and demerits of the technology) was collected and incorporated. According to their feedback Bako-09 variety of finger millet has greater yield advantage and productivity to their locally owned variety. However, they also criticized that the limited capacity of the center to address the majority of farming community in the study areas. Hence, the Woreda Agriculture and Natural Resource office in collaboration with Zonal Agriculture and Natural Resource office and Agricultural Unions should hold the turn to scale up the technology in wider scale.

Training

Training was organized to introduce the available agricultural technologies with their nature and management practices to both trial farmers and DA's in the trial sites. It was given for the target community on meaning and importance of cluster based demonstration, Role and responsibility of members contained in cluster, post-harvest handling and commercialization of the new technologies. Manuals were prepared and distributed for farmers and Development Agents. The training given covered a total of 141 target communities out of which 100 of them were male and 41 were female.

Table 3: Training given

Area of training	No of participants				Total
	Farmers		SMS		
	M	F	M	F	
Meaning and importance of cluster base demonstration Role and responsibility of members contained in cluster post-harvest handling and commercialization Improved agricultural technologies and their possible impact on livelihoods	92	38	8	3	141

Field Day

Field day was among the means used to share experience among stakeholders. Accordingly, field day was organized in Dale Sedi district (Camo and Gandaso) and Sayo district (Maxa and Tabor) in order to share experience among agricultural stakeholders. During field day a total of 208 stakeholders out of whom 162 were male and 46 were female attended.

Table-4 Field day participants

No	Area of training	No of participants				Total
		Farmers		SMS		
		M	F	M	F	
1	Maize and Potato Large scale demonstration	34	18	11	8	141
2	Finger millet and Common bean Large scale demonstration	81	19	36	1	137
Overall total		115	37	47	9	208

Economic return to farmers

Different agricultural commodities are produced in west and Kellem Wollega zones mostly for household consumption and marketing purpose. In achieving food security and diversifying household income it contributed huge for the stakeholders. Farmers those participated in cluster based scaling up of the different varieties of those five agricultural crop achieved slight progress in ensuring their food security as well as income gained. During scaling up a total of 4.7 quintal of improved Finger millet, 5.5 quintal of improved maize variety, 35 quintal of improved Potato varieties, 4.8 quintal of improved Common bean varieties and 8 quintal of improved Bread wheat varieties were distributed for farmers from which a mean total of 279qt, 1466.3 qt, 554.2 qt ,117 qt and 242 qt of Finger millet, Maize, Potato, Common bean and Bread wheat were harvested, respectively. Generally total of 2658.46 qt of seed were harvested during the project life span.

Future direction/The Way forward

In the current large-scale demonstration because of the five commodities rendered to the farmers totally more than two thousand six hundred quintals were harvested only from less than 50 hectares of land. It is imaginable how much our country could reap from her arable land provided that if technological demonstration and technical backstop would be provided.

CONCLUSIONS AND RECOMENDATIONS

Cluster based Prescaling up of different varities of five(5) agricultural crop were conducted in Dale Sedi, Dale Wabera and Seyo districts of Kellam and Lalo asabi and Guliso districts of West Wollega zones. The Project covered a total of 49.16 ha of lands from which a total of 2658.46 Qt was harvested. During project life span a total of 201 house holds where adressed and training was given for total of 141 target stakeholders to capacitate participants on different agricultural technologies and management practices, post harvest handling and comercialization. The collected farmers feed back was mostly positive towards the distributed agricultural commodty varieties. Therefore, those scaled up varieties is recommended for wider scaling up works. In addition it is recommended that the agricultural and natural resource offices at zone and district levels found in West and Kellem 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 varieties and improve production and productivity of those commodities in West and Kellem Wollega zones.

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Cluster-Based Pre-Scaling up of Improved Finger Millet Varieties in East Wollega Zone Districts, Western Oromia

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ABSTRACT

The average yield of finger millet is low in Ethiopia due to different production constraints such as limited availability of improved varieties, lack of formal seed delivery system, limited adoption of the available technologies, blast diseases and threshing problem. In western Oromia, farmers used local varieties due to lack of formal seed delivery systems in the zones and also lack of improved recommendation packages. This activity was initiated to scale up and popularize full packaged improved finger millet varieties in finger millet production potential districts of east Wollega zone in 2019. Three districts (Boneya Boshe, Wayu Tuka, and Gida Ayana) were selected from East Wollega zone and a total of 6 clusters were established. Pre-scaling up of the crop conducted on 22 ha of land and 80 farmers (53 male and 27 female) were included in the cluster. Those participant farmers were trained on issues of cluster seed production system, agronomic practices and crop management before the commencement of actual work. Finger millet seed, fertilizer and agrochemicals and training were delivered by Bako agricultural research center, and farmers mostly participated in land preparation, sowing, weeding and harvesting. All necessary agronomic practices for Finger millet production were applied as deemed necessary in a similar fashion on all farmers' plots. Gudatu variety was produced at Wayu Tuka district, Bako-09 was produced at Gida Ayana and Gute variety at Boneya Boshe district. The average yield obtained from Gute variety was 2.22 t ha^{-1} followed by Bako-09 variety (2.04 t ha^{-1} and least for Gudetu variety (1.74 t ha^{-1}). Therefore, scaling-out of the variety with full production packages should be carried by district extension agents for similar agro-ecological areas through establishing and strengthening seed producer Cooperatives.

Keywords: Agronomic practices, Cluster based, Finger millet, pre-scaling up

INTRODUCTION

In spite of significant achievements in agricultural sector, the problem of food nutrition and security remains a key challenging development and healthy issue in Ethiopia. Many reports shown that the country is also experiencing unfavorable climate change whereby several parts of the country are suffering from drought, erratic rainfall patterns, poor soil fertility and poor farming technologies (FAO, 2018; Dessi, 2018; Mohamed, 2017; Endalew *et al*., 2015) that worsening food security situation in the country. In addition, the population of the country estimated to reach 190.9 million by 2050 (Population reference Bureau, 2018). Hence, to meet future food demand requires use of crops tolerant to harsh environment and expansion of intensification of the present production that ensure sustainable food availability at house-hold level.

Finger millet is one of the crops underutilized, but the main important plant genetic resources that could be plays crucial role in dietary needs and income sources for millions of poor farmers in places like Ethiopia and other less developed countries (Asefa *et al*., 2018; Kassahun and Solomon, 2017; Birhanu, 2015). Its adaptability to wide range of environment with minimal input requirements, short growing season, productivity on marginal land where other crops cannot perform and withstanding significant soil acidity make finger millet important cereal crops for future human use (Soumya *et al*., 2016; Upadhvava *et al*.. 2007). Nutritionally, its calcium content is 10 times greater than wheat, maize or brown rice and 3 times higher than milk (Kumar *et al*., 2016; Bora, 2013), and also important in the diets of children, pregnant and breast-feeding women. More over it is used as medicinal value in management of measles, anaemia, diabetes and reduce cancer (Babu *et al.,* 2007), and also for brewing due to its good malting qualities. The grain can be stored for up to 10 years or more without deterioration and weevil damage (Asfaw *et al*., 2018)

Ethiopia is among the major finger millet growing countries in eastern Africa followed by Kenya (Asfaw *et al*., 2018). The Ethiopian Central Statistical Authority data from 1995-2017/18 showed that the area devoted to finger millet cultivation and its production is generally increasing. For instance, in 2017/18 rainy season, the total land areas of about 10,232,582 ha (80.71%) was under cereals, of which finger millet covered about 456,057.31 ha (4.5 %) and 10,308,23.15 tones grain yields (CSA, 2018). Regionally, Oromia contribute 20.6 % of the total cultivable land and 21.3 % of total production in the country. Specifically, east Wollega Zone has a good potential in Bonaeya Boshe, Wayu Tuka, Diga and Gida-Ayana districts. According to ILRI-SLP-Crop Residue project survey conducted in 5 districts of east Wollega zone, finger millet took a rank of 1-3 in terms of area coverage. In the area, it is widely used as bread combined with maize flour, injera mixed with tef and also used as porridge, cake, traditional breakfast called "*chacabsa*", soup for babies as well as for adults and distilled spirit locally known as *Areke*. Despite its high yield potential and tolerance to harsh conditions, the recent national average yield is about 2.2 t ha^{-1}. This yield is even below the regional (Oromia) average grain yield of 2.3 t ha^{-1} (CSA, 2018), regardless reported yield potential in the range of 4-5.0 t ha^{-1} (Kebede *et al*., 2019; Mulatu *et al.*, 1995). Even though many biotic and abiotic factors can contribute to this big yield gaps, shortage of improved varieties, disease damage (blast), lack of formal seed delivery systems are among the foremost factors contributing to low productivity this crop (Asfaw *et al*., 2018; Birhanu, 2015; Tefera and Adane, 2013).

Generation, popularizing and dissemination of improved finger millet varieties with its full package management technologies through cluster-based pre-scaling up are amongst the strategies to up-lift productivity of the crop. Besides dissemination of varieties; training and field days in the process of the cluster-based pre-scaling up activities are other benefits in raising the capacity and knowledge of the participated farmers and other stallholders. In addition, advisory services during supervision and follow up of the disseminated technologies in cluster-based approach creating awareness for large number farmers in the area. Moreover, various sources shown that cluster-based scaling up of the improved technologies are very important to create multiple impacts and address a large number of farmers and areas (Asfaw *et al*., 2018; Zewdu *et al*., 2018; Tefera and Adane, 2013). To this, Bako agricultural research center are conducted a multi-location variety development and released 11 finger millet varieties so far for western Oromia and similar locations. As far as this, the first variety, Boneya was released in 2002 followed by Wama in 2007, Bareda in 2009, Gute in 2009, Gudetu in 2014, Addis-01 in 2015, Urji in 2016, Diga-1 in 2016, Bako-09 in 2017, Diga-2 in 2018 and Kumsa in 2019 (Variety registration, 2018). Nevertheless, growers in Western Oromia produce local variety and traditionally use broadcasting sowing methods using 25-30 kg ha^{-1} seeds. Thus, once a new crop technology verified and selected by the end users, scaling-up and popularization of the technologies are the next step to generate demands and awareness towards the technologies. Therefore, this activity was conducted with the objectives of scale-up and popularizes of finger millet production technologies to create multiple impacts and address a large number of farmers in the area.

MATERIAL AND METHODS

of the Locations

The activity was conducted during the rainy season of 2019 in east Wollega zone in three districts *via* Boneya Boshe,Wayu tuka and Gida Ayana selected as AGP II mandate areas and representativeness in terms agricultural production particularly on their finger millet production potential. The areas located in a sub-humid Western Ethiopia and have variable climatic condition with a rainfall pattern of unimodal and maximum precipitation being received in months of May to begging of September. In generally, the rainfall is erratic; onset is irregular, its amount and distribution are unpredictable. The farming system of the area is a mixed crop-livestock agriculture and is one of the most important finger millet growing belts in western Oromia, and cultivation of maize, pepper, soybean, coffee (at Gida Ayena) and livestock farming are the major means of livelihood of the rural community (Dagnachew *et al*., 2018; Zerihun and Hailu, 2017). The agro-ecologies of the districts are indicated according to table 1.

Site Selection and Establishment of Cluster

From east Wollega zone, three districts were selected based on their potential and accessibility for supervision, monitoring and evaluation. At Boneya Boshe district's two Kebele, namely Ejersa Gute and Jawis were selected. Whereas, at Wayu Tuka district's three Kebele, Gida Abako, Gida Basaka, and Gute Badiya were addressed. In Gida Ayena only one potential Kebele's were selected. Participant farmers were selected based on willingness, gender composition and capacity and capability to properly execute the planned pre-scaling up activity. One cluster that comprises 3-6 ha was established in each Kebele. One cluster have 8-20 farmers depending on number of cluster per district who contributes at least 0.25 ha of land. A total of six cluster were established. Finally, pre-scaling up of the crop conducted on 22 ha of land (6 ha at Boneya Boshe, 6 ha at Gida Ayena and 10 ha at Wayu Tuka) and 80 farmers (53 male and 27 female) were included in the cluster.

Table 1: Agro-ecologies of the districts

District	Altitude (m)	Temperature (°c)	Rainfall (mm)	Soil type
Bilo Boshe	1501–2700	25–33	850–1250	Loam, Clay loam & sandy loam
Gida Ayena	800–2195	15–27	900–1400	Red loam Nitiosols
Wayu Tuka	1450–3300	12–32	1400–2400	Sandy 35% and clay loam 60 & others 5%

Input Preparation and Field Management

The fields were ploughed three times at different time intervals to have fine soil contact with finger millet seed at planting. Three improved Finger millet varieties viz. Gudatu, Bako-09, Urji and Gute which was released by Bako agricultural research center were planted on selected farmers' fields land based on the adaptation agro-ecology of each variety. Accordingly, at Biloboshe district Gute variety, Wayu Tuka Gudetu variety and at Gida Ayana Bako-09 variety were planted. Blended NPS fertilizer was applied at 100 kg ha^{-1}, while 90 kg urea fertilizer rate were used similarly for all cluster which was applied half at time of planting and the rest half applied at tillering growth stage. But all recommended NPS were applied at planting. To control weed 2, 4D, herbicide were used for all clusters. All selected farmers in a cluster were applied these recommended packages for finger millet production. Fields were managed by participant farmers with close supervision of researchers and DAs. All other necessary agronomic practices were carried out in a similar fashion on all clusters and farmers field as per the recommendation for the finger millet in the area.

Roles and Responsibilities of Stakeholders during Implementation

Agricultural Growth Program (AGP-II) is one of the leading stallholder and have a lion share in providing resource like financing to the program for training, fertilizers, herbicide and insecticides (to control termites). It is also involved in periodic monitoring and evaluation together with Bako agricultural research center and Agricultural office staffs. The second stallholder, Bako agricultural research center (BARC) is the nuclear and mandate center for major AGP crops including finger millet in the area. The center was supplying improved finger millet seed for participated farmers in the cluster. Additionally, researchers of the center had providing trainings for the stalk holders. Moreover, BARC has an immense contribution in periodic monitoring and evaluation of farmer's field and played great role in close supervision, and organizing farmers filed day. Farmers are another stallholder in this cluster approach seed production that participated in allocate land and perform required agronomic practices. In addition farmers implemented advice getting from researchers and DAs synchronizing with their own indigenous knowledge and also played a key role in farmers filed days. Respective district Agricultural and Natural Resource office as also involved in selecting participant farmers and fields. The experts of district agricultural office and other concerned bodies (like district head) were participated during periodic monitoring and evaluation together with BARC, and leading role in supervising DA's, as well as the field activities. Further, they smooth the process of input distribution and follow up day to day activities.

RESULTS AND DISCUSSION

Stockholders Capacity Building

Before planting both theoretical and practical training with clear objectives were given to participant farmers, development agents, and extension, cooperative and union experts before the commencement of actual work (Table 2). The training were mainly focused on cluster based seed production system, constraints and opportunities in finger millet production in the area, finger millet agronomic practices (land preparation, method of sowing and seeding rates, type of fertilizer used, its rates and time of application, variety to be used, and weeding and insect pest control), pre-harvest and post-harvest managements, marketing and value chain approaches. The training helped farmers in improve their knowledge, skills and attitudes towards the importance of this crop in the livelihoods of the rural community.

Table 2: Training participants on finger millet production packages at Boneya Boshe, Gida Ayena and Wayu Tuka in 2019 rainy season.

Districts	Farmers		Development agents		Other agricultural experts		Total
	Male	Female	Male	Female	Male	Female	
Boneya Boshe	30	10	2	2	5	-	49
Gida Ayena	6	2	2	-	5	-	15
Wayu Tuka	21	9	3	3	4	1	41
Total	57	21	7	5	14	1	105

Field Days

A mini field day was organized and a total of 90 farmers, 15 development agents, 20 experts from district and 10 researchers were participated on organized field days by Bako agricultural research center with collaboration of AGP-II and respective districts. The field day program was

Covered and transmitted by Oromia Broadcasting Network Television and radio as well as Ethiopian Broadcasting Television and radio to disseminate the technologies for wider community. Lastly, discussion was performed to grasp farmers and other participants reaction on strength and limitation of the planted finger millet varieties and agronomic packages used during the processes in the production. Farmers highly interested for the varieties and also needs on other crop varieties such as early maturing sorghum and soybean. Farmers also points out that timely distribution of seeds with required amount and variety with different color are curial for further production of the varieties of finger millet.

Yield Performance of the Improved Finger Millet Varieties across Districts

As depicted in table 3, a total of six clusters and 78 farmers from three districts were covered, and produced improved seeds on 26 hectares. As a result, a total of 51.74 tones of improved seeds of finger millet varieties were obtained, of which 22.15 tones were Gute variety, 17.38 tones Gudetu and the rest 12.21 tones were Bako=09. The overall average yield of varieties revealed that the higher yield of 2.22 t ha^{-1} followed by 2.04 t ha^{-1} was attained from Gute and Bako-09 varieties, correspondingly. In contrary, minimum average yield (1.74 t ha^{-1}) was recorded from Gudetu variety at Wayu Tuka district. However, the obtained yield is still below the potential productivity of the varieties. For instance, the potential yield of Bako-09 variety can produce 2.98 t ha^{-1} at research field and 2.4-2.6 t ha^{-1} on farmers' field. But Gudetu variety can give 2.3 and 2.1 t ha^{-1} at research and on-farm field, correspondingly. On the other hand, Gute variety can produce 3.5 t ha^{-1} at research and 2.0-2.1 t ha^{-1} on farmers' field (Variety registration 2017; 2014; 2009). Over all, the varieties showed better performance than local cultivars which produced by majority of the farmers in terms of yield and other parameters, and hence, selected by the farmers for further dissemination and multiplication in the area.

Table 3: Summary of clusters covered & yield performance of finger millet varieties in the area.

Districts	№ of cluster	№ farmers	Varieties used	Area covered (ha)	Harvested GY (t)	Average GY (t ha^{-1})
Boneya Boshe	2	40	Gute	10.00	22.15	2.22
Gida Ayena	1	8	Bako-09	6.00	12.21	2.04
Wayu Tuka	3	30	Gudetu	10.00	17.38	1.74
Grand total	6	78		26.00	51.74	2.00

Mean Yield performance of Improved Finger Millet Varieties on Farmers' field

The yield of improved finger millet varieties in spite of varietal differences were also varied among clusters to same districts. For instance, in Boney Boshe district's, the average yield of Gute variety at Ejersa Gute cluster was 2.6 t ha^{-1} (Figure 1 (a)). In Jawis clusters, however, the yield was accounted 2.4 t ha^{-1} from the same variety. Similarly, high variable amount of yield were observed among farmers in the same cluster that planted one variety of finger millet. To this, the attained yield from Gute variety per farmers ranges between 1.4 to 2.8 t ha^{-1} at Jawis cluster (Figure 2). While at Ejersa Gute Cluster, the yield harvested from the same variety ranges from 1.6 to 2.6 t ha^{-1}.

In the same fashion at Wayu Tuka district, high yield differences were observed among clusters' that produced similar variety of finger millet (Figure 1 (b)). In the district a total of three clusters namely Gida Abako, Gute Badiya, and Gida Basaka established and Gudetu finger millet variety was planted on a total of 10 hectares. Each cluster consists of 10 farmers and a total of 30 farmers addressed. The highest yield of 2.4 t ha^{-1} achieved at Gida Abako cluster. Conversely, minimum yield (1.6 t ha^{-1}) was recorded at Gida Basak clusters. Likewise, high yield variation was observed between farmers field that produced similar variety in the same cluster. According to harvested yield per farmers, the yield obtained ranges between 1.1 to 3.2 t ha^{-1} (Figure 3). On the other hand, at Gida Ayena districts only one cluster (Homi) was established and Bako-09 variety produced on a total of 6 hectares that comprise eight farmers. From this variety, on average yield of 2.04 t ha^{-1} was recorded. However, the yield attained form this variety on farmers' field showed variation and ranges from 1.7 to 2.6 t ha^{-1} (Figure 4).

This yield difference among farmers in the same cluster that planted similar variety might be due to variability's among farmers field in soil fertility status and the different levels of farm land utilization intensity and the ability of some farmers to apply inputs (farm yard manure, crop residues, organic or inorganic fertilizers) to some fields over time (Tittonell *et al*., 2012; Penny, 1996). Similarly research reports indicated that the heterogeneity of farmers field were contributed to a great extent in yield variations of crops with similar crop variety and nutrient application in the soil during planting (Hailu *et al*., 2018; Tolera *et al*., 2015; Vanlauwe *et al.*, 2014; Schmid *et al*., 2002). This indicates the call for site based crop management (variety development, fertilizer application rate and type, herbicide, etc) for finger millet production.

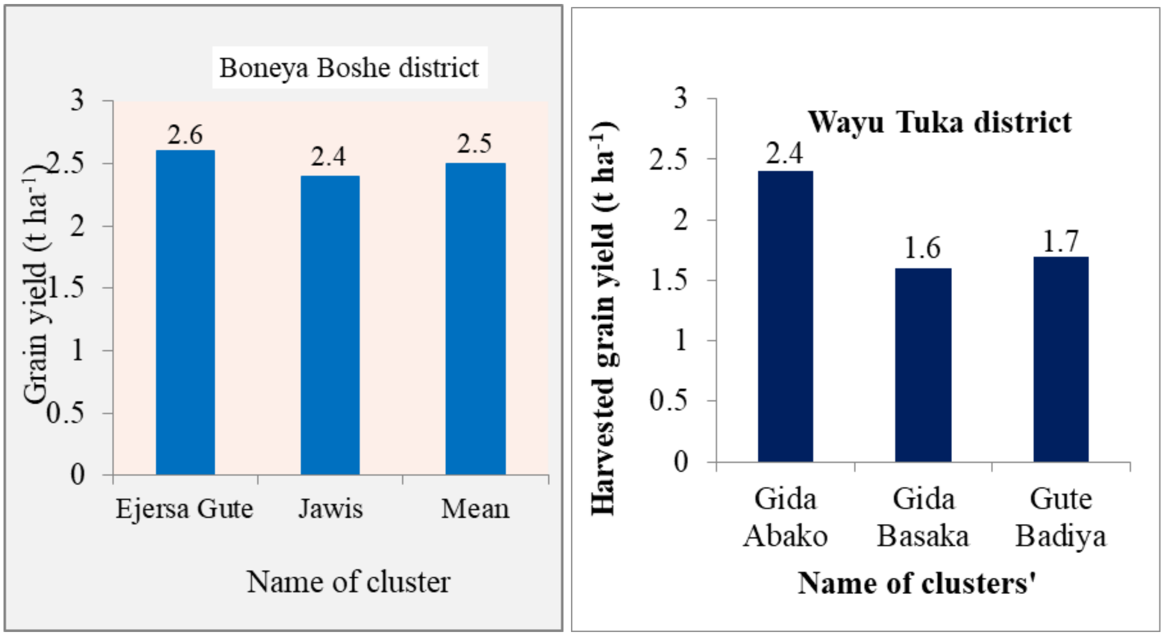

Figure 1: Mean yield of finger millet variety per cluster at Boneya Boshe (a) and at Wayu Tuka (b) districts.

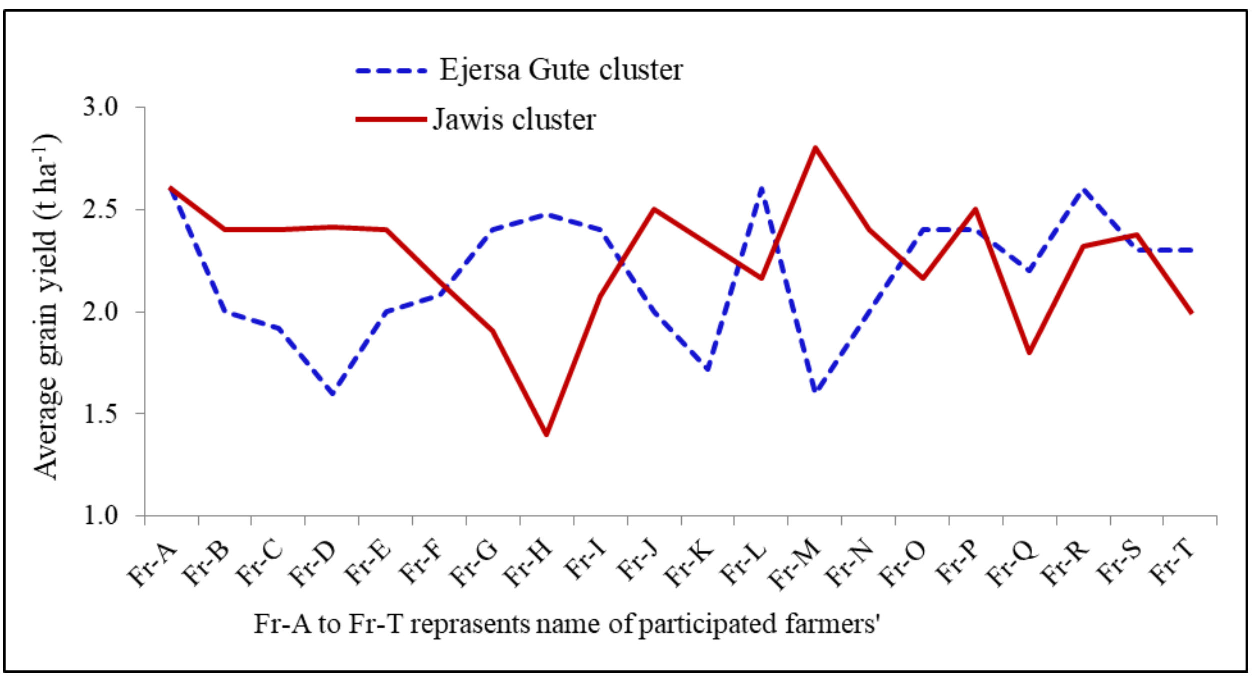

Figure 2: Yield of finger millet variety on farmers' field at Boneya Boshe districts.

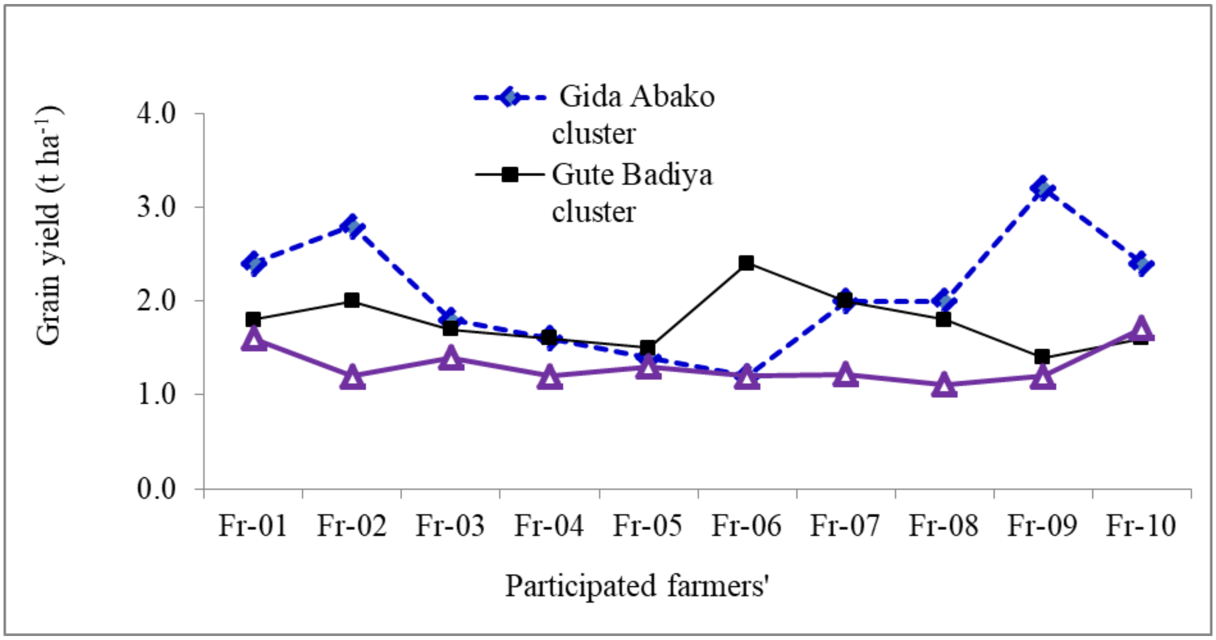

Figure 3: Yield of finger millet variety on farmers' field at Wayu Tuka district (Fr-01 to Fr-10 indicates name of farmers).

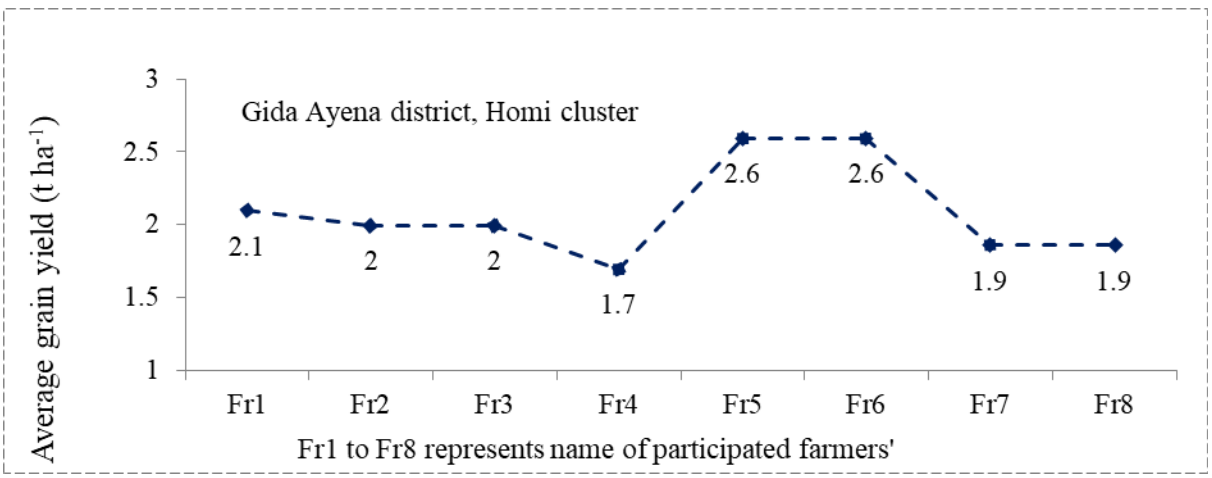

Figure 4: Yield of finger millet variety on farmers' field at Gida Ayena district

Conclusion

Despite the huge yield potential and area under finger millet production in eastern Wollega zone, western Oromia, its current productivity is by far below the yield of research fields and its yield potential. Limited availability of improved seed, lack of improved crop recommendation technologies and formal seed delivery systems are the foremost constraints contributed to low productivity of this crop in the area. On the other hand, amount and distribution of appropriate improved finger millet varieties, chemicals, its utilization and threshing problem across the zones highly influenced the productivity and importance of this crop at farmers' level (not pay considerable attention as other crops). By recognizing these problems, Bako agricultural research center in collaboration with AGP-II conducted the pre-scale up and popularized full packaged improved finger millet varieties in cluster approach at east Wollega zone, western Oromia, on 22 ha in 2019 rainy season. Based on attained yield, Gute variety gave the maximum yield of 2.22 t ha^{-1} at Bilo Boshe district followed by Bako-09 variety (2.04 t ha^{-1}) at Gida Ayena. Whereas, Gudetu variety was gave the least yield (1.74 t ha^{-1}) at Wayu Tuka district. In conclusion, scaling-out of the varieties with its full production packages should be carried by zonal/district extension agents for similar agro-ecological areas through establishing and strengthening seed producer Cooperatives.

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Cluster Based Pre-Scaling up of Improved Sesame Technologies in Buno Bedellee Zone of Chewaka District

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ABSTRACT

Sesame seed is one of the oilseed crops grown for export purpose in Ethiopia. The cluster based pre-scaling up of improved sesame technologies were practiced at Chewaka district with the objectives of popularizing improved sesame technologies for smallholder farmers, establish community based seed production and marketing scheme to facilitate farmers to farmers seed exchange, strengthen knowledge's and skills of farmers on sesame production and management practices and provide recommendations on community-based sesame seed production. A total of nine farmers were participated per cluster on sesame production. The technical skills of cluster groups on sesame seed production were improved through practical demonstrations and give trainings. The high quality sesame variety named as 'waliin' variety with recommended agronomic practices was supplied for cluster groups by Bako Agricultural Research Center. A total of seventeen quintal (Qt) of sesame seed was harvested from three hectares. On average, the estimated yield of sesame was 5.6 qt/ha. The variable sesame yield was recorded among the farmers due to variable plant population, soil fertility and high shattering problem of the crop during harvesting. The cluster approach has proven to be a successful sesame seed production model under potential sesame production ecosystem that has improved the production and supply of good quality of sesame seeds.

Keywords: Cluster approach, Waliin variety, seed system, Chewaka district

INTRODUCTION

Ethiopia is one of the famous and major producers of sesame in sub-Saharan Africa, and Ethiopian sesame is among the highest quality in the world (Baraki and Berhe, 2019). Sesame ranks first in total area and production from oil crops during 2013; and Tigray, Oromia, Amhara and Benshangul Gumuz regions are the major producers in Ethiopia (Ayana, 2015). Due to its importance as a major export commodity the area coverage and production has increased in the last consecutive years in Ethiopia. There is an enormous potential to expand sesame seed production in Ethiopia through cultivation of additional new land (Zerihun, 2012). Through transfer of technology and the provision of inputs, the increment of production and yield will be achieved strongly.

In spite of the growing demand for sesame seeds and oil in Ethiopia, the productivity, production and oil extractions methods are traditional. Though Ethiopia is among the top 5 sesame seeds producers in the world, the potential benefit that could be obtained is below the optimum due to the use of traditional technologies and/or unavailable high-level sesame oil seed processing/refining industries in the country (Assefa, 2019). Even though the performance of sesame is very good on virgin fertile soils, the shortage of virgin fertile land is very limited todays in Ethiopia for sesame production (Girmay, 2018). Therefore, production of sesame on normal agricultural land with input application is mandatory to sustain its production. Cluster seed production is one methods of reducing constraints of sesame production through integrating the experience of different farmers. Thus, the objectives of the study were to popularize improved sesame technologies for smallholder farmers in Chewaka district, establish community based seed production to facilitate farmers to farmers seed exchange, give awareness for farmers on sesame production and management practices and provide recommendations to farmers in community-based sesame seed production.

MATERIALS AND METHODS

Approaches implemented

The cluster based sesame seed multiplication was conducted in Jagal kebele, Chewaka district in Buno Bedelle Zone, Western Oromia Regional State. A total of nine farmers were participated on cluster seed production. Different activities would have been implemented separately and/or collaboratively with different stakeholders on provision of training, dissemination of seeds, organize farmers' field day in the district to conduct the activity. Before implementing the activity, meeting was organized for concerned stakeholders to set joint action plan. At the planning stage, all stakeholders' roles and responsibilities were identified and clearly defined for effective work of activities and sharing of information. Training was delivered for farmers and development agents were believed as one of the prominent inputs to speed up adoption of sesame varieties and its agronomic practices. In this regard, the following sesame technologies scaling up and out program stakeholders with their respective roles and responsibilities. Though existing stakeholders could implement their priority roles and responsibilities and some success mainly from production aspect of crop value chain development, gaps on marketing aspects. The different stakeholders participated on this cluster based sesame seed production were Bako Agricultural Research Center, Agriculture and Rural Development Office (ARDO), Bore Bako Farmers Union (BBFU), Agricultural Growth Program (AGP-II) and farmers.

Provision of training for experts and development agents and farmers engaged in sesame cluster seed production was very critical for success of the work. The training was organized before planting of sesame, where all the concept of cluster approach was explained. The extension staff of the site and AGP-II project leaders were also taken on study visit to see and interact with district and zonal level experts.

Farmers Field day

Field day is an event on which an area containing successful farming practices is open for people to visit and learn (Stephen and John, 2014). Such agricultural shows create demand for technologies and encouraged farmers to buy the technologies being demonstrated (Stephen and John, 2014). Field day was organized to create awareness on improved sesame production technologies availability, suitability and market opportunity. It is also one forum to get feedback from farmers and other stakeholder about the program for the better future works.

Monitoring and evaluation

Project evaluation is important to get evidence about what project has achieved, what works and what doesn't work and it is useful for taking the project forward, demonstrating effectiveness and satisfying sponsors, government and community. Based on the schedule arranged in planning phase, responsible bodies prepared and send reports to higher officials and funding agents monthly, quarterly and annually to evaluate progress of the program. Joint monitoring and evaluation process at field level with different stakeholder's were held at mid-season to understand their strength and weakness and to access additional feedback directly from farmers for their future plans.

Data collected

Farmer's feedback/perception, number of farmers participated on training and yield data obtained from each farmer's field was collected after harvest of the crop.

RESULTS AND DISCUSSION

Extension Services on Sesame Production

Improved varieties of Sesame

Based on fact and result obtained from earlier conducted demonstration and promotion experiment, '*Waliin*' sesame variety showed better performance in terms of yield, drought tolerance and others parameters compare to other sesame variety was recommended for further scale up and multiplication based its yield advantage and farmers demand created during demonstration in the area. Based on created demand of farmers and research recommendation. *Waliin* sesame variety seed was multiplied by the center for further scaling up using cluster approach. From Chewaka district, Jegal kebele was selected to scale up *Waliin* sesame variety based on cluster approach. From this kebele nine farmers were selected to implement the activity. The *'Waliin*' sesame varirty seed was covered three hactres of land under farmer's field using cluster approach. A total of 15 kg of improved sesame variety was delivered for selected farmers in the cluster. The required amount of fertilizer rate was covered by the farmers themselves to apply cost-sharing extension approach.

Table 1: Summary of inputs distributed to the farmers

District	Kebele	Input	Amount given (kg)	Area covered (ha)
Chewaka	Jagal	*Waliin* variety	15	3
		NPS	300	
		UREA	150	

Yield variability across farmers

The average yield obtained from farmers per unit area were accounted 560 kg/ha for *Waliin* variety. Similarly, the minimum and maximum yields obtained from a hectare of land were accounted 370 kg ha^{-1} and 816 kg ha^{-1}, respectively. Yield difference observed among the participant farmers was due to differences in soil fertility, shattering problem, management practices and poor establishment of plant population. Yield obtained from sesame variety at variety trial and demonstration trial stage was higher than scaling up stages due to day to day monitoring and follow up, continuous management and full agronomic packages conducted by researchers at research fields whereas yield obtained during cluster based pre-scaling up stages were variable because it was implemented under farmers managed conditions.

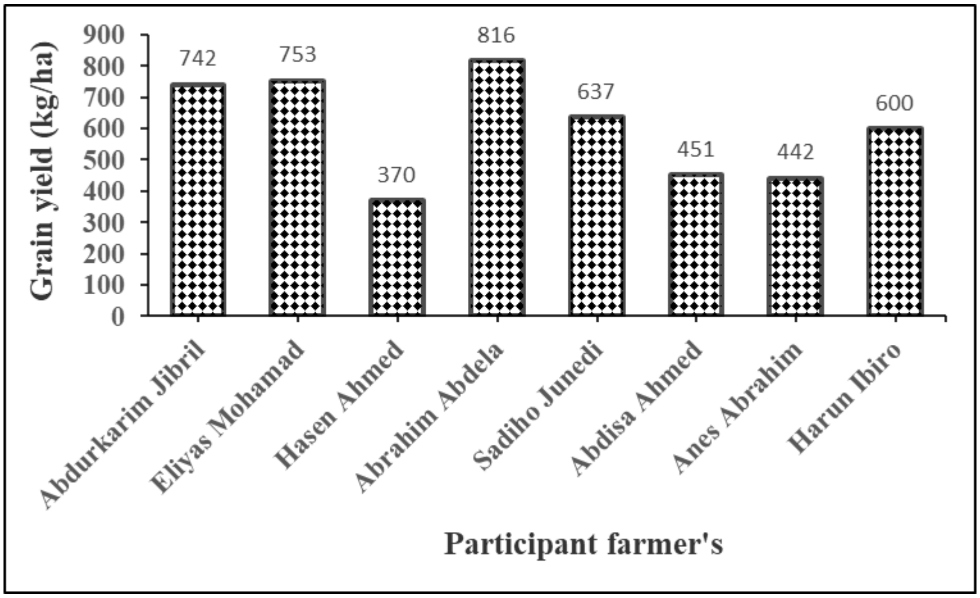

Fig-1: Yield of sesame variety (waliin) obtained from each farmer's plot

Training

Besides input distribution, training was prepared for the farmers, extension agents and agricultural experts on sesame agronomic practices, production and pre-harvest and post-harvest managements to improve knowledge, skills and attitudes of trainees. As indicated in Table 2, a total of nine farmers, four extension agents and four agricultural experts had to participate in training program. Participatory training method was followed during implementation of training program for sharing knowledge's, skills and experiences on sesame productions. During this training the concept of cluster approach, duties and responsibilities of different stakeholders and sesame production packages were explained for the farmers.

Table 2: Number farmers, woreda experts and development agents participated on training during 2019.

Zone	District	Kebele's	SMS		DAs		Farmers		Total
			Male	Female	Male	Female	Male	Female	
Buno Bedelle	Chewaka	Jawis	2	1	2	1	7	2	15

CONCLUSION AND RECOMMENDATIONS

Path of improved agricultural technologies in agricultural research centers started from technologies development up to impact evaluation on farmer's livelihoods. Cluster seed production is one methods of reducing constraints of seed production through integrating the experience of different farmers. The technical skills of these cluster groups on sesame seed production were improved through practical demonstrations and trainings. The clustered groups were supplied with high quality source seed of sesame variety (waliin) by Bako Agricultural Research Center. The sesame yield difference was recorded among the farmers due to variable plant population, soil fertility and high shattering problem of the crop during harvesting. Therefore, the cluster approach has proven to be a successful sesame seed production model under potential sesame production ecosystem that has improved the production and supply of good quality of sesame seeds. Thus, it is advisable to apply cluster approach for technology scaling up under farmers' fields to address large number of farmers and to protect quality of seed for further multiplications, better to reduce yield gap between research and farmers field through applying continuous management and full agronomic practices on farmer's field and advisable to scale up improved sesame varieties on large number of end-users through horizontal and vertical scaling up approach to create impacts on farmers' livelihoods.

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Cluster Based Pre-Scaling up of Improved Soybean Technologies in Bako Tibe, Wayu Tuka Chewaka and Boneya Boshe districts, Western Oromia

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ABSTRACT

The cluster based pre-scaling up of improved soybean technologies were practiced in Bako Tibe, Wayu Tuka, Boneya Boshe and Chewaka districts in 2019 main cropping season with the objectives of popularizing improved soya bean technologies for smallholder farmers in selected AGP-2 districts, establish community based seed production to facilitate farmers improved seed exchange, strengthen knowledge's and skills of farmers on soya bean technologies production and management practices. Three soybean varieties (Korme, Keta and Dhidhessa) were used for applying cluster based soya bean production in the areas. Korme variety was used for Wayu Tuka and Chewaka clusters while Dhidhessa variety was used for Bako Tibe. A total of fourty two farmers were participated across all districts. The technical skills of cluster groups on sesame seed production were improved through practical demonstrations and give trainings. The high quality soybean varieties named as 'Korme, Keta and Dhidheessa' varieties with recommended agronomic practices were supplied for cluster groups by Bako Agricultural Research Center. The 111.6 Qt of korme soybean variety was harvested from Wayu Tuka cluster. The yield obtained from Chewaka cluster ranges from 10 Qt/ha to 24 Qt/ha and an estimated yield of 159.25 Qt harvested. Similarly, 40 Qt of soybean harvested from Bako Tibe. Thus, scaling-out of Dhidhessa and Korme varieties should be carried by districts extension agents for similar agro-ecological areas through strengthening seed producer Cooperatives due to its special merit of this variety.

Keywords: Cluster based approach, soybean variety, seed system, sustainability

Back ground and Justification

In Ethiopia, soybean is a multipurpose crop, which can be used for a variety of purposes including preparation of different kinds of soybean foods, animal feed, soy milk, raw material for the processing industry, and it counter effects depletion of plant nutrients in the soil resulting from continuous mono-cropping of cereals, especially maize and sorghum, thereby contributing to increasing soy fertility (Hailu and Kalemu, 2014). According to CSA (2017) report soybean was produced on about 38,166.04 ha of land and 81241.833 tons produced in 2017 main cropping season with the productivity of 2.1 t ha^{-1}.

Food insecurity and malnutrition are among the urgent challenges that developing countries face these days. The major staple food crop of most developing Sub- Saharan African Countries, maize, contains low protein (5.2-13.7 %) (FAO, 2010). The challenges are especially acute in Ethiopia and relatively more serious in the rural than urban areas, mainly because of a low level of understanding of a balanced diet and lack of capacity to purchase animal source proteins. Thus, soybean is cheap and rich source of protein for poor farmers, who have less access to animal source protein, because of their low purchasing capacity (Hailu and Kalemu, 2014).

Cluster based approach is being focused in agriculture and allied sectors. In cluster farming which is one of the cluster based approach real profit is generated by merging several small farms to a mother farm. The entire arrangement forms a cluster, an entrepreneurial group which shares the burden and profits. Darcy and Michele (2015) reported that in scaling up innovations adequate time and planning is vital to have successful scaling up program. Planning phase should considered the resources and support they could access, choices they made about who to partner with and how to achieve impact, and the windows of opportunity - political, cultural and social condition of intervention area.

Despite the significance of soybean to address food and nutrition insecurity problems prevailing in the country, little emphasis has been given to production, supply and export of this important commodity (Hailu and Kalemu, 2014). Therefore, the objectives of the study were to with the objectives of popularize improved soya bean technologies for smallholder farmers in selected AGP-2 districts, establish community based seed production to facilitate farmers improved seed exchange, strengthen knowledge's and skills of farmers on soya bean technologies production and management practices.

MATERIALS AND METHODS

Approaches implemented

The cluster based soybean seed production study was conducted in Bako Tibe, Wayu Tuka, Chewaka and Boneya Boshe districts in Western Oromia. A total of forty two farmers were participated on cluster seed production across districts. Different activities would have been implemented separately and/or collaboratively with different stakeholders on provision of training, dissemination of seeds, organize farmers' field day in the district to conduct the activity. Before implementing the activity, meeting was organized for concerned stakeholders to set joint action plan. The joint action plan includes planning …… At the planning stage, all stakeholders' roles and responsibilities were identified and clearly defined for effective work of activities and sharing of information. Training was delivered for farmers and development agents were believed as one of the prominent inputs to speed up adoption of sesame varieties and its agronomic practices. In this regard, the following sesame technologies scaling up and out program stakeholders with their respective roles and responsibilities. Though existing stakeholders could implement their priority roles and responsibilities and some success mainly from production aspect of crop value chain development, gaps on marketing aspects. The different activities that have been implemented by different stakeholders separately as well in collaboration were described as follows.

Bako Agricultural Research Center

- Supplying improved soybean technologies (improved seed, Bio fertilizer)
- Providing trainings to development agents and farmers
- Involved in periodic monitoring and evaluation of farmers field
- Play leading role in close supervision
- Play leading role in organizing zone level farmers filed day

Agriculture and Rural Development Office (ARDO)

- Involved in selecting participant farmers
- Involved in periodic monitoring and evaluation together with BARC and AGP-II staffs
- Play leading role in supervising DA’s
- Facilitate seed distribution and follow up day to day activities
- Play leading role in organizing farmers exchange visit

Bore Bako Farmers Union (BBFU)

- Collection of seeds from farmers during harvesting time
- Involved in market assessment activity
- Creating market linkages for farmers
- Facilitate input supply to farmers

Agricultural Growth Program (AGP-II)

- Providing budget to the program
- Involved in periodic monitoring and evaluation together with BARC and Agricultural office staffs

Farmers

- Allocate land and perform required agronomic practices
- Implementing advice getting from researchers and DAs synchronizing with their own indigenous knowledge
- Participating in FERGs to multiply selected scaling up and out crop seeds
- Play key role in farmers filed days
- Supply grain to primary cooperatives/ union

Farmers field day

Field day is an event on which an area containing successful farming practices is open for people to visit and learn. Such agricultural shows create demand for technologies and encouraged farmers to buy the technologies being demonstrated (Stephen and John, 2014). Field days was organized at each district to create awareness on improved soybean production technologies availability, suitability and market opportunity. It is also one forum to get feedback from farmers and other stakeholder about the program for the better future works. The field day event was organized at Wayu Tuka cluster at pod setting stage of the crop.

Monitoring and evaluation

Project evaluation is important to get evidence about what project has achieved, what works and what doesn’t work and it is useful for taking the project forward, demonstrating effectiveness and satisfying sponsors, government and community. Based on the schedule arranged in planning phase, responsible bodies prepared and send reports to higher officials and funding agents monthly, quarterly and annually to evaluate progress of the program. Joint monitoring and evaluation process at field level with different stakeholder’s were held at mid-season to understand their strength and weakness and to access additional feedback directly from farmers for their future plans.

RESULTS AND DISCUSSION

Yield variability across clusters

Yield variability across the farmers' field was very high. The performances of soybean varieties were among the districts. This might be due to soil fertility difference, farmer's management. The crop showed yellow color on some clusters especially at Wayu Tuka and Chewaka. These yellowing of the soybean crop showed the importance of nitrogen application to soybean. Some farmers told us nitrogen application to soybean increase the probability to escape from soybean rust. Thus, there is a need to find the appropriate rate of starter nitrogen for soybean. Farmers like cluster approaches to increase the productivities of soybean. Three soybean varieties (Korme, Keta and Dhidhessa) were used for the cluster based seed production. One hundred eleven quintals (111.6 Qt) of korme soybean variety was harvested from six hectares at Wayu Tuka cluster. The yield obtained from Chewaka cluster ranges from 10 Qt/ha to 24 Qt/ha and a total of 159.25 quintals was harvested from eleven hectares. Similarly, 40 quintals of soybean was harvested from four hectares at Bako Tibe cluster (Fig. 1). No soybean yield was harvested from Boneya Boshe cluster due to poor managements and low soil fertility.

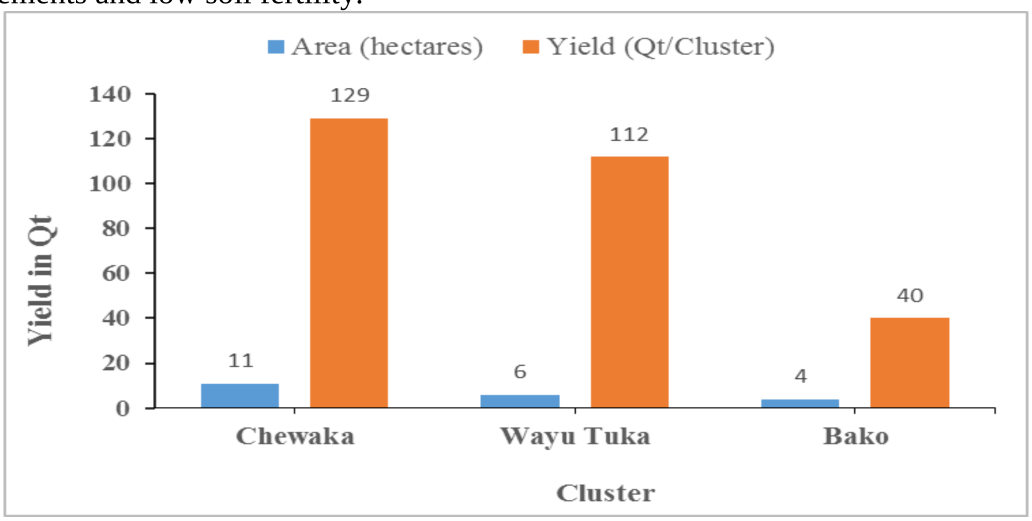

Fig. 1. Showed yield of soybean harvested per each cluster and area of production

Farmer's perception

Cluster based approach is being focused in agriculture and allied sectors. In this approach known as cluster farming real profit is generated by merging several small farms (satellites) to a mother farm. The entire arrangement forms a cluster, an entrepreneurial group which shares the burden and profits. Farmers like cluster approaches to increase the productivities of soybean. Also they like soybean varieties with its packages. Farmers like Dhidhessa variety whereas dislike ketta variety due to low performance. Also they told us the importance of nitrogen application to soybean (nitrogen application to soybean increase the probability to escape from soybean rust at Chewaka (farmer's response). Lack of market linkages for soybean produce is another problems that decrease the sustainability of soybean production in the study areas.

Capacity development of extension staff and farmers

Training of extension staff and farmers engaged in soybean cluster seed production was very critical. The training was organized for farmers, development agents and woreda experts before planting of soybean, where all the concept of cluster approach was explained. The extension staff of the site, researchers and center level AGP-II project leader were also taken on study visit to see and interact with district and zonal level experts during the training. During this training the concept of cluster approach, duties and responsibilities of different stakeholders and soybean production packages were explained for the farmers.

Table 1: Number of farmers, woreda experts and development agents participated on training of soya bean during 2019.

Zone	**District**	**Kebele's**	**SMS**		**DAs**		**Farmers**	
			Male	Female	Male	Female	Male	Female
East Wollega	B/Boshe	Jawis	2	1	2	1	10	2
	Wayu Tuka	Megna kura	2	1	3	0	28	2
West Shoa	Bako Tibe	Tulu Sangota	2	0	2	0	10	0
Buno Bedelle	Chewaka	Jegal	3	0	2	0	18	2
Total			**9**	**2**	**9**	**1**	**66**	**6**

Lessons Learnt

Several lessons have been learnt from the cluster based pre-scaling up of soybean technologies. These lessons are critical for scaling up of the improved soybean technologies and its replication in new areas for sustainable soybean seed production under the western Oromia context. Cluster based seed production basically entails the strengthening of the informal seed production system for production of good quality seed at the farm level. It involves the organization of interested farmers or a community into a seed producer group. From this cluster based soybean production, all fellow farmers likes the full packages of soybean production to increase the productivities of the crop. The support of researcher, extension staff and formal seed sector is very important for a sustainability of the cluster.

CONCLUSION AND RECOMMENDATIONS

Cluster based pre-scaling up is efficient and a sustainable seed production model for small holder soybean farmers, especially when the formal sector cannot service the need of the farmers. Cluster based pre-scaling up of improved soybean technologies were undertaken at Chewaka, Wayu Tuka, Bako and Boneya Boshe during 2019 cropping season to improve the sustainability of soybean production in western Oromia. Thus, it can be concluded that, scaling-out of soybean varieties with its production packages should be carried by different stakeholders in soybean potential areas of western Oromia through strengthening seed producer cooperatives.

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

- It is advisable to apply cluster approach for technology scaling up under farmers' fields to address large number of farmers in western Oromia.
- It is better to reduce yield gap between research and farmers field through applying continuous management and full agronomic practices on farmer's field.

- It is advisable to scale up improved soybean varieties on large number of end-users through horizontal and vertical scaling up approach to create impacts on farmers' livelihoods.

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Cluster Based Pre Scaling up of Improved Chickpea Variety at Adola Rede District of Guji Zone, Oromia Regional State, Ethiopia

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ABSTRACT

Farmers of the study areas have no experience to cultivate chickpea, probably due to lack of improved chickpea varieties prior to on farm demonstration that was conducted to create demand. But the demand for dissemination was not carried out due to lack of multiplied seed and budget shortage to incur from other sources. Therefore, funded by AGP-II, cluster based pre scaling up of improved chickpea variety (Habru) was carried out at Adola Rede district, Guji Zone in 2019. The main objective of the study was to promote improved chickpea variety and thereby increases production and productivity and income of the farmers in the study area and similar agro ecologies. Two peasant associations were selected based on their potential to produce chickpea. FREG approach was followed to implement pre scaling up process. Consequently, 12 farmers of gender inclusive were clustered as FREG at each trial sites owing three hectares of land, each farmer contributing 0.25 hectare. Trainings were given for farmers. In total, 24 farmers (16 male & 8 female were benefited scaling up). Development agents, subject matter specialists and different stakeholders were participated on field day & field visit. Recommended seed and fertilizer rates, row between space and plant were used with all management practices. Joint monitoring and evaluation were organized. Field day was organized on which different stakeholders participated and experience was shared. Quantitative data such as yield was collected and analyzed using SPSS whereas farmers' feedbacks were analyzed qualitatively. In spite of the pest infestation at the flowering and pod setting stages and prevalence of little rainfall, a mean yield of 1.19 tons ha^{-1} was obtained which is promising and very important in improving livelihood of farmers. Therefore, this technology should be sustained for more popularization. Agro chemicals in advance to avoid pest infestation, planting at early September to escape from drought occurrences should be given due emphasis

***Key words**: Cluster based pre scaling up, FRG approach, Habru variety*

INTRODUCTION

Chickpea (Cicer arietinum L.) is a very important crop that is mainly used for human and animal food (Hossain *et al*., 2016), and it is the second most widely grown legume worldwide (Pang *et al*., 2017) after soybean (Varshney *et al*., 2014). This crop can be grown in many areas, including marginal land and low fertility areas (Esfahani *et al*., 2014), and its cultivation plays a key role in maintaining soil fertility, especially in tropical regions, thus representing an important component of crop rotation. Current global chickpea production is approximately 13 million tons (FAO, 2014).

Chickpea is widely grown across the highlands and semi-arid regions of Ethiopia and serves as a multi-purpose crop. The country is also considered as the secondary center of diversity for chickpea (Anbessa and Bejiga, 2002). It has a major role in the daily diet of the rural community and parts of urban population. The crop is being exported to Asian countries and is contributing positively to the country's foreign exchange earnings. The total land coverage and yield of chickpea in Ethiopia are estimated to be 242703.73 hectares and 499425.55 tons, respectively (CSA, 2017/18). Despite its nutritional values, high economic importance, the national average yield of chickpea is still lower than its potential, 2.058 t ha^{-1} (CSA, 2017/18). This is due to pest/disease and lack of improved chickpea varieties.

Chickpea is considered less labor-intensive crop and its production requires less external inputs as compared to cereals. As stated in (Shiferaw and Hailemariam, 2007), it plays a significant role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140 kg N ha^{-1} from air and meet most of its nitrogen requirement. After harvest, it leaves substantial amount of residual nitrogen for subsequent crops and adds some amount of organic matter to maintain and improve soil health and fertility. This saves the fertilizer input cost not only for chickpea but also for the subsequent crops (Tena *et al*., 2016)]. Chickpea has the ability to grow on residual moisture which gives farmers the opportunity to engage in double cropping, where chickpea is sown at the end of the rainy season following the harvest of the main crops (Endalkachew *et al*., 2018). This allows more intensive and productive use of land, particularly in areas where land is scarce. It is also an excellent source of protein, fiber, complex carbohydrates, vitamins, and minerals thus can help alleviating malnutrition and improving human health. The growing demand in both the domestic and export markets provides a source of cash for smallholder producers. Because of its deep tap root system, chickpea can withstand drought conditions by extracting water from deeper soil layers. It also increases livestock productivity as the residue is rich in digestible crude protein content compared to cereals.

In spite of its immense use, chickpea is not in the production in the potential areas of Guji Zone and farmers of the study areas have no experience to cultivate, probably due to lack of improved chickpea varieties. To mitigate under production, adaptation trial of different chickpea varieties were conducted in midland of Guji Zone. Consequently, Dalota and Habru were best performed in yield and their trait to tolerate drought and disease. Accordingly, on farm demonstration of these two varieties were conducted at few farmers of Adola Rede, midland district of Guji Zone through Farmers Research Group (FRG) approach in the recent years. During demonstration of chickpea, farmers liked and preferred these varieties based on their criteria of yield performance, good economic return, market demand, tolerant to drought and disease. Consequently, farmers of the study areas were demanding these varieties for dissemination since the demonstration stage alone could not assure the sustainability of these varieties for wider popularization and to enhance the livelihood of smallholder farmers in the study areas. But due to lack of multiplied improved chickpea varieties, these varieties were not further disseminated in midland areas. Therefore, conducting cluster based pre scaling up of improved chickpea variety (Habru) was crucial to pave the way for further popularization and dissemination of this technology among farmers of midland agro-ecologies in Guji Zone with main objective to promote improved chickpea variety and thereby increase production and productivity and income of the farmers in the study areas and similar agro ecologies

MATERIALS AND METHODS

Description of the Study Area

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

Implementation Approaches Followed to the Cluster Based Pre Scaling Up Activity

In principle, pre scaling up activity is led by demonstration and participatory variety selection with farmers and pertinent stakeholders. Therefore, the chickpea technology was demonstrated on certain farmers at the respective sites in the recent years where the technology was intended to be scaled up. Results from the evaluation process publicized that Habru variety had met the farmers' requirement that paved the way to this project. It was based on that result the cluster based pre scaling up phase was planned and executed using necessary extension approaches.

For the sake of enhancing efficiency and effectiveness, integration and cooperation with different stakeholders implemented for the achievements of the strategy. Accordingly, organizing stakeholder forum for discussion with responsible and cooperative participants at district level to have a common understanding of cluster based pre scaling up activity, signing memorandum of understanding, appointing contact persons and establishing Farmers Research Extension Groups (FREGs) at each peasant association were done successfully. Trainings on capacity building regarding knowledge, skill and attitude of chickpea production, management and package, post-harvest handling, concept of cluster based pre scaling up, economic importance of chickpea, FREG approach and seed dissemination mechanism was delivered for farmers, agricultural experts and development agents (DAs) by multidisciplinary team consists of breeder, pathologist, agronomist, agricultural research-extensionist and socio economics. Chickpea technology (Habru) with its recommended packages and other agricultural inputs like fertilizers, pesticide the so called PROFIT were distributed to participating farmers after training. FREG member farmers and other follower farmers were encouraged to participate in the physical activities from the beginning up to the end. Joint monitoring and evaluation like regular field visit by extension agents and extension counterparts, joint field visit and supervision at different crop stages, field day organized, discussion session and result communication forum were also structured. Seed delivery mechanisms like convincing the host farmers to appreciate farmer-to-farmer seed exchange mechanism with an optimum price at the end of the activity life span facilitated.

Stakeholder Analysis

In enhancing chickpea variety generation, dissemination, improving chickpea production and productivity, Bore Agricultural Research Center was closely working and has made frequent consultation with its respective stakeholders. Pre scaling up activity should be done by different actors in partnership and collaborative approach. So, stakeholder analysis is highly important for institutional arrangement (who does what?) before embarking on the pre scaling up activity. Thus, stakeholder analysis was undertaken to identify potential stakeholders. Points such as: who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? How does the collaboration support the opportunities to bring the required impact? Consequently, zonal and district agricultural experts, district cooperatives, Development Agents and researchers were the identified stakeholders with their roles, duties and responsibilities clearly stated in implementing the activity.

Table 1. Roles and responsibilities of stakeholder in implementing the activity

No	Stakeholders	Roles and responsibility
1	Bore Agricultural Research Centre	➢ Coordination and facilitation, ➢ Provision of chickpea technologies ➢ Provision of training ➢ Technical backstopping ➢ Organize Field days and ➢ Supervision and joint monitoring and evaluation with zone and district Bureau of agriculture and Natural Resource
2	Agriculture and Natural Resource Office (at zone, district and peasant association)	➢ Assist in site and participant farmers' selection ➢ Follow up day to day activities from zone to peasant association level ➢ Assist in providing training ➢ Facilitate seed distribution ➢ Jointly organize and participate on field days
3	FREG farmers	➢ Allocate land and perform required agronomic practices ➢ Actively participate in the training for capacity building ➢ Share skills and experiences to neighbour farmers ➢ Transfer produced seed to follower and surrounding farmers and ➢ Finally, supply excess produced seed to cooperatives
4	Cooperatives	➢ Agricultural input supply ➢ Facilitate chickpea seed marketing

Site and Farmers Selection

This pre-scaling up activity was the continuation of the past demonstration of the chickpea varieties recent years before. Selection of the district was accomplished by a multi-disciplinary team of Bore Agricultural Research Center (BoARC) using self-experience gained during chickpea demonstration activity in collaboration with experts of the respective district. Accessibility and potentiality, convenience of the areas to the technologies and representativeness of the trial fields in terms of location and suitability for more farmers to visit the field, were the most important criteria to select both the district and the kebeles under consideration.

As Development Agents are nearer to, and information rich about the farmers in their respective jurisdiction, the task of farmer selection was entirely left to them given the farmers fulfill the criteria set by researchers. On top of this, having appropriate and sufficient plots, good history of managing experimental or non-experimental plots were the other criteria used to select the host farmers. Accordingly, from each peasant association one FREG which comprises 12 clustered farmers was nominated based on their interest to work in group and provide three hectares of land per cluster (one fourth of hectare per farmer). The clustered FREG member farmers were re clustered in to three sub groups comprising of four farmers with one hectare of land. Consequently, a total of 24 hosting farmers were organized as FREG, under which other farmers were trained and organized as follower farmers to share knowledge, skill and experience for further promotion mechanism.

Pre Scaling Up Design

Bore Agricultural Research Centre was the supplier of all agricultural inputs; seed, fertilizers-NPS and UREA, PROFIT- pesticide). One improved chickpea variety (Habru) was planted on clustered farmers during the autumn season. The seed were incurred in advance from other source of improved seed supplier in consultation with Debre Zeit Agricultural Research Center. The variety was treated with full recommended chickpea production packages (agronomic recommendations and practices). Row planting method and other crop management practices were used during the pre-scaling up activity. The recommended seed rate of 100 kg ha^{-1} with the spacing between rows 40 cm and between plants 10 cm. Shallow planting of 5 cm depth was used in the presence of moderate soil moisture. The recommended inorganic fertilizer rate 30 kg ha^{-1} N and 60 Kg ha^{-1} NPS were applied at planting time. All farm operations (land preparation, land levelling, planting, weeding, agro-chemical spray to avoid chickpea pod borer, harvesting, threshing) were carried out by FREG member farmers with close assistance and supervision of concerned participating institutions (Research Center and Extension Division of Agricultural and Natural Resource Office). Farmers' full participation at all stages of the activity was maintained during the implementation period.

Joint Monitoring and Evaluation

From the very beginning of site selection until harvesting, frequent visits to farmers, monitoring and provision of technical advice, follow up actions were designed based on emerging knowledge, skill and technical needs. Researchers, extension agents, experts and farmers were jointly participated on continues supervision of the experiment.

Technology Dissemination Methods

Appropriate extension approaches and all extension teaching methods were employed during the implementation of the cluster based pre scaling up activity. These were:

- ✓ Telephone call
- ✓ Field visit and supervision
- ✓ Field day

- ✓ Method demonstration (to impart the skills) and result demonstration (to show the performance)
- ✓ Group meeting and discussion
- ✓ Training (both theoretical and practical)
- ✓ Mass media (OBN Television)
- ✓ Print Media (leaflets, brochures, posters) were used for creating awareness, enhancing clients' knowledge and skill, changing attitude on using fully recommended packages of improved chickpea technology and the importance of farmer-to-farmer variety dissemination across similar agro -ecologies.

Method of Data Collection and Analysis

Data such as total amount of inputs distributed for participant farmers, total number of farmers participated in the training, field day by gender, role of farmers and other stakeholders in technology dissemination, yield data, income from adoption of technology, impact in livelihood due to adoption of the technology and farmers perception were collected using checklists through interview and discussions. The collected data were entered into SPSS and analyzed using descriptive statistics and narrative.

RESULTS AND DISCUSSION

Yield Performance

In spite of the inevitable variability in performance between and even within clustered locations, yield performance of the chickpea variety was still promising. The variability in yield performance might have stemmed from difference in land preparation as the farmers of the study areas were very busy in harvesting crops of the main rainy season, so lagged behind in preparing their land in the recommended extent, the status of soil fertility, difference in management and pest infestations during flowering and pod setting stages coupled with prevalence of little rain fall in the areas and others. Despite this fact, a mean yield of 1.19 tons ha^{-1} was obtained.

Table.2. yield of chickpea across clusters in Adola Rede district.

No	AGP- II peasant association	Yield across clusters in Adola Rede district (in tons ha^{-1})			Total	Mean
1	Cluster at Darartu	Sub- cluster one	Sub- cluster two	Sub- cluster three		
		1.5	1.3	1.1	3.9	1.3
2	Cluster at Kiltu Sorsa	1.2	1.1	0.9	3.2	1.07
	Total	2.7	2.4	2.0	7.1	1.19

Capacity Building and Knowledge Sharing

Training of Farmers and Other Stakeholders

Participatory training was given to farmers and stakeholders by multi-disciplinary team of researchers consisting of breeder, agronomist, pathologist; extensionist and economist drawn from Bore Agricultural Research Center (BoARC) on issues like economics importance of chickpea, nutritious, suitable ecologies and weather condition for chickpea production, the importance of crop rotation to break mono cropping problem, chickpea production and management packages, diseases like insect and pests and their controlling ways; agrochemical applications and post-harvest and the concept of FREG approaches. A total of 114 farmers (27 female) from the districts of which 24 FREG member farmers, 16 DAs, 9 subject matter specialists (SMS), and 2 experts from cooperative office at Adola Rede district were participated (Table 3). The training materials were printed and dispersed to the agricultural experts and development agents.

Table 3. Summary of chickpea training of participants.

Year	**District**	**Participants**					
2019	Adola Rede	Farmers		Total	DAs	Experts and stakeholders	Grand total
		Male	Female				
		87	27	114	16	11	
	Total	87	27	114	16	11	141

Input Distribution

All the necessary inputs like seeds and fertilizers were distributed for the host farmers. Anti pest chemical, the so called profit was also distributed and sprayed at the pest infestation period. During the course of cluster based pre scaling up process, a total of 24 farmers (16 male and 8 female) were directly reached.

Table 4. No of beneficiary farmers, area covered and input distributed.

AGP- II District	Area covered (hectare)	No of farmers		Amount of inputs distributed			
		Male	Female	Seed (in quintal)	NPS(in quintal)	UREA(in quintal)	Profit(in liter)
Adola Rede	6	16	8	6	3.6	1.8	6
Total	6	24		6	3.6	1.8	6

Field Day

Field day is one of extension services and methods used to transmit information and creation awareness for larger clients and on which bad and good practices evaluated. Field day can be organized at different stages in crop production systems. It can be two or three times on which the stages are at vegetative, flowering and maturity depending on crop type and nature produced with available financial and logistic resources. Field day is used as tool to address large number of farmers, even invited farmers who did not produce improved chickpea to create massive awareness and large impacts on technologies for further production and scale up on farmers' fields. Not only farmers but also other stakeholders were invited to participate on the event.

Consequently, a total of 52 farmers, 6 development agents and 5 experts from district government offices were participated on the occasion. In addition, during field day mass extension methods like leaflets, banner and Television were used to reach large clients. The field day was communicated by Oromia Broadcasting Network, a Regional State Television Program to disseminate information for wider community in local language. A total of 40 leaflets were distributed for the participants which describes the production, agronomic practices and overall managements of improved chickpea. Finally, at the end of the visit during field day, group discussion was conducted to grasp farmers' feedback on strength and weakness of improved chickpea. Besides, broad issues like constraints in agricultural production, needs and interests of farmers on other improved varieties and availability of agricultural inputs are points rose by participants on the program.

Farmers' Feedback about Chickpea

During the course of the cluster based pre scaling up process and at the final stage of the activity, an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that chickpea liked by farmers as it is planted at the end of the main rainy season following the harvest of the main crops and has the ability to grow on residual moisture, can survive drought conditions, which gives farmers the advantage to engage in double cropping. This allows more intensive and productive use of land. It was also revealed to have good market price.

Economic Return to Farmers

Farmers of the study areas benefited from this cluster based pre scaling up process in multi dimensions; clustered FREG member farmers obtained chickpea seed of 6 quintals, NPS 3.6 quintals, UREA 1.8 quintals and 6 liters of PROFIT- pesticide chemical for free. This sidestepped the burden of suffering inputs which could have cost them about 3000ETB, 1350 ETB and 200 ETB for seed fertilizers and chemicals respectively, a total of 4550 ETB ha^{-1}. Besides, every management activities like from the beginning of land preparation up to threshing was performed by the cooperation of clustered FREG farmers themselves and expenses for wage was minimized. Chickpea seed were properly stored at the house of each host farmers. So that follow farmers and other farmers from similar agro ecologies were advised to access to those variety at their dominion. This could also avoid the transaction cost of acquiring chickpea seed for follower farmers and enable to extend the availability of chickpea seed, FREG member farmers produced an average yield of 1.19 tons ha^{-1} and hence got a benefit of 41650 ETB ha^{-1}, with an average price of 3500 ETB a quintal. This could contribute a lot to minimize food insecurity and improve livelihood of farmers at the study areas and similar agro ecologies.

CONCLUSIONS AND IMPLICATIONS

The result indicated that the variety gave promising under moisture stress cropping season, and good trait for double cropping and marketability. The high protein content of chickpea increases its nutritional value and therefore improves the consumption behaviors of the community. Moreover, it was profitable and generally adds soil fertility. For the combined effect of all these traits, the technology is very important in improving livelihood of farmers in the study areas. Hence, the technology should be sustained to reach more number of farmers over wider geographical areas of similar agro ecologies. Bureau of Agriculture and Natural Resource of Adola Rede district should go further as Bore Agricultural Research Center (BoARC) could not go beyond this limit. Securing agro chemicals in advance to avoid pest infestation, timely preparation of land and planting at early September depending on the soil moisture content to escape from drought occurrence should be given due emphasis.

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Pre-extension demonstration of improved faba bean varieties in highlands of East Guji Zone, Southern Oromia, Ethiopia

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ABSTRACT

The activity was conducted in 2019 main rainy season at Bore, Dama and Ana Sora districts of East Guji zone, Oromia, Ethiopia with the objective of evaluating yield performance of improved faba bean technologies under farmers' circumstances, assessing farmers' perception or preference and raising farmers' knowledge and skill on faba bean production and management practices. Two Kebele per district were selected based on faba bean production potential and 15 farmers were selected from each Kebele as one FREGs member. Thus, a total of 6 FREGs comprising 90 farmers (64 male & 26 female) were established. One improved faba bean variety (Alloshe) was demonstrated with standard check (Walki) on plot size of 100 m^2 area per variety at 40 cm inter- and 10 cm intra- row spacing and with recommended seed and fertilizer rates. Human capacity building was provided such as through training, exchange visit and field day to enhance farmer to farmer learning on faba bean production. Observation, measurement and face to face interview were employed to collect the data and the collected data were analyzed by descriptive statistics and farmer's preference was analyzed qualitatively. The demonstration result revealed that improved variety and standard check were almost comparable average grain yield which gave 4060 kg ha^{-1} and 3960 kg ha^{-1}, respectively. Thus, based on grain yield obtained, farmers' preference and economic return of both varieties are recommended for further scaling up/out.

Key Words: *Demonstration, faba bean, Farmers' preference, FREGs.*

INTRODUCTION

Pulses are important food crops due to their high protein and essential amino acid content. The seeds of pulse crops are typically made up of 20 to 25% protein as compared to 6 to 10% protein content in major cereal crops. Pulses are also rich in dietary fiber and usually have only small amounts of oil. The protein of pulse seeds is high in the amino acids lysine and methionine, making pulses nutritionally complementary to cereals, which are deficient in these two essential amino acids. Pulses are the main source of protein in the diet of vegetarians, and feature prominently in the traditional cuisine of virtually every region of the globe (Sitou and Mywish, 2011). The straw from the crop is also used as fuel in Sudan and Ethiopia (Tewodros *et al*., 2015).

Ethiopia is one of the major faba bean (Vicia faba L.) producing countries in the world (FAO, 2015). It is the fourth largest faba bean exporting country next to France, Australia, and the United Kingdom (FAO, 2016). Faba bean takes the largest share of area (492,271.60 ha) and production (1041953.5 tones) of the pulses grown in Ethiopia (CSA, 2019).

This crop has manifold advantages in the economic lives of the farming community in the high lands of the country. It is a source of food, feed, cash to farmers and also play significant role in soil fertility practices. The crop usually grows in Nitisol and Vertisol dominated areas of Ethiopia mixed with cereals and field peas. The average national yield of faba bean is about 2.117 ton/ha (CSA, 2019) which is very low compared to the average yield of 3.7 ton/ha in major producer countries (FAOSTAT, 2017).

The major factors that are usually mentioned for the low yield of faba bean in Ethiopia include climatic, edaphic, biotic (diseases, pests and weeds) factors, and poor agronomic practices. On the other hand, the on- farm average yield of released faba bean varieties reaches up to 3.5 ton/ha (FAOSTAT, 2017). This indicating the existence of considerable yield gap between farmer managed and researcher managed plots.

Highlands of East Guji Zone is one of the administrative Zones in Oromia Region, Southern Ethiopia which has a huge potential for faba bean production. In addition, the area has got plenty of rainfall for a longer duration in a year. Thus, the crop is grown in the highland areas of the Zone. Despite the potential of the area faba bean production is limited by lack of improved verities which can tolerate disease and certain biotic factor like chocolate spot and rust.

So far, Gebelcho and Walki varieties of faba bean were demonstrated and pre scaled up to farmers. Nevertheless, both varieties were susceptible to chocolate spot and rust. To solve this problem, Bore Agricultural Research Center Pulse Research Team was adapted and evaluated eleven new variety of faba bean during 2017/2018 production season. From those newly released Alloshe variety was recommended for demonstration due to its relative disease tolerant. Therefore, the pre extension demonstration of improved faba bean varieties in the highland of East Guji Zone is essential.

MATERIALS AND METHODS

Description of study areas

The experiment was executed at Bore, Ana Sora and Dama districts during the main cropping season of 2019/20 under rain-fed conditions. Bore district is situated in the Northern part of Guji Zone, Oromia regional state at a distance of 385 km from Addis Ababa and 210 km from Zonal capital city, Negele. Astronomically, Bore is located between 6^{o}57'27” - 6^{o}20'52” latitudes and 38^{o}25'51” - 38^{o}50'21” longitudes. It has elevation ranging from 1400-2800 meters above sea level. The annual rain fall is about 1200-1400 mm and the annual temperature of the district ranges from 11.1 up to $21c^{0}$. The major soils of Bore district are Nitosols (red basaltic soils) and Orthic Acrosols. The two soils are found on the highland areas, and they are red brown and black brown in colors and on sloping topography and their utilization are good under natural vegetation respectively.

Ana Sora district is situated at a distance of 410km from Addis Ababa and 180 km from zonal capital city, Negele. Astronomically, the district is located between 6^{o}20'30” - 5^{o}57'30” latitudes and 38^{o}39'30” - 38^{o}57'30” longitudes. The district is characterized by two types of climatic zone, namely temperate, Dega (locally known as Bada) and Woina dega (locally known as Bada-dare). It has humid and sub humid moisture conditions, with a relatively longer growing season. The annual rainfall nearly about 1000-1500 mm and the annual temperature of the district is nearly about 15 up to 20 c^0. Dama district is also well known by production of potato, faba bean bread wheat, food barley, enset, forest product production.

Site selection

Pre-extension demonstration of faba bean varieties were conducted in Bore, Ana Sora and Dama districts of East Guji Zone. Purposively two Kebeles from each district were selected based on their accessibility and faba bean production potential.

Hosting farmers' selection

Farmer's research group (FRG) approach was followed to select farmers and group under hosting farmers. A total of 6 FRGs were organized having 64 male and 26 female members. Among the FRG members, a total of eighteen (18) interested hosting farmers were selected. Having suitable and sufficient land to accommodate the trials, initiatives to implement the activity in high-quality, vicinity to the roads and willingness to explain the technologies to others were the criteria used to select the hosting farmers.

Materials used and Field design

The recently released faba bean variety (Alloshe) and the standard check (Walki) were planted on selected hosting farmers land on 10 m x 10 m plot for each variety in the main cropping season. Full packages of technologies that include row planting at 40 cm inter- and 10 cm intra- row spacing, recommended seed rate of 150 kg per hectare and fertilizer rate of 100kg of NPS per hectare were applied. In addition, twice hand weeding was done on time.

Bore Agricultural Research Center (BOARC) was the source of agricultural inputs (seed and fertilizers). Land was provided by hosting farmers. Land preparation was carried out by trial/hosting farmers, whereas land leveling, planting, follow up and visit, harvesting, threshing were handled and managed by BOARC Agricultural Extension Research Team.

Data types and methods of data collection

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

Data analysis:

The collected agronomic data was analyzed using descriptive statistics. Farmer's preferences to demonstrated varieties were also analyzed qualitatively and profitability of each variety was also identified by using NFI (Net farm income). Technology gap was analyzed by the formula used by Dhaka *et.al.* (2010) as follows:

Technology gap = Potential yield qt/ha – demonstration yield

Whereas yield advantage of the demonstrated varieties was calculated using the following formula.

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

RESULTS AND DISCUSSIONS

Capacity Building

In order to capacitate the farmers' knowledge on faba bean production trainings were given for selected Farmers Research Group members, Development Agents (DAs), and Subject Matter Specialists (SMSs). Exchange visit and mini field days were organized to enhance farmer to farmer learning on the production and management of faba bean. Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge during training and field day organized. Table 1 shows the number of farmers, development agents, district office of agriculture experts and other participants who attended training, exchange visit and field day of faba bean demonstration.

Table 1. Capacity building methods and number of participant for demonstration of faba bean

Capacity building methods	Participants	Number of participant		
		Male	Female	Total
A. Training	Farmers	62	28	90
	DAs	9	3	11
	SMSs	11	1	12
B. Exchange Visit	Farmers	17	3	20
	DAs	3	1	4
	SMSs	3	1	4
	Others	4	1	5
C. Field day	Farmers	48	22	70
	DAs	11	3	14
	SMSs	15	-	15
	Others	31	7	38

Yield performance of the demonstrated varieties

As shown in the following table 2, the mean grain yield obtained from newly released Alloshe variety was 4060 kg ha^{-1} whereas 3960 kg ha^{-1} gained from standard check Walki variety. The mean grain yield obtained from both varieties was almost analogous. The result of this demonstration was greater than previously conducted scaling up of faba bean which was 3376 kg ha^{-1} (Basha Kebede and Dembi Korji (2017). Yield advantage of Alloshe variety over Walki were insignificant which was only 2.52 %, this implies that yield obtained from both varieties were almost comparable.

Table 2. Grain yield performance of faba bean varieties demonstrated

Yield performance of faba bean varieties in Kg/ha						
Variety	N	Minimum	Maximum	Mean	Std. Deviation	Yield advantage (%)
Alloshe	18	3300	5200	4060	4.65440	2.52
Walki	18	3200	4900	3960	4.29774	

Table 3. Result of independent sample t test

Equal variances assumed	Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
	.087	.769	.632	34	.531	.944	1.493

Table 3 show that since the significance value for the Levene test is high (greater than 0.05), we used the results that assume equal variances for both groups. During faba bean demonstration, the equal variances are assumed (p = .769 > .05). This indicates that there is no statistically significant difference between the two means yield of both varieties.

Technology gap

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). According to Dhaka *et al*. (2010), its contribution is to narrow down the gap between the yields of different varieties and to provide location specific recommendations.

Table 4. The result of technology gap for faba bean varieties

Parameter	Faba bean Varieties	
	Alloshe	Walki
Technology gap (qt/ha)	6.4	-1.6

As indicated in the above table, the technology gap is 6.4 qt/ha and -1.6 qt/ha for Alloshe and Walki varieties, respectively. The demonstrated yield of Walki variety 39.6 qt/ha was greater than its potential yield which was 38 qt/ha. However, yield gap of Alloshe variety between potential and demonstrated yield were 6.4 qt/ha as the potential yield of Alloshe variety was 47 qt/ha, but 40.6 qt/ha demonstrated mean yield. This indicated that the lowest gap was observed on Walki variety, which in turn shows the demonstration yield, is greater than the potential yield by 1.6 qt/ha at the study areas.

Financial analysis

In terms of profitability, the financial analysis result shows that an average profit of 52,632.83 and 50,743.94 ETB per hectare was obtained from Alloshe and Walki varieties, respectively, in one production season. Table 5 indicates that both varieties were profitable at the study area. The farm get price during production season was 20 ETB for one kilogram of faba bean for both varieties. Total revenue was calculated by multiplying price by yield obtained (TR= Y x P), growth marginal rate was calculated by subtracting total variable cost from total revenue (GM = TR-TVC) and the final profitability was calculating by subtracting total fixed cost from total growth marginal rate (Profit= GM-TFC).

Table 5. Cost benefit analysis of faba bean demonstrated varieties in ETB/ha

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Yield of Alloshe Kg ha^{-1}	18	3300	5200	4060	4.65440
Yield of Walki Kg ha^{-1}	18	3200	4900	3960	4.29774
Farm get price (P)	18	20.00	20.00	20.0000	.00000
Total Fixed cost	18	3000.00	3000.00	3000.0000	.00000
Total variable costs	18	24603.00	26403.00	25589.3889	444.45540
Total cost	18	27603.00	29603.00	28644.9444	504.67561
Total Revenue of Alloshe	18	66000.00	104000.00	81222.2222	9308.79126
Total Revenue of Walki	18	64000.00	98000.00	79333.3333	8595.48445
Gross margin of Alloshe	18	40397.00	78697.00	55632.8333	9214.91889
Gross margin of Walki	18	38397.00	72697.00	53743.9444	8465.65677
Profit of Alloshe	18	37397.00	75697.00	52632.8333	9214.91889
Profit of Walki	18	35397.00	69697.00	50743.9444	8465.65677

Feedbacks and farmers' preference

Research is circular in which improved (new) varieties were released from research center and disseminated to farmers. In participatory research activities like sowing on farmers' field the farmers had sound feedback on what they obtained or observed improved varieties from research centers by researchers. During the demonstration of faba bean farmers provide constructive feedbacks, this feedback goes back to research agenda for further research on faba bean technologies for researchers.

The demonstrated faba bean varieties were compared based on farmers' preferences such as: maturity date, disease tolerant, pod per plant, seed per pod, grain yield, lodging status, good crop stand, seed size and profitability of the varieties farmers preferred both varieties as their first choice.

CONCLUSIONS AND RECOMMENDATIONS

Pre-extension demonstration of faba bean varieties was carried out on eighteen (18) representative trial farmer's fields. Improved variety Alloshe with standard check Walki variety was demonstrated under farmer condition. The demonstration result revealed that both varieties performed good where 4060 kg ha^{-1} and 3960 kg ha^{-1} was harvested from Alloshe and Walki varieties respectively. Moreover, final profitability from both varieties was viable at the study area. In terms of farmer's feedbacks and preference both varieties was preferred as their first choice based on maturity date, disease tolerant, pod per plant, seed per pod, grain yield, lodging status, good crop stand, seed size and profitability. Therefore, based on grain yield obtained, farmers' preference and economic return of both varieties are recommended for further scaling up/out.

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Cluster Based Pre Scaling up of Improved Irish Potato Variety at Highland Districts of East Guji Zone, Southern Oromia, Ethiopia

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ABSTRACT

Irish potato of Gudane variety was proved to be yielder and disease tolerant than any Irish potato varieties which were demonstrated at the study areas. Therefore, Cluster based pre scaling up of Irish potato was conducted at two districts of East Guji Zone, Bore and Ana Sora in 2019. The main objective of the study was to promote improved Irish potato variety and thereby increase production and productivity and income of the farmers in the study areas and similar agro- ecologies. One kebele per district was selected based on their potential to produce Irish potato. FREG approach was followed to implement pre scaling up process. Consequently, 12 farmers of gender inclusive were clustered as FREG at each trial sites owing three hectors of land, each farmer contributing 0.25 hectare. In total, 24 farmers (17 male & 7 females were benefited scaling up). Training was given for farmers, Development agents, subject matter specialists and different stakeholders. Recommended seed and fertilizer rates, row between space and plant were used with all management practices. Diffused Light Storages were constructed at both study sites. Joint monitoring and evaluation were organized and undertaken. Field day was also organized on which different stakeholders participated and experience shared. Quantitative data such as yield was collected and analysed using SPSS whereas farmers' feedback were analysed qualitatively. A mean yield of 14.9 tons ha $^{-1}$ obtained. The technology has paramount importance in improving livelihood of farmers as more yield could be harvested. Hence, Bureaus of Agriculture and Natural Resource of respective districts should hand over to sustain the technology and reach more number of farmers over wider geographical areas of similar agro ecologies. Securing agro chemicals in advance, early planting and construction of Diffused Light Storage are highly recommended.

Key words: cluster based pre scaling up; diffused light storage; freg approach; *Gudane variety*

INTRODUCTION

Potato (Solanumtuberosum L.) is one of the most important food crops in many countries of the world (Hirpha A. 2010). It is an important food and cash crop in eastern and central Africa, playing a major role in national food security and nutrition specially in disaster situations, poverty alleviation and income generation, and provides employment in the production, processing and marketing Sub-sectors (urge M. et al., 2012). In volume of production it ranks fourth in the world after maize, rice, and wheat with annual production of 314.1 million tons cultivated on about 18.1 million hectares of land (Hirpha A. 2010) and among the root crops, potato ranks first in volume produced and consumed, followed by cassava, sweet potato, and yam (Struik PC, Wiersema SG 1999).

Potato is efficient in converting resources such as labour and capital in to a high energy food. Its efficiency of protein production is also higher than commonly realized. If carefully managed, it gives the highest yield of nourishment per hectare of all basic food staffs in tropical countries. Furthermore, the growing period is only 90-125 days; enable multiple cropping for optimum use of the available land moisture. Hence, it is noted that in potato producing areas double cropping is possible (Abera G. *et al*., 2005).

Potato is grown for food, animal feed, industrial uses and for seed tuber production. The main use is still as direct food but, an increasing proportion is processed into snack food. Potato is important for subsistence farmers but may also be a cash crop (Getachew T. *et al.,* 2012).

Potato was introduced to Ethiopia in 1858 by the German Botanist Schemper. Since then, potato became an important garden crop in many parts of the country. About 70% of the available agricultural land is suitable for potato production which is located at an altitude of 1500 to 3000 m.a.s.l with an annual rainfall between 600 and 1200 mm (MoARD 2010). However, a number of production constraints that accounts for low yield have been identified in the country. The major ones are lack of stable, well-adapted, high yielding, acceptable and disease resistant cultivars and using of local cultivars, which are highly susceptible to late blight that sometimes leads to 100% yield loss (Woldegiorgis *et al.*, 2008).Improved potato varieties together with improved management proved to give three to four fold yield advantage as compared to local varieties together with traditional production and management practices (Hassen A. *et al.*, 2015).

In the highland districts of East Guji Zone, Irish Potato is one of the most important root and tuber crops produced on spring (belg) and autumn (meher), Ethiopian production seasons and mainly in spring season. Irish Potato is produced mainly as cash crop and in some extent as food crop by farmers in the highland areas. Regardless of its role in the farming system and in supporting the national economy, yield has been low and stagnant for several years due to different reasons. There could be several reasons for this but the most important ones are lack of improved varieties with desirable agronomic practices, lack of farmers' awareness on how to preserve improved seed, low yield potential of local varieties, and diseases. Particularly limit production and distribution of improved seed among resource poor farmers. In addition to this, the access of the improved varieties has been low for poorest segment of farmers. The study areas are potential for potato production despite the prevalence of stated production constraints. In relation to this, there is high need of improved technologies of this crop by farmers that can enable them to improve their income through increased production & productivity. Gudane variety was proved to have potential for up scaling to improve productivity, food and nutrition security, and climate resilience of resource poor farmers during adaptation and demonstration by Bore Agricultural Research Centre at some highland parts of the study areas. Therefore, cluster based pre scaling up of improved potato technology would help to enhance production and productivity of the crop for better livelihood, improvement of food security and self sufficiency of small scale farmers in the study areas.

MATERIALS AND METHODS

Description of the Study Areas

The study was conducted in selected highland districts of East Guji Zone. Bore and Ana Sora were the two districts selected for this study among the highland districts in the East Guji

Zone. The districts are characterized by two agro climatic zones, namely humid which starts in early April up to October and sub humid which starts late November up to beginning of March. The major soils of the two districts are Nitosols (red basaltic soils) and Orthic Acrosols. The two soils are found on the highland areas, and they are red brown and black brown in colors and on sloping topography and their utilization are good under natural vegetation. The farmers of these districts produce cereals such as wheat, barley and maize, pulses such as faba bean and pea. Tubers like Irish Potato and others such as fruits and vegetables were in the study area.

Bore District

Bore district is placed at a distance of 385 km from Finfine, capital city of Ethiopia and 205 km from Negele, the capital town of East Guji Zone. Geographically, Bore district is at the Northern part of East Guji Zone. While astronomically situated between 5^o57'23"- 6^o26'52" northing latitudes and 38^o25'51"- 38^o56'21" easting longitudes. Most of the earth surface of the district has an undulating land surface with an elevation ranging from 1450-2900 meters above sea level. It has the annual rain fall of 1250 mm and the annual temperature ranges from 15-24 ^{0}c.

Ana Sora District

It is situated at a distance of 410 km from Finfine and 180 km from Negelle. Astronomically, the district is located between 6^o20'30"- 5^o57'30" northing latitudes and 38^o39'30" - 38^o57'30" easting longitudes. It is most humid and sub humid moisture condition, which has relatively longer growing season. It comprises the annual rain fall of 1750 mm and mean temperature of 17.5-28 ^{o}c.

Approaches to the Cluster Based Pre Scaling Up Activity

Technically, pre scaling up activities is headed by demonstration and participatory variety selection with farmers and pertinent stakeholders. Hence, in the recent years, the potato technologies were demonstrated on some farmers at the respective sites where the technology was intended to be pre scaled up. Results from the evaluation process revealed that Gudane variety had met the farmers' requirement that paved the way to this activity. It was based on this result that the cluster based pre scaling up phase was planned and executed using extension approaches.

For the sake of enhancing efficiency and effectiveness, integration and cooperation with stakeholders implemented for the achievements of the strategy. Accordingly: Organizing stakeholder forum for discussion with responsible and cooperative participants at district level to have a common understanding of this activity, signing memorandum of understanding, appointing focal persons and establishing Farmers Research Extension Groups (FREGs) at each kebele were done successfully. Trainings on capacity building regarding knowledge, skill and attitude of potato production, management and package, construction of Diffused Light Storage, concept of cluster, economic valuation of potato, FREG approach and seed dissemination mechanism was delivered for farmers, agricultural experts at district level and development agents (DAs) by multidisciplinary team organized from Bore Agricultural Research Center (BoARC). Distribution of potato technology (Gudane) with its recommended packages and other agricultural inputs (agro-chemicals) to participating farmers. FREG member farmers and other follower farmers were encouraged to participate in the physical activities from the beginning up to the end. Joint monitoring and evaluation like regular field visit by extension agents and extension counterparts, joint field visit and supervision at different crop stage, field day organized, discussion session and result communication forum were also structured. Seed delivery mechanisms like convincing the host farmers to appreciate farmer-to-farmer seed exchange mechanism with an optimum price at the end of the activity life span facilitated.

Stakeholder Analysis

In enhancing potato technologies generation, dissemination, improving Irish Potato production and productivity, Bore Agricultural Research Centre was closely working and has made frequent consultation with its respective stakeholders. Pre scaling up activity should be done by different actors in partnership and collaborative approach. So stakeholder analysis is highly important for institutional arrangement to share roles and responsibilities before embarking on the pre-scaling up activity. Thus, stakeholder analysis was undertaken to identify potential stakeholders. Points such as: who are the stakeholders? How big is their stake? How much they are closer to the project? What are their roles, duties and responsibilities in implementing the activity? How does the collaboration support the opportunities to bring the required impact? And finally the roles, duties and responsibilities of each actor were clearly stated in implementing the activity. To this end, zonal and district agricultural experts, district cooperatives, Development Agents and Researchers were the identified stakeholders.

Table 1. Stakeholder roles and responsibilities in implementing the activity

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

Sites and Farmers Selection Procedure

Selection of the districts was accomplished by a multi-disciplinary team from Bore Agricultural Research Centre using self-experience gained during potato demonstration activity in the recent years and collaboration with experts of the respective districts. Accessibility and potentiality, convenience of the areas to the technology and representativeness of the trial fields in terms of location and suitability for more farmers to visit the field, were the most important criteria to select both the districts and the kebeles under consideration.

As Development Agents are nearer to and information rich about the farmers in their respective locality, they were entirely given the work of farmers selection based on the criteria set by researchers. On top of this, having appropriate and sufficient plots, good history of managing experimental or non-experimental plots were the other criteria used to select the participating farmers. Accordingly, from each kebele one FREG which comprises 12 clustered farmers was nominated based on their consent to work in group and provide three hectares of land per cluster. The clustered FREG member farmers were re- clustered in to three sub groups comprising of four farmers with one hectare of land. Consequently, a total of 24 hosting farmers as FREG were organized, under which other farmers were organized as follower farmers to share knowledge, skill and experience for further promotion mechanism.

Planting Materials and Agronomic Practices

Gudane, Irish potato variety that were recently adapted and demonstrated at Bore Agricultural Research Centre were pre scaled up at 24 clustered farmers' field. The seed rate were 1.8 tonnes ha^{-1} with a spacing between rows 75 cm and between plants 25 cm. So that 10.8 tons of improved Gudane of this variety were delivered for a total of six hectors of land and for 24 FREG farmers at both trial sites. 100 Kg ha^{-1} Urea (50 Kg at planting time and 50 Kg during earthing up) and 200 Kg ha^{-1} NPS was applied at planting time. All the management practices such as land preparation and weeding were applied as per the recommended for Irish potato production. All farm operations such as land preparation, land levelling, planting, weeding, harvesting, and construction of Diffused Light Storage for potato storage were carried out by FREG member farmers with close assistance and supervision of concerned participating institutions (Research Centre and Agriculture and Natural Resource Office). INDOFIL M- 45, a preventive fungicide used for the control of Late Blight in potato was also sprayed at the rate of 2.2 Kg ha^{-1} in 750 litres of water and the application was repeated once at fortnight interval, Farmers' full participation at all stages of the activity was maintained during the implementation period.

Joint Monitoring and Evaluation

From beginning of site selection until harvesting, frequent visits to farmers, monitoring and provision of technical advice, follow up actions were designed based on emerging knowledge, skill and technical needs. Researchers, extension agents, experts and farmers were jointly participated on continues supervision of the experiment.

Technology Dissemination Methods

Appropriate extension approaches and all extension teaching methods were employed during the implementation of the cluster based pre-scaling up activity.

- Telephone call

- Field visit and supervision
- Field day
- Method demonstration (to impart the skills) and result demonstration (to show the performance)
- Group meeting and discussion
- Training (both theoretical and practical)
- Mass media (TV OBN)
- Print Media (leaflets, brochures posters) were used for creating awareness, enhancing clients' knowledge and skill, changing attitude on using fully recommended packages of improved potato technology and the importance of farmer-to-farmer variety dissemination across similar agro -ecologies.
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Method of Data Collection and Analysis

Data such as total amounts of inputs distributed for participant farmers, total number of farmers participated in the training and field day by gender, role of farmers and other stakeholders in technology dissemination, yield data, income from adoption of technology, impact in livelihood due to adoption of the technology and farmers perception were collected using checklists through interview and discussions. The collected data were entered into SPSS and analysed using simple descriptive statistics and narrating the qualitative explanation of the farmers.

RESULTS AND DISCUSSION

Yield Performance

In spite of the inevitable variability in performance between and even within clustered locations, yield performance of the potato variety was promising, though by far less than the potential yield it could give. The variability in yield performance might have stemmed from difference in land preparation in the recommended extent, as farmers of the areas normally lagged behind in early preparing their land, they preferred the usual way of preparing their land, for the sake of their livestock to graze on it, the status of soil fertility, difference in management and rust out break during flowering stage and others. Despite this fact, a mean yield of 14.9 tons ha^{-1} was obtained.

Table 2. Potato yield obtained across districts

No	Districts	Yield across sub- clusters (tons ha^{-1})			Total	Mean
1	Bore	Sub- cluster one	Sub- cluster two	Sub- cluster three		
		17.0	15.0	12.3	44.3	14.8
2	Ana Sora	16.0	14.7	14.3	45.0	15.0
Total		33.0	29.7	26.6	89.3	14.9

Capacity Building and Knowledge Sharing

Before the beginning of the cluster based pre scaling up activity, a comprehensive trainings were given. In this regard, training on knowledge, skill and attitude were the main approaches that used to create awareness about improved potato technologies among farmers, to capacitate the farmers' and others' knowledge and skill about potato and management packages. To this end, multidisciplinary team were organized to deliver the training in capacity building and facilitating extension efforts of potato technologies. The team was composed of socio-economist, research-extensionist, breeder, pathologist, agronomist and weed scientist from Bore Agricultural Research Centre.

A total of 100 farmers (70% male and 30% female) from the two districts of which 24 FREG member farmers, 12 DAs, 9 subject matter specialists (SMS), 2 experts from union and 2 experts from cooperative office at Bore and Ana Sora districts were participated on both theoretical and on-spot training on potato production and management packages (Table 3). Particularly, the trainings were focused on available improved potato production technologies (varieties, agronomic recommendations and packages, etc.); input utilization; weeds, diseases like Late Blight and their controlling ways; agrochemicals applications and safety precautions and; the importance of crop rotation to break mono cropping problem, the concept of FREG approaches and quality seed production techniques and post-harvest handling and knowledge and skill of Diffused Light Storage construction. The training materials were printed and dispersed to the agricultural experts and development agents.

Table 3. Summary of potato training participants

Year	AGP- II Districts	Participants						Total
		Farmers			DAs and experts			
		Male	Female	Total	DAs	Experts	Total	
2019/20	Bore	35	15	50	6	7	13	63
	Ana Sora	35	15	50	6	6	12	62
Total		70	30	100	12	13	25	125

Input Distribution

All the necessary inputs like seeds and fertilizers were distributed for the host farmers. Anti-rust chemical was also distributed and sprayed. During the course of cluster based pre scaling up process, a total of 24 farmers (17 male and 7 women) were directly reached. Total number of farmers reached, area covered and amount of inputs distributed were indicated in Table 4.

Table 4. No of beneficiary farmers, area covered in hectare and input distributed.

AGP-II Districts	Area covered (hectare)	No of farmers			Amount of inputs distributed			
					Potato Seed of Gudane variety (in tons)	INDOFIL M-45 (in Kg)	Fertilizers incurred by farmers (in quintals)	
		Male	Female	Total			NPS	UREA
Bore	3	8	4	12	5.4	13.2	6	3
Ana Sora	3	9	3	12	5.4	13.2	6	3
Total	6	17	7	24	10.8	26.4	12	6

Field Day

Field day is one of the extension services and methods used to transmit information and creation awareness for larger audience and on which bad and good events evaluated. Field day can be organized at different stages in crop production systems. It can be two or three times on 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 farmers who did not produce improved potato to create massive awareness and large impacts on technologies for further production and scale up on farmers' field. Not only farmers but also other stakeholders were also invited to participate on the event. In addition, during field day mass extension methods e.g. leaflets, banner and Television were used to reach large audience.

Consequently, a total of 70 farmers (22 women), 14 development agents and 15 experts and 38 other stakeholders were participated on the occasion. Besides, information on the field day was propagated by Oromia Broadcasting Network to disseminate information for wider community. A total of 120 leaflets were distributed for the participants which describes the production, agronomic practices and overall managements of improved potato. Finally, at the end of visit during field day, group discussion was conducted to grasp farmer's feedback on strength and weakness of improved potato variety. Besides, constraints in agricultural production in general and potato Late Blight in particular; needs and interest of farmers on other improved varieties were points raised by participants on the program.

Farmers' Feedback

During the course of the cluster based pre scaling up process and at the final stage of the activity, an assessment was made to know how the farmers perceived the technology. Result of the assessment revealed that potato technology was liked by farmers as the productivity of potato from small unit areas of land was proved to be very vast when compared to other crop technologies. Moreover, the technology had also premium price at the peak time when stored in diffused light storage and sold in the form of seed. The other attributes of this technology is that it is sown at the early stage of the main cropping season and harvested after 90-120 days. This provides farmers with the advantage of engaging in double cropping. This allows more intensive and productive use of land that intern increases the income and livelihood of farmers. The issue of agro chemicals for potato fungus was frequently raised by the farmers.

Economic Return to Farmers

Farmers of the study areas benefited from this cluster based pre scaling up process in multi dimensions; clustered FREG member farmers obtained potato seed of 10.8 tons and 26.4 Kg of INDOFIL M- 45, fungicide chemical for free. This evaded the burden of suffering inputs which could have cost them about 21600 and 4160 ETB ha^{-1} for incurring seed and chemical even though fertilizers cost (4500ETB ha^{-1}) burdened to FREG member farmers to insure sense of ownership to the project. Moreover, every management activities starting from the very beginning to the end of project life span was performed by the cooperation of clustered farmers themselves and expenses for wage was minimized. Diffused Light Storage were built at each trail sites (standard storage at Bore, Abayi Kuture kebele and from locally available materials at Ana Sora, Raya Boda kebele) and potato tubers were stored and geminated at each trial sites to ensure seed availability. So that follow farmers and other farmers from similar agro ecologies could accessed to available potato technology at their vicinity with very minimal transaction cost. FREG member farmers produced an average yield of 14.9 tons ha^{-1}. This indicated that FREG member farmers earned the average net profit of 174300 ETB ha^{-1}. This could contribute a lot to ensure food security and improve livelihood of farmers.

CONCLUSIONS AND IMPLICATIONS

The activity was supplementary to the methods that the research system follow in its technology transfer via research-extension linkage. Along with the option of improved technology transfer to access limited areas, the approach has served to activate the local formal and informal seed systems. Because the cluster based pre scaling up was intended that the produced seed would reach other farmers at similar agro ecologies. This improved access to the technology used in the intervention. The linkage created among the different stakeholders assured the use of seed produced for the intended purpose.

The technology is very important in improving livelihood of farmers in the study areas as it gave vast tuber yield and benefit from small unit areas of land given that the use of full production package. This alleviates the food security problems and ensures availability of potato seed from which farmers of the study areas suffer, only if stored in Diffused Light Storage, otherwise securing potato seed in the study areas is continued to be a major problem. Early planting during the beginning of rain at the main cropping season, particularly in March, minimizes the problem of mono cropping and Late Blight in potato. The activity was completed, and the extension division of the centre does not disseminate the technology further than this boundary. Therefore, the technology should be handed over to the respective Bureaus of Agriculture and Natural Resource of Bore and Ana Sora districts for further promotion and reach more number of farmers over wider geographical areas of similar agro ecologies. Other local organizations mainly focus on seed sector such as unions, NGOs and farmers' cooperative should further promote and scale up the technology in reducing quality seed problem and boost the economy by reducing poverty and addressing food insecurity problem of the country in general and study areas in particular. Securing agro chemicals in advance and early planting is highly recommended to escape from potato disease. Potato farmers should also give due emphasise to construct Diffused Light Storage at least from locally available materials depending on their economy.

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Participatory varietal selection (PVS) of improved hybrid Maize Varieties in moisture stress areas of Harari and DDA in AGP-II district

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ABSTRACT

Maize is one of the most important cereal crops in eastern part of Ethiopia in general and Harari region in particular. The activity was proposed to evaluate the adaptability and performance of the hybrid maize varieties and identify high yielding and full fill the farmers' preference. A total of five drought tolerant maize varieties; three hybrids and two OPV (standard checks) were evaluated in RCBD with three replication in lowland areas of Harari region and Dire Dawa Administration city of AGP-II districts in 2019/20 main cropping season. Data were collected from days to anthesis, days to silking, Days to maturity, plant height, cob length and grain yield and farmers ranking. Analysis of variance revealed that high significance differences were recorded in all parameters evaluated among the varieties observed. The result indicated that the variety MH-140 recorded the highest yield with the mean values of 46.38 quintal grain yield per hectare followed by varieties MH-138 and Damota with grain yield 41.65 and 34.71 quintals per hectare respectively, whereas M-4 recorded lowest grain yield of 24.45 quintal per hectare. Damota, MH-138 and MH-140 recorded the highest plant height of 175.3 cm, 171.5 cm and 169.7 cm respectively. Farmers were also evaluated the performance of these maize varieties starting from vegetative stage to maturity with their own criteria. They were selected the best performing varieties depending on their selection criteria like; cob length, grain kernel size/ grain filling, plant height, number of cobs per plant, disease reaction. Accordingly, they were selected MH-140, Damota and MH-138 respectively which fulfill their criteria. Therefore, depending on the analyzed data and farmers selection MH-140 and MH-138 drought tolerant hybrid maize varieties were recommended for demonstration and farther study for the study areas and similar agro-ecologies.

Keywords: Drought, Hybrid maize varieties, selection criteria

INTRODUCTION

Maize (*Zea mays* L) is a major food crop and source of animal feed in Africa, Americas and Asia (Bergvinson, 2000). It is the third most important cereal after wheat and rice globally and the most widely distributed (Siwale *et al.,* 2009). Maize is one of the most important crops grown in Ethiopia (Mosisa *et al.,* 2007). It ranks second after teff in area coverage 18.60% (2,367,797.39 ha) and first in total production 30.08% (94,927,708.34 quintals) (CSA, 2018/19). In Ethiopia, it is grown in the lowlands, the mid-altitudes and the highland regions and most important field crop in terms of area coverage, production and utilization for food and feed purposes. It is the most extensively cultivated food crops and main source of calorie in western, southern and eastern part of Ethiopian (Dagne *et al.*, 2008). With the introduction of the hybrid seeds and the high yielding open pollinated varieties, and the increasing local demand, the importance of the crop may increase even further (Mosisa et al., 2007).

Maize is currently grown across 13 agro-ecological zones, which together cover about 90 percent of the country. The small-scale farmers that comprise some 80 percent of Ethiopia's population are both the primary producers and consumers of maize in Ethiopia. Maize production of Ethiopia increased from 2.34 million tonnes in 1998 to 9.5 million tonnes in 2019 growing at an average annual rate of 30.08%. Despite the large area under maize, the national average yield of maize is about 3.992 t/ha (CSA, 2018/19). This is by far below the world's average yield which is about 5.21 t/ha. The low productivity of maize is attributed to many factors like frequent occurrence of quality of seed varieties, drought, declining of soil fertility, poor agronomic practice, limited use of input, insufficient technology generation, lack of credit facilities, poor seed quality, disease, Insect, pests and weeds particularly, Striga. Varietal selections in maize in Ethiopian have usually been dominantly based on grain yield. Large numbers of breeding lines have been developed at various research stations and their performance evaluated across multi-location tests over several years and only a few varieties are so far identified. Varietal evaluation and decisions were only by researchers; however, this did not lead to the expected speed of variety release, or their dissemination afterwards. In addition, in developing new materials and extending them to farmers, classical plant breeding faces two major obstacles. First, new varieties can be disappointing to farmers where undesirable traits go undetected during the breeding process. Secondly, breeders necessarily discard many crosses and varieties during the selection process because of traits considered undesirable; however, these traits may actually be of interest to farmers. These illustrate the communication gap between researchers and farmers. The importance and complex nature of agricultural research demands coordinated effort among biological scientists, extension agents and farmers in order to ensure that appropriate technology is developed and promoted (Rao *et al*., 2004).

Participatory plant breeding/selection has shown success in identifying more number of preferred varieties by farmers in shorter time (than the conventional system), in accelerating their dissemination and increasing cultivar diversity (Weltzien, E. *et al*., 2003). Therefore, adding information on farmers' perspectives of plant and grain trait preferences to these criteria will be helpful to the variety selection process. Research costs can be reduced and adoption rates increased if the farmers are allowed to participate in variety testing and selection (Yadaw *et al*., 2006).

Some improved hybrid maize varieties has been released by the different regional and federal research centers in the nation but farmers are still stress on few local maize varieties. Farmers have little information about the released varieties both agronomic practice and their economic importance because the varieties were released without the involvement of farmers and the released varieties had not yet evaluated in the study area. To improve the problem, participatory variety selection is the better option to fit the crop bring together of both target environments and user preferences. Farmers in Harari and Dire Dawa are highly demanding better yielding varieties to maximize their production and to multiply in large scale, which consecutively increase income and improve the livelihood of their families or members. Therefore, the objectives of this study were to evaluate and select the best performing hybrid maize variety/ies and to identify farmers' preferences and selection criteria to the study area with the participation of farmers.

MATERIALS AND METHODS

Participatory evaluations of improved hybrid maize varieties were conducted at Dire Dawa Administration City and Harari Region of eastern Ethiopia during 2019/20 main cropping season under rain fed condition in two location. The locations were Wahil of Dire Dawa Administration City (DDA) and Qile/Erer at Harari region of AGP-II districts on the farmers' field. Recently released hybrid maize varieties in Ethiopia were collected and used for the study area. Selection of the host farmers was made based on their representativeness of the majority of smallholder farmers and their ability to disseminate the information to other farmers.

The experiment was laid out in randomized complete block design (RCBD) with three replications. The recently released hybrid and drought tolerant maize varieties used were MH138, MH140 and Damote with two standard checks Melkasa-2 and Melkasa-4. Each experimental plot had 3 m × 4 m with a gross area of $12m^2$. The intra and inter row spacing were 25 and 75 cm, respectively. The distance between plots and replications were 0.5m and 1m apart respectively. Two seeds per hill were sown, which were thinned to one plant per hill after three weeks with the rate of 25 kg ha^{-1}. Fertilizer in the form of UREA and NPS was applied at the rate of 100 and 100 kg ha^{-1}, respectively. NPS was used all once during planting while UREA was applied at knee height (during 8-10 leaf). All other important agronomic practices and management was applied equally to all the entries at their proper time as required.

Data collection

All agronomic data were collected from the three central rows out of the five rows per plot. The data collected include plant height, days to 50% (tassling, silking and maturity), hundred grain weights and grain yield per hectare were collected and analyzed. Plant height (cm) of five randomly selected plants per plot was measured from ground level to the point where the tassel started branching when 50 % of the plants in the plot reached tasseling stage and the mean value was taken as plant height. Days to tasseling, silking and physiological maturity of the crop was recorded when 50% of the plants in the plot reached to their respective phonological stages. Hundred grain weights was determined by counting and weighing from the bulk of shelled grain at 12.5% moisture level and expressed in grams for each plot. Grain yield was determined by harvesting the entire net plot area and converted into kilogram per hectare.

Participatory evaluation methodology was used to acquaint the farming communities and extension workers with the improved hybrid and drought tolerant maize varieties for facilitating their wider dissemination of the selected varieties in the future. The selection of the farmer's field was done in collaboration with development agents. Selection of individual farmer was made on meeting with key informants familiar about the crops to determine the adaptability and the growth performance of all maize technologies through the entire growing period.

Frequent monitoring of the trials by researchers and farmers was made throughout the cropping seasons to collect data on agronomic traits and farmers' assessments. Farmers evaluated the varieties throughout the growth period and at harvest by their own indigenous criteria they set. The criteria they used for evaluation was recorded. Scores was given on a scale from 1(very good) to 5(very poor) for the criteria they set.

Data Analysis

The researchers' recorded agronomic data were subjected to statistical analysis of variance (ANOVA) using Genstat 15th edition. Significant difference between and among treatment means were assessed using the least significant difference (LSD) at 5% level of probability. Farmers' selection data were analyzed using simple ranking method in accordance with the given value (De Boef and Thijssen, 2007).

RESULTS AND DISCUSSION

Researchers' Varietal Evaluation

The analysis of variance showed significant differences among the varieties (P< 0.05) for all the traits measured. However, mean squares for replication were not significant for all the traits measured (Table 1). Analyses of variance (ANOVA) revealed that very highly significant difference (P<0.001) on days to 50% anthesis, grain yield and hundred seed weight; highly significant difference (P<0.01) on days to 50% silking and significance difference (P< 0.05) on days to physiological maturity and plant height was recorded (Table 1).

Table 1. Mean square of yield and agronomic traits for the maize varieties planted at the study area during 2019/20 main cropping season

		Mean square (M.S.)					
Source of variation	d.f.	DA	DS	DM	PH-cm	Gyld-Qt-ha	HSW-g
Replication	2	11.267	8.467	18.867	65.4	4.38	2.6
Variety	4	58.1***	31.433**	10.233*	828.28*	278.58***	58.667***
Error	8	2.6	2.383	5.283	93.65	16.01	1.017
Mean		76.47	83.13	135.93	160.1	34.6	33
CV (%)		2.1	1.9	1.7	6	11.6	3.1

*-Significant at 5%, **and ***- Significant at 1%.; df= degree of freedom; DA= Days to 50 % anthesis; DS= Days to 50% silking; DM= Days to physiological maturity, PH = plant height, Gyld-Qt-ha=grain yield (Qt/ha), HSW-g = 100 seed weight (g).

Mean performance of phonological parameters of maize varieties

The analyses of variance for the phonological data were presented in Table 2. The analysis stated highly significant differences (P≤ 0.001) for days to 50% anthesis, significant (P< 0.05) difference for days to 50% silking and physiological maturity. Days to antheisi, silking and physiological maturity is one of the variety selection criteria, in particular in areas where drought and moisture stress is major problems. The overall average days to 50% anthesis was 76.47 days with a range of 71 days for the standard check (M-4) to 83 days for the variety Damota and days to 50% silking ranged from 78.67 days (M-4) to 87 days (Damota) with the mean values of 83.13 days (Table 2). The earliest variety in days to physiological maturity was recorded by standard check M-4 (133 days) followed by M-2 (135.7 days) and MH-138 (136 days) in which no no significance difference was observed whereas the latest days to physiological maturity was recorded by variety MH-140 followed by Damota with the mean values of 137.7 days and 137.3 days respectively.

Table 2. Mean grain yield and agronomic data of hybrid maize varieties tested at Wahil and Erer districts in 2019/20 cropping season

Variety	DA	DS	DM	PH-cm	Gyld-Qt-ha	HSW-g
Damote	83 b	87 d	137.3 b	175.3 a	34.71 b	38.67 a
M-2 (S.check)	74.67 b	81.67 b	135.7 ab	140.6 b	25.68 c	31.33 c
M-4 (S.check)	71 a	78.67 a	133 a	143.7 b	24.45 c	28.67 d
MH-138	77.67 b	83 bc	136 ab	171.5 a	41.68 ab	29.67 cd
MH-140	76 b	85.33 cd	137.7 b	169.7 a	46.38 a	36.67 b
Mean	76.47	83.13	135.93	160.1	34.6	33
CV (%)	2.1	1.9	1.7	6	11.6	3.1
LSD (P< 0.05)	3.036	2.907	4.328	18.22	7.53	1.898

DA= Days to 50% anthesis, DS= Days to 50% silking, DM= Days to physiological maturity, PH = plant height (cm), Gyld = grain yield (Qt/ha), HSW = Hundred seed weight. Means with the same letter within the same column are not significantly different.

Mean performance of growth and yield and yield components

The overall mean plant height was 160.1 cm, with the range of 140.6 cm (M-2) to 175.3 cm (Damota). The tallest in plant height was recorded by variety Damota with height of 175.3 cm followed by MH-138 and MH-140 with a mean height of 171.5 cm and 169.7 cm respectively. The standard checks; M-2 and M-4 varieties had recorded the lowest mean plant height 140.6 cm and 143.7 cm respectively (Table 2). The mean grain yield value of the tested maize varieties ranged from 24.45 Qt ha^{-1} to 46.38 Qt ha^{-1}. The highest grain yield was obtained from hybrid maize varieties MH-140 with a value of 46.38 Qt ha^{-1}. In addition, two hybrid maize varieties (MH-138 and Damota) gave high yields (Table 2). However, the lowest grain yield was obtained from OPV maize varieties (standard checks) M-2 and M-4 with a mean values of 24.45 Qt ha^{-1} and 25.68 Qt ha^{-1}.

Farmers' Evaluation

The farmers who participated and evaluated the trial were representative to the area and having long experience in farming. Before beginning of the selection process, selected farmers' from the district were asked to set their priority selection criteria. Accordingly, earliness, drought tolerance, plant height, cob length, grain yield, grain size and color and vigorousity, were identified as the most important farmers' selection criteria. Ranking of varieties were done on a scale of 1-5, 1 being very good and 5 being very poor.

Participatory farmers varietal selection and ranking showed that variety MH-140 was ranked highest (1.4), followed by Damota and MH-138 with the values of 1.7 and 1.9 respectively. Variety M-2 (standard check) got least rank with values of 3.1 followed by M-4 (standard check) during farmers' selection.

Researchers' had selected the tested varieties depending on the collected and analyzed data. Drought tolerant, plant height and grain yield was determined as the most important data in the study areas and accordingly, MH-140, MH-138 and Damota got first to third rank respectively. The rank given by researchers and farmers are compared and showed that in some varieties researchers rank did not match with farmers rank. The results also revealed that farmers' preferences in some cases coincide with the researchers' selection. Accordingly, variety MH-140 was ranked 1st by both researchers and farmers whereas Damota which was ranked 2nd and MH-138 ranked 3rd by the farmers' evaluation and selection was ranked vice versa by the researchers evaluation. This result clearly showed that farmers a major selection criterion is not only yield rather combination of other non reproductive parameters. The present investigation confirms the observation by Bellon (2002) that farmers' perception about crop varieties are not always the same as researchers and if given the opportunity, farmers are able to express their preferences differently.

Table 3. Farmers' varietal selection and ranking at Wahil districts of DDA during 2019/20 cropping season

	Varieties				
Criteria	**Damote**	**M-2**	**M-4**	**MH-138**	**MH-140**
Earliness	3	1	1	2.5	3
Drought tolerance	2	2	2	1	1
Plant height	1	3	3	1.5	2
Cob length	1	3	2	2	1
Grain yield	2	4	4	2.5	1
grain size & color	1	4	3	2	1
Vigorousity	2	5	4	1.5	1
Overall score	12	22	19	13	10
Average score	1.7	3.1	2.7	1.9	1.4
Rank	2	5	4	3	1

CONCLUSION AND RECOMMENDATION

Participatory varietal selection has significant role in technology adaptation and dissemination in short time than conventional approach. In this investigation the most important farmers' evaluation and selection criteria earliness, drought tolerance, cob length, grain size and color, plant height, grain yield and vigorousity. Based on the criteria they set, their preferred varieties were MH-140, Damota and MH-138. However, researchers recommended MH-140 and MH-138 drought tolerant hybrid maize varieties for the study area based on the data analysis, agro ecologically suitability. Therefore, from the researchers and farmers evaluation hybrid varieties of MH-140 and MH-138 were recommended for the study areas and similar agro-ecologies for further demonstration and dissemination.

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Pre-extension Demonstration and Evaluation of Melkassa Maize Varieties in selected AGP-II districts of Harari region and Dire Dawa Administration

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ABSTRACT

Pre-extension demonstration and evaluation of early maturing maze varieties with the objectives of promoting and popularize improved melkassa varieties technologies and to create awareness, improving farmers' knowledge and skills through giving training and to improve farmers' livelihood and enhance stakeholders' participation. A total of twenty (20) trial farmers were selected from two potential Maize growing kebeles of Dire Dawa administration council and one from Harari region. Four FRG having 60 farmers were established at each kebele. Two improved maize varieties (Melkassa-2 and Melkassa-6) were replicated on the plot of 20mx20m. Training on which a total of 142 participants and field day on which 63 participants took part were organized at Dire Dawa and Harari region. Melkassa maize varieties were evaluated based on their early maturity, yield, Disease tolerance, cob size. The yield performance of the improved varieties (Melkassa-2 and Melkassa-6) were 32.10 and 29.05 qt/ha at Dodota, 26.89 and 26.02qt/ha at Bishan Bahe, respectively. The average yield performance of melkassa-2 somewhat higher than melkassa-6 at and statistically significant difference 10% probability level Accordingly, the yield advantage of the melkassa-2 variety over the melkassa-6 was 5.24% under farmer condition and both varieties recommended to scale up because of yield farmers prefer them.

Key words: Demonstration, Maize, Melkassa-2, Melkassa-6

INTRODUCTION

Maize (*Zea mays L.)* is one of the most valuable cereal crops used in the human nutrition in various parts of the globe. It is currently grown across 13 agro-ecological zones which together cover about 90 percent of the country. Maize is a multipurpose crop, providing food and fuel for human being and feed for animals (poultry and livestock). Its grain has great nutritional value and can be used as raw material for manufacturing many industrial products (Afzal *et al.,* 2009). Three dominant cereal crops wheat, rice and maize provide 50% of human food calories (Worku, et al, 2012). Maize is one of the most important cereal crop cultivated in Ethiopia (CIMMYT, 2014). It is ranking second in area coverage and first in total production; about 40% of the total maize growing area is also located in low-moisture stress areas.

Availability of the limited number of drought tolerant maize varieties that reached few smallholders was the main factor for instability and low production in low-moisture stress areas of the country (Worku, *et al,* 2012). In South Omo zone similar agro-ecology with East Hararghe zone maize rank first in area coverage (19896.48hectar) and total production (485780.71 quintal). Its productivity (24.42quintal/hectare) very low when compare potential maize areas (33.qt/ha) (CSA, 2013).

The low yield in this area is mainly attributed to recurrent drought, low levels of fertilizer use, and low adoption of improved varieties. Melkassa-2 gave highest yield (50qt/ha) at alduba during 2010 (Tekle Yoseph, etail, 2014), but it gave low yield (32.22qt/ha-) at alduba in 2013; this may due fluctuation of rainfall in precipitation; in quantity and distribution within and across seasons in the study area. Because at lobet with supplementary irrigation M2 gave high grain (49.66qt/ha) and M6, M4 gave yield 43.87, 41.31 qt/ha at lobet respectively even the environment was quiet different (Wadajo Gebre, 2015). Therefore, this activity was aimed at demonstrating nutritionally the best performing, and drought tolerant maize varieties to the target area.

MATERIALS AND METHODS

This research on nutritionally important Maize varieties was conducted in Agricultural Growth Program-II selected districts of Harari region and Dire Dawa Administration council.

Site and farmers' selection

Kebeles were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting that is Dodota kebele from Erer Waldaya and Bishan bahe from Biyo Awale were selected purposively.

Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in form of Farmers Research Group (FRG) with the member of 15 farmers per PAs in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 4FRGs (2FRG/ PA) from one PA 15 farmers and a total of 60 farmers were grouped in 4FRG at Harari and Dire Dawa. In the FRG 5 farmers were trial farmers (3 male trial farmers and 2 female trial farmers) and 10 farmers worked with trial farmers.

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

District	PAs	No. of trial farmers	FTCs	Area covered
Biyo Awale	Bishan Bahe	10	1	20mx 20m for each plots
Erer	Dodota	10	-	
Total		20	1	

Research design

Two improved treatment (M2&M6) Maize varieties and one local check, were replicated across five trial farmers per PAs. Two improved were sown on 10 farmers land by 20m*20m plot size of land from individual trial farmer used for each experiment/ varieties. Each variety planted at the Plot Size: 20mx20m, Seeding rate25-30 kg/ha, Spacing 75cm*30cm (Between row and plant), Fertilizer rate NPS 100kg/ha

Technology evaluation and demonstration methods/technique

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

Data Collection

Qualitative data were collected through personal field observation, individual interview, focus group discussion by using checklist; and quantitative data were collected by sheet tools.

Data analysis

Quantitative data were analysed using simple descriptive statistics (Mean, Frequency and Percentage), iindependent Samples T-test to compare the mean of one sample with the mean of another samples to see if there is a statistically significant difference between the two, while the qualitative were analysed narrative explanation and argument.

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for the sake of publicity of the work done Development agents, experts and farmers were participated on the training given on maize production and management, post-harvest handling and marketing information. Field day was also organized for more awareness creation.

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

		Dodota		Bishan Bahe		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	40	10	35	26	111
2	DAs	4	1	5	3	13
3	District experts	4	2	4	2	12
4	Journalist	3	0	3	0	6
	Total	51	13	47	31	142

Among the training participant stakeholders, 78% were farmers. From those farmers, 32% were female farmers' participant.

Mini-field day organized

Table 3: Type of profession and number of participants on the mini field day at research sites

		Dodota		
No.	Participants	Male	Female	Total
1	Farmers	39	10	49
2	DAs	3	1	4
3	District experts	4	3	7
4	Journalists	3	0	3
	Total	**49**	**14**	**63**

Mini field day was organized at Erer waldaya woreda Dodota kebele, 55 farmers (35 male and 20 females), 7 DAs and 4 experts participated on mini field day organized at Kile P. 39 farmers (13 female and 26 male) selected both M2 and M6. Eleven farmers (2 female and 9 male) selected M2 based on early maturing and yield. Both are similar according to farmers' preferences by food test, stack and drought tolerant. Different extension materials were distributed for the participants that were 50 leaflets and 27 small manuals on the technology that are organized in Afaan Oromoo and English languages. During min-field day different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved melkassa-2 technology production because of better yield. Moreover, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Agronomic and yield performance

The following table describes the yield performances of the demonstrated melkassa maize varieties across the study site. The yield performance of the improved varieties (Melkassa-2 and Melkassa-6) were 32.10 and 29.05 qt/ha at Dodota, 26.89 and 26.02qt/ha at Bishan Bahe, respectively. The average yield performance of melkassa-2 somewhat higher than melkassa-6 at and statistically significant difference 10% probability level

Table 4: Yield performance of improved melkassa maize varieties across districts

PA	**Varieties**	**N**	Std. Deviation	**Mean (qt/ha)**	**Maximum**	**Minimum**
Dodota	Melkassa-2	10	3.540	32.10	35.00	26.00
	Melkassa-6	10	3.157	29.05	35.00	25.70
Bishan Bahe	Melkassa-2	10	2.374	26.89	31.40	23.00
	Melkassa-6	10	1.742	26.02	28.60	23.30
Total			3.582	28.51	35.00	23.00

Table: 5. Independent t-test

Equal variances assumed	Test for equal variances		t-test for equality of means				
	F	Sig.	T	df	Sig.(2-tailed)	Mean difference	Std. Error Differences
	5.02	.031	1.7738.084			1.960	1.102

Yield Advantage

The result indicated that Melkassa-2 variety has better yield (58.12 qt/ha) when compared with Melkassa-6 check (55.07qt/ha). Accordingly, the yield advantage of the Melkassa-2 variety over the melkassa-6 was 5.24% under farmer condition.

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

Yield advantage % = Yield advantage of new variety – Yield advantage of st; check X 100
Yield advantage of standard check

Table 6: Summary of yield performance in study areas

Varieties	Average yield qt/ha	Yield difference qt/ha	Yield advantage over the local check (%)
Melkassa-2	58.12	-3.06	**5.24**
Melkassa-6	55.06		

Source: Own computation 2018/19

Economic Analysis

Table 7: Financial analysis for bread wheat varieties across the districts

Financial analysis					
Location: Dodota			Location: Bishan Bahe		
Parameters	Varieties		Parameters	Varieties	
	M-2	M-6		M-2	M-6
Yield qt/ha(Y)	32	29	Yield qt/ha(Y)	27	26
Price(P) per quintal	1150	1150	Price(P)per quintal	1150	1150
Total Revenue (TR)=TR=Y*P	36,800	33,350	Total Revenue (TR)=TR=Y*P	31,050	29,900
Variable costs			**Variable costs**		
Seed cost	950	950	Seed cost	950	950
Fertilizer cost	2836	2836	Fertilizer cost	2836	2836
Labor cost	4750	4750	Labor cost	4750	4750
Total Variable costs(TVC)	8,536	8,536	Total Variable costs(TVC)	8,536	8,536
Fixed costs			**Fixed costs**		
Cost of land	4000	4000	Cost of land	4000	4000
Total fixed costs (TFC)	4000	4000	Total fixed costs (TFC)	4000	4000
Total cost (TC) =TVC+TFC	12,536	12,536	Total cost (TC) =TVC+TFC	12,536	12,536
Gross Margin (GM) = TR - TVC	28,264	24,814	Gross Margin (GM) = TR - TVC	22,514	21,364
Profit=GM-TFC	24,264	20,814	Profit=GM-TFC	18,514	17,364

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved Melkassa maize varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were Early mature, Very Good in yield, Disease tolerance, Good seed color, Good seed size, Very good performance throughout growing stage, Very good biomass yield, Very good palatability of stalk feed, Very good nutritional value and food test .Based on the above criteria's; farmers evaluated the varieties and ranked Melkassa-2 followed by Melkassa-6. Therefore, most farmers selected both improved Melkasa Maize varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties. The trial farmers in the three locations are aware of the physical characteristics and field performance of all the maize varieties. The major variety selection criteria of farmers in the two locations were almost similar as a result preferred based on traits nutritional value, early maturity yield, seed color, performance, disease tolerance, palatability of stalk, biomass respectively as shown table 8.

Table 8: Ranks of the varieties based on farmers' selection criteria**.**

Crop varieties	Farmers rank	Reasons
Melkassa-2	1st	early mature, very good in yield, disease tolerance, good seed color, good seed size, very good performance throughout growing stage, very good biomass yield, very good palatability of stalk feed, very good **nutritional value and food test**
Melkassa-6	2nd	relative to early maturity, good in yield, relative to disease tolerance, very good seed color, very good seed size, good performance throughout growing stage, good biomass yield, relative to good palatability of stalk feed, relatively good **nutritional value and food test**

Table 9: Pair-wise ranking matrix result to rank variety traits.

Code. no	Traits	Early maturity	Yield	Disease tolerance	Seed color	Performance	Biomass	Palatability of stalk	Nutritional value	Frequency	Rank
1	Early maturity		2	3	1	1	6	1	1	4	4^{th}
2	Yield			3	2	2	2	2	2	6	2^{nd}
3	Food test and Nutritional value				3	3	3	3	3	7	1^{st}
4	Seed color					5	5	4	4	2	6^{th}
5	Performance						5	5	5	5	3^{rd}
6	Disease tolerance							6	6	3	5^{th}
7	Palatability of stalk								7	1	7^{th}
8	Biomass									0	8^{th}

CONCLUSION AND RECOMMENDATION

Even though these improved varieties were introduced, different smallholder growers are still using the planting material which has been obtained from their local markets. Moreover, lack of appropriate agronomic practices and a little attention given to the crop production makes the study area below average producers and the biomass of the produced maize has important benefit for livestock. Moreover, the yield of the improved varieties (Melkass-2 and Melkassa-6) showed statistically significant difference at 10% probability level between two improved varieties across the location and therefore, both varieties were recommended for further scaling up in similar agro-ecology.

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Cluster-based pre-scaling up of improved Barley technologies in Horro and Jimma Rare Districts of Horro Guduru Wollega zone, Oromia

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ABSTRACT

Barley varieties adaptation conducted from 2007 to date indicated that no food barley variety was found better than HB-1307 in terms of yield, adaptability, and disease reaction in western Oromia. The potential of this variety for yield and disease reaction has made the variety highly preferred by the farmers. This activity was initiated to popularize improved barley technologies for smallholder farmers in two selected AGP- II districts and to strengthen the knowledge and skills of farmers on barley production technologies and management practices. Two districts (Horro and Jima Rare) were selected from Horro Guduru Wollega zone and one cluster on each of the district was established. Each cluster comprises five hectares of land and a total of 16 farmers have participated. Those participant farmers were trained on issues of cluster based seed production system, agronomic practices and crop management issues before the commencement of actual work. Barley seed, fertilizer and agrochemicals and training were delivered by Bako agricultural research center researchers and farmers mostly participated in land preparation, sowing, weeding, and harvesting. All necessary agronomic practices for barley production were applied as deemed necessary in a similar fashion on all farmers' plots. Averagely, 4.50 tons per hectare of seed yield was produced which is higher from the national and regional average. In addition to yield increment, farmers were well aware of good agronomic practices. Although the variety is old currently no variety is better than HB-1307. Therefore, it needs to be further popularized until new variety will be released and recommended for these areas.

Keywords: Agronomic practices, Cluster based pre-scaling up, HB-1307

INTRODUCTION

Barley is one of the commonly grown food security crops in high altitude areas of Ethiopia (FAO, 2017). The crop is used for the preparation of different foodstuffs, such as *Injera*, *Kolo*, and local alcoholic beverages (Asresie *et al.,* 2015). Food barley is commonly cultivated in stressed areas where soil erosion, occasional drought or frost limits the ability to grow other crops (Berhanu *et al.,* 2005) which grown by small-scale farmers for subsistence. Barley straw is used as animal feed, especially during the dry season (Getnet *et al.,* 2015). It is grown in a wide range of agro-climate regions under several production systems and best on well-drained soils and can tolerate higher levels of soil salinity than most other crops (Mulatu and Lakew, 2011). Among the major cereals, barley ranks fourth most important crop in terms of productivity and fifth in terms of area coverage and total production in Ethiopia as well as Oromia region (CSA, 2018).

The national area coverage of barley was estimated to be 951,993.15 hectares with productivity of 2.16 tons per hectare while the regional area coverage and average productivity was estimated to be 451,279.26 hectares and 2.41 tons per hectare, respectively (CSA, 2018) and the producers were mostly produced food barley (Alemu *et al.*, 2014). Similarly, the total area coverage for Horro Guduru Wollega zone was estimated to be 12,295.25 hectares with productivity of 1.79 tons per hectare (CSA, 2017).

Though, productivity of barley in the study zone is still far below the national average of the country (CSA, 2017). Low productivity constrained by low yielding ability seed cultivars, low soil fertility, soil acidity, poor soil drainage, and frost, diseases (scald, net and spot blotch, and rust) which can cause yield losses of 67%, insect pests (aphids and shoot fly) which can cause yield losses of 79% and 56%, respectively (Chilot *et al.*, 1998 cited by Mulatu and Lakew, 2011) and poor extension service in technology adoption (Elias *et al.*, 2015).

Recently, to boost the productivity and production of barley for the last six decades (Mulatu and Lakew, 2011), a concerted effort has been made by researchers, development experts, and farmers through participatory research and development efforts. Bako Agricultural Research Center has been conducted a serious barley research on high yielding variety released and appropriate agronomic practices have been recommended in high lands of East and Horro Guduru Wollega zones and West Shewa zone. Accordingly, barley adaption trail for released varieties conducted from 2007 to date indicated that no food barley was found better than HB-1307 in terms of yield, adaptability and disease reaction. The potential of this variety for yield and disease reaction has made the variety highly preferred by farmers. Therefore, based on adaptability, yield potential and farmers' preference, Bako Agricultural research center has been demonstrated, maintained, and multiplied HB-1307 in highland areas of Western Oromia with AGP-II financial support.

MATERIALS AND METHODS

Description of the Study Areas

The activity was conducted in Horro and Jimma Rare districts of Horro Guduru Wollega zone. Both districts were selected purposively based on barley production potential and result of demonstration.

Horro district is located in Western Oromia at about 310 km from *Finfinnee* (Capital city of Ethiopia). Geographically, the study area is located $37^0$22' E longitude and $09^0$33' N latitude with an elevation ranges of 1600-2900 meter above sea level. The district is categorized into three agro-ecology include lowland (51%), midland (37%) and highland (12%). The annual rainfall of the study area ranges of 1500-2700 mm and has an annual temperature ranges of 15-22^{o}c. The major grown crops are wheat, tef, barley, potato, faba bean, and nug (HGWZFDOSP, 2018).

Jimma Rare district is located at about 220 kilometers distance from *Finfinnee* to the western direction of Ethiopia. Geographically, the study area is located $37^0$87' E longitude and $09^0$88' N latitude with an elevation ranges of 1900-2240 meter above sea level. The district is divided in to three distinct geographical areas with different proportion; namely, highland (0.26%), midland (46.74%) and lowland (53%). The annual rainfall of the study area ranges of 1300-1700 mm and has an annual temperature ranges of 12-22^{o}c. The major grown crops are wheat, barley, tef, potato, faba bean, and field pea (HGWZFDOSP, 2018).

Cluster and Field Selection

BARC-AGP-II barley cluster based pre-scaling up employed innovation system approaches as a guiding principle in technology dissemination process. Following these approaches two potential barley growing districts (Horro and Jimma Rare) were selected from Horro Guduru Wollega zone with collaboration of districts agriculture office. A group of small-scale farmers were encouraged to cluster their fragmented land and form partnerships for easy access to inputs and service. Accordingly, from each district one cluster having 5 hectares of land was selected based on land availability and farmers interest. Finally, two clusters having 10 hectares and 32 hosting farmers were selected based on their interest.

Training of stakeholders

Training is one of the means through which improved agricultural technologies, knowledge and skills are conveyed to the small-scale farmers. It is the principal in technology transfer process that enables farmers to use the new improved technologies accurately. Researchers from BARC provided both theoretical and practical training to farmers, development agent and district experts on improved barley technologies with cluster, major barley diseases identification and their management, quality seed production and post-harvest handling of barley production.

Stakeholders' role and responsibility

Multidisciplinary team collaboration and linkage are some key indicators for every success. Partnership is an agreement to do something together and it was benefit all the involved parties, bring results that could not achieved by a single partner operating alone, and reduce duplication efforts. A successful partnership enhances the impact and effectiveness of action through combined and more efficient use of resources.

This activity was implemented by the multidisciplinary team of Bako Agricultural Research Center consisting of crop breeder, pathologies, agronomist, agricultural economics and agricultural extension researchers with the collaboration of districts SMS members and Development Agents (DAs). Before the implementation of activity, joint plan meeting was made at district to share experience, setting a common vision and objectives, defining all the necessary functions to make the innovation system work, identifying the roles of each stakeholder based on the defined function and formulating task sharing with clear responsibilities among stakeholders. Accordingly, the following stakeholders were shared their roles and responsibilities.

Table 1. Stakeholder roles and responsibilities

#	Stakeholders	Roles and responsibility
1	Agricultural Growth Program (AGP-II)	• Providing budget to the activity • Involved in monitoring and evaluation • Attending on the arranged field days
2	Bako Agricultural Research Center (BARC**)**	• Distribution of inputs (seed, fertilizer and agro-chemical) • Providing training (theoretical and practical) to SMS, DAs, and farmers • Organize field monitoring and evaluation • Arrange field day, etc.
3	Agriculture Development Office (district and Kebele)	• Involved in site and participant farmers' selection • Follow up day to day activities monitoring and evaluation • Play leading role in seed distribution and daily supervision • Play leading role in organizing farmers for field day and exchange visit, etc.
4	Cooperatives	• Involved in marketing of seed/grain from farmers • Involved in market assessment and linkages • Facilitate inputs supply to farmers • Involved in field day, monitoring and evaluation
5	Farmers	**-**Land allocated (at least 0.25 ha) Perform required agronomic practices (sowing, weeding, guarding, harvesting, threshing, etc) -Actively participated on training and field day Participating in FERG to multiply selected scaling up and out crop seed Share skills and experiences to neighbor farmers -Supply excess produced seed/grain to cooperatives and transfer seed to surrounding farmers

Input distribution to farmers

Having successful cluster based scaling up and out activity demanded timely supply an expected amounts of seeds, fertilizer and agrochemical with expected quality. These inputs were distributed to the hosting farmers by researchers through district agriculture experts. Accordingly, about 13 quintals of BH-1307 barley seed, 10 quintals of NPS, 10 quintals of Urea, 10 liters of 2-4-D herbicide were distributed to the hosting farmers. All NPS fertilizer was applied once at planting while Urea fertilizer was applied in split at planting and tillering stages of the crop.

Monitoring and evaluation

In the program, based on the schedule arranged in planning phase, responsible bodies prepared regular monitoring and evaluate on progress of the activity. Joint monitoring and evaluation process at fieled level with different stakeholders were held at mid-season to understand their strength and weakness and to access additional feedback directly from farmers for the activity.

Data Collected and Analysis Methods

Yield performance, numbers of participants on training, monitoring and evaluation event, all inputs and output information, and farmer's opinions/perception regarding to variety performance and other attributes were collected and analyzed with SPSS software like graph was used to analyzed the data

RESULTS AND DISCUSSION

Stakeholders Awareness Creation

Researchers from BARC have provided both theoretical and practical training to farmers, development agents and SMSs. The training was focused on barley production techniques with cluster, major barley diseases with their management, quality seed/grain production and post-harvest handling. Accordingly, about 8 SMSs, 9 DAs, 2 cooperative experts, and 45 farmers were trained by researchers (Figure 1). The result shows that, about 69 stakeholders were participated on training (Figure 1) and they shared their knowledge and skill obtain during awareness creation of improved packages of barley technologies with cluster and it created good innovation networks and learning on stakeholders.

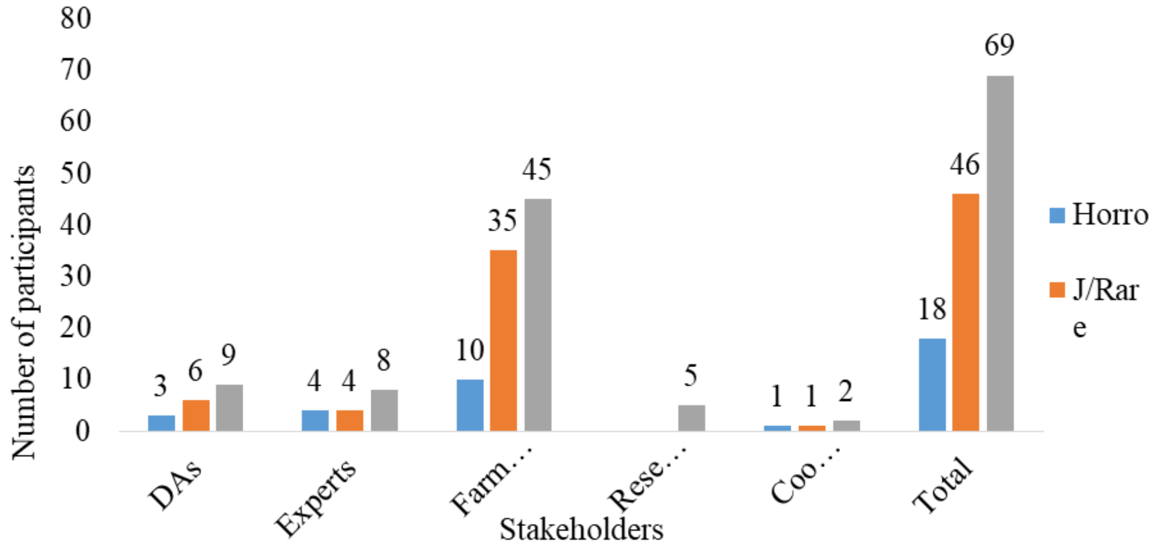

Figure 1. Awareness creation of stakeholders

Yield Performance

The barley cluster based pre –scaling up activity yield performance with CSA data yield was summarized in the following figure (Figure 2). The average yield obtained from cluster was 4.50 tons per hectare which is more than double yield advantage with CSA data in the zone which is 1.79 tons per hectare and higher than national average (2.11 tons/hectare) as well as regional average (2.41 tons per hectare) which shown in figure 2. This yield difference gained due to variety and awareness on management. In the study cluster there is variability of yield performance might be due to soil fertility and difference in management (weeding practice).

The result shows that cluster based pre-scaling up of barley yield was higher than pre-extension demonstration result which is 3.22 tons per hectare (Effa *et al.*, 2017). This high yield may be due to soil fertility, cluster based approaches, and best management.

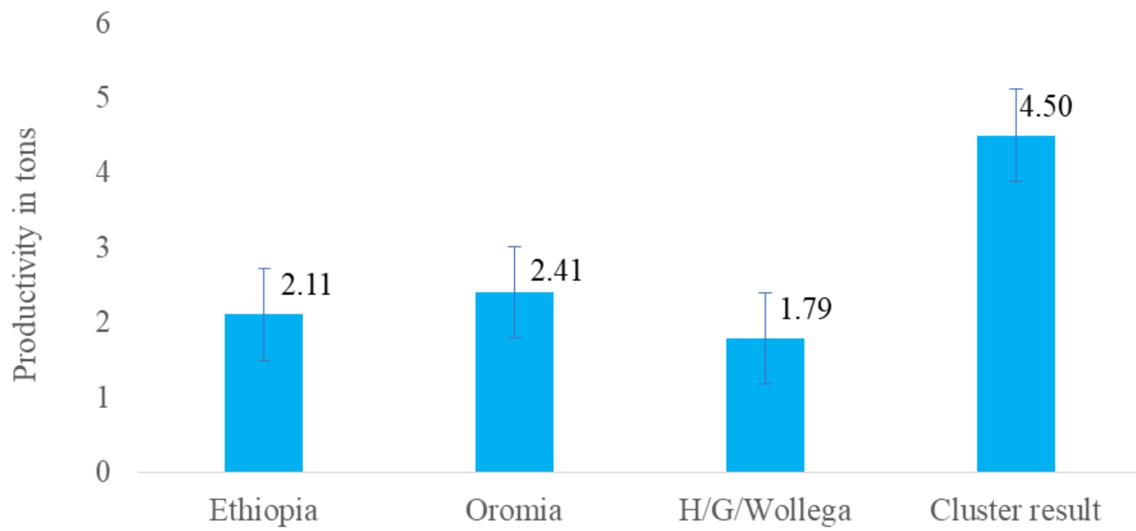

Figure 2. Barley productivity difference between CSA 2017 data and cluster result in tons

Feedback of the Farmers

During feedback gatherings, farmers and DAs were asked about the advantages and disadvantages of the improved barley technologies. Accordingly, Farmer Extension Research Group (FERG) farmers listed the advantage of new technologies over the local in terms of yield, color, relatively resistance to disease and insect. The participant farmers also appreciated the new research approaches (cluster) than the conventional farming system and the advantage over precious approach due to quickness in operations, team spirit, share knowledge, labor and experiences and encourage each other.

CONCLUSION AND RECOMMENDATION

Cluster based pre-scaling up of improved barley BH-1307 variety was very important for dissemination of technologies in highland area of Horro Guduru Wollega zone. This cluster based pre-scaling up increased the yield of barley production in the study areas and gained about 4.50 tons per hectare which is higher than national, regional and zonal average yields. This yield advantage obtained due to variety, awareness creation on production management, and cluster based innovation approaches. Based on stakeholders' feedback the variety performance was better than local varieties produced. Therefore, based on yield advantage and positive feedback of stakeholders, the variety needs to be further popularized until new variety will be released and recommended for these areas with full package of technologies.

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Cluster-based pre-scaling up of improved Rice technologies in southwest Oromia

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ABSTRACT

Rice is considered as the "Millennium Crop" and expected to contribute to pledging food security in Ethiopia. The aim of the study was popularizing the best performing rice variety on large scale through cluster approach pre-scale up and to strengthen the skill of farmers on rice production technologies. The activity was conducted at ChewekaWoreda, south west Oromia, where there is a high potential for upland rice production. The total area addressed for pre-scaling up of rice production was about 15 hectares and Chewaka rice variety was used for the targeted study areas. Two cluster sites and farmers were selected from Jagankebele purposively based on the potential production of the commodity and other criteria. A total of 30 farmers (18 Male and 12 Female) were participated. Farm activities were carried out by the farmers with close supervision of researchers and extension agents. Extension services such as technical advice, inputs supply and training were delivered and organized for the farmers. Yield, disease data and farmers‟ perceptions and interests were collected. As a result, the average yield obtained from both clusters was 3.72 tons ha-1. Moderate reaction to blast and low reaction to brown spot were recorded. Therefore, scaling up of Chewaka varieties for the wider community over locations should be strengthened and conducted by government sectors and non-governmental organizations for sustainably improving the productivity of the crop.

Keywords: Cluster based pre-scaling up, training, Rice

BACKGROUND AND JUSTIFICATION

Rice (Oryza sativa L.) is the foremost staple food for more than 50% of the world's population. It is estimated that by the year 2025, farmers in the world should produce about 60% more rice than at present to meet the food demands of the expected world population at that time (Thakur *et al.,* 2011). It is important staple food crop in Africa with a growing demand that poses an economic challenge for the African continent. In Ethiopia, rice is among the target commodities that has received emphasis in the promotion of agricultural production and has played a vital role to ensure food security in the country since there is an ample of land for rice production (MoARD, 2010). The potential rice production area in Ethiopia is estimated to be about 30 million hectares, of which more than 5 million ha are highly suitable. There is an increasing trend in both area and production of the crop (MoARD, 2010). Currently, Amhara, SNNP, Oromiya, Somali, Gambella, Benu Shangul Gumuz, Tigray and Afar regions are rice producing regions in Ethiopia. The amount area under rice cultivation in Ethiopia is low as compared to the potential areas. Along with the increased level of production, there is increased volume of rice import. Though the grain production of rice increased from 71, 393.7 ton (2009) to 301,134.8 t (CSA, 2018) still importing of rice increased dramatically from 22,500 tons in 2008 to 311,827 tons in 2016 (FAO,2016), it proved that the production and demand have huge gap and needs especial attention. Generally, rice has great potential and can play a critical role in contributing to food and nutritional security, income generation, poverty alleviation and socio economic growth of Ethiopia. Chewaka is one the potential areas of rice production in south west of Oromia. The area is characterized by suitable agro-ecology for rice production and extensively rice is being produced. However, in south western, the production and productivity was low when compared with the national productivity even though the area has high potentials. There are many factors that being influenced rice production and productivity in the areas among where low access to newly released improved rice varieties was limited as well as both farmers and DAs have less awareness about newly released technologies and its production systems are the major ones. Thus, the purpose of this research was in order to increase production and productivity of rice production through participatory, popularization, selection, transfer and pre-scaling up of the rice variety.

MATERIALS AND METHODS

Cluster based pre-scaling up of rice was carried out atsouth western Oromia of Chewaka district. The selected area is generally receiving reliable rainfall and characterized by extensive rice production systems. Among the rice producers, one rice growing potential village was selected from the district with the composition of men, women and youth farmers were involvement in the village. One improved rice varieties (Chewaka) was planted on selected farmers' field in cluster of 15 hectare. The variety was treated with full recommended rice production and management packages. The seed rate used 80 kg/ha and fertilizer rate 100/150 kg/ha NPS/UREA with split application of nitrogen: 1/3 at planting time and 2/3 at tillering stage of the crop. After preparation and distribution of rice technologies and other agricultural inputs, regular field visit by extension agents, joint field visit and supervision at different crop stage was carried out. Field day and popularization were organized and the variety was pre-scaled up and evaluated jointly by farmers, agricultural experts, development agents and researchers to show potential of varieties at crop maturity stage. Some important diseases, yield data, and the farmers' opinions, ideas, perceptions, interest and views were collected.

RESULT

Training

Training has a paramount role in enabling stakeholders for creating awareness about technologies characteristics and feasibility and plays a great role for technology promotion as well. Field day was organized by Bako agricultural research center and coordinating role was given for the team organized from different discipline. A total of 35 participants, out of which 30 farmers and 5 development agents/ subject matter specialists participated on training. The training contents including rice agronomic practices, production and preharvest and post-harvest managements to improve knowledge, skills and attitudes of traineesfor better production and handling systems. Access to trainings for proper production of rice and organized feedback about the production constraints for the researchers provides the room to access and strengthen farmers and researchers learning room.

Grain yield

The pre-scaling up of improved rice variety (Chewaka) was carried out in Jagan kebele, Chewaka district of south western Oromia in the 2019/2020 cropping seasons. The variety was treated with full recommended rice production and management practices. The result of the study revealed that the average yield obtained from chewaka variety was 3720 kg ha^{-1} and with better performance against brown spot and blast of the variety $quintals^{-ha}$. Also, the variety was showed better performance against brown spot and blast.

CONCLUSION AND RECOMMENDATION

Rice is the most potential crop produced in Chewaka and other similar agro ecologies. Smallholder farmers' income and food security can be increased and ensured when improved varieties are used with recommended packages. Limited access for improved varieties of rice and low productivity of the local variety are the main limiting factors hindering small holder farmers' livelihood improvement. The pre-scaling up of improved Rice variety (chewaka) was undertaken in one PAs or kebeles of Chewaka district of south west oromia in 2019/20 cropping seasons. Bako Agricultural Research Center was provided all inputs to the farmers and the variety was treated with full recommended rice production and management practices. The result of the study revealed that the average yield obtained from chewaka variety was 3720 kg ha^{-1}. The variety was showed better performance in terms of yield and diseases reaction in the intervention area. Generally, based on the farmers' preference & grain yield result showed that improved variety of chewaka was recommended for more pre-scaling up and expansion of the selected variety with its full packagesis essential to improve production and productivity of rice in west oromia and for similar agro ecologies.

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Cluster-based pre-scaling up of improved Hot Pepper technologies in East Wollega Zones. The Case of Bilo Boshe and Wayu Tuka Districts, Oromia

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ABSTRACT

Hot pepper is one of the most important spice crops widely cultivated around the world for its pungent flavor and aroma. In Ethiopia, hot pepper is the most widely cultivated vegetable crops. It is being cultivated as cash crop for its high price compared to other crops. The farmers of the selected districts produce different types of local hot peppers and the released varieties such as Bako local, Mareko fana and Oda haro. These varieties do not all the specification of the producer in yield and quality and some of them are susceptible to various diseases and some of them are low yielder. However, farmers in the project area are preferred to produce market demanding Marako Fana variety. Therefore, Marako fana variety which has high demand by the consumers and high market price were selected and produced by cluster. This activity was conducted in 2 districts having one cluster each. A total of 14 (8 male and 6 female) voluntary farmers having 4 ha (2 ha from each cluster) of land were selected. Marako fana variety seed were provided for each farmers and they were sown the seeds and managed the seedlings on their own plot of lands with the support of Das, searchers and word experts. All the selected lands from both selected cluster were planted with Marako Fana variety. All agronomic recommendations and crop management activities were implemented according to the recommendation. Mini-field day was organized by AGP-2 and Bako agricultural research center with coordinating role was given for cluster team members. Farmer's during mini-field day and interviews reveals that production of hot pepper using improved variety of Marako fana with full agronomic recommendation are given high dry pod yield and quality dry pod. 13.5 Qt/ha of dry pod yield were produced in average even though it differs by location and farmers. Therefore, scaling-out of the variety with full production package should be carried by districts extension agents for similar agro-ecological areas through establishing and strengthening seed producer Cooperatives.

Keywords: Clustering, Marako Fana, pre-scaling up

BACKGROUND AND JUSTIFICATION

Hot pepper (*Capsicum annuum* L.) belongs to genus *Capsicum* and family Solanaceae. It is one of the most important spice crops widely cultivated around the world for its pungent flavor and aroma (Ikeh *et al*., 2012; Obidiebub *et al*., 2012). In Ethiopia, hot pepper is commonly cultivated within an altitude ranges of 1400 to 1900 meter above sea level (m.a.s.l) (EIAR, 2007), which receives mean annual rainfall of 600 to 1200 mm, and has mean annual temperature of 25 to 28°C (EIAR, 2007). The milled powder hot pepper is an essential coloring and flavoring ingredient in traditional diets and green pods is usually consumed with other foods in Ethiopia.

Hot pepper is being cultivated as cash crop for its high price compared to cereals. It is consumed as vegetable at green pod stage. Whereas the dry pod used as condiments for traditional sauces preparation. It is also one of the most important export commodities for oleo-risen extraction (Wubalem, 2019).

There are two big hot pepper production systems in Ethiopia. The first and most important production system mainly undertake during rainy season at an altitude range of 1400 and 1900 m.a.s.l. with intensive management activities, for its dry pod (Alemnew, 2010). The second and less intensive system of hot pepper production, however, is primarily done for its green pod at wide altitude range with less management activities applied. This production system uses either irrigation or rain fed water. Moreover, very recently production of this crop is rapidly flourishing under both traditional and modern small scale irrigated agriculture in the western region.

It accounts for more than 73.09 percent of total area under vegetable production and 35.81 percent of vegetable production of the country (CSA, 2018). About 5 percent of the total production goes to the processing plant for extraction of Oleoresin for export (Yayeh, 1994). Hot pepper is one of the popular crops grown in Western Oromia. It accounts for 90.48 percent and 75.24 percent of the total area and 94.85 percent and 53.4 percent of the total production of vegetables in east Wellega and West Shewa zones, respectively. The Private Peasant participated in production of hot pepper in 2013/14 Meher Season were 130,299 and 115, 022 in west Shewa and east Wellega zones respectively (CSA, 2013/14). The amount of dry pod yield harvested in smallholder farm was about 400 kg/ha, and national average yield is about 40 kg/ha (Fekadu and Dandena, 2006). In terms of price per unit weight, the price of hot pepper is higher than other vegetables and cereals in market (Shumeta, 2012).

As a result, the production is increasing in the smallholder farming system of Amahra, Oromia, and Southern Nation Nationality and Peoples (SNNP) Regional States of Ethiopia (Abebayehu *et al.* 2014). However, the productivity is still low as compared with other vegetable crops, this could be attributed to lack of adequate nutrient supply, diseases incidence, poor aeration, poor agronomic practices and lack of high yielding cultivars (Abebayehu *et al*. 2014).

The farmers produce different types of local hot peppers and the released varieties such as Bako local, Mareko fana and Oda haro. These varieties do not all the specification of the producer in yield and quality and some of them are susceptible to various diseases and some of them are low yielder. However, farmers in the project area are preferred to produce market demanding Marako Fana variety. Hence, Ethiopians have strong attachment to dark red colored pepper which has high value principally for its high pungency and color.

The potential of this variety for market price has made the variety highly preferred by farmers. Therefore, based on farmers' preference and market value Bako Agricultural research center has been maintained and multiplied the seed of Marako fana variety with AGP-II financial support and disseminated and pre-scaled up in AGP II districts

MATERIALS AND METHODS

Approaches implemented

The project was conducted in Bilo Boshe and Wayu Tuka districts of East Wollega zone on 14 farmers based on interest and availability of land for cluster. Each district had one cluster which have 2 ha based on land availability and farmers interest. Farmers' selection and implementation of the project given for all stakeholders' with their roles and responsibilities were defined clearly for effective networking of activities and sharing of information. There were different activities that have been implemented by different stakeholders separately as well in collaboration. It included provision of training, dissemination of seeds, organizing of farmers' mini-field day. Training delivered to farmers, DAs and agriculture experts was one of the prominent inputs to speed up adoption of hot pepper production and management technologies and it was delivered before the start of the activity.

Theoretical training and project objective awareness was provided before the implementation of the activity and practical on-farm training was given for the producers', DAs' and district expertise just at transplanting time. Mini-field day was organized at each district to create awareness on improved hot pepper production technologies availability and suitability. It was also one forum of getting feedback from farmers and other stakeholder about the variety and production technology for better future works.

Monitoring and Evaluation

Concerned researchers, district Agricultural office and DA's were continuously monitored the project from the initial site selection to harvesting. Joint monitoring and evaluation process at filed level with different stakeholders and center monitoring and evaluation committee was held at mid-season to understand their strength and weakness and to access additional feedback directly from farmers for their future plans.

RESULTS AND DISCUSSION

Site Selection and Training:

Before implementation of the project researchers, District Agricultural office concerned experts and DA's were assessed the potential of the area for hot pepper production. The willingness of the farmers to contribute their farm land according to the project aim (in cluster approach) and to implement the activity was also assessed. After site selection and implementing farmers selection training was provided for concerned district experts, DAs and implementing farmers on hot pepper production and management packages by researchers on both districts (Bilo Boshe and Wayu Tuka). "Sintera" hot pepper cluster was the name given by the farmers during training at Bilo Boshe district; which is the name of village where the cluster was formed. At "Sintera" hot pepper cluster 18 farmers, 4 district experts and 4 DAs (21 male and 5 female) were participated on the training provided.). Similarly, "Digo" hot pepper cluster was the name given by the farmers for the cluster which indicates the name of a village found in Boneya Molo Kebele at Wayu Tuka district where the cluster was formed. At "Digo" hot pepper cluster 16 farmers, 4 district experts and 3 DAs (20 male and 3 female) were participated on the training provided.

Mini field day and evaluation:
Before harvesting of the crop mini field day were organized at both locations which comprises researchers, district agricultural office expertise, DAs' cluster implementing farmers and some neighboring farmers. During evaluation and discussion lessons were learned and feedback were given about the production technologies of hot pepper. In Bilo Boshe district 45 farmers, 4 DAs' and 4 district expertise were participated on evaluation and discussion. During discussion both positive and negative opinions were raised from the participants which used as feedback for the researchers. Compared to the farmers' practice of hot pepper production of the area, the integrated hot pepper production package implemented by Bako Agricultural Research Center was appreciated. Accordingly, good establishment of the crop, free of Fusarium wilt disease where the farmers used full production packages, uniform pod size and color demanded by market which earn high price and highly interested on the discussion made on hot pepper production packages knowledge gained.

However, the producers complain on the spacing between the rows (large), plants transplanted on the ridge were lodged hence they bear more pods, rainfall shortage at the end hence planting time were late, farmers participated on hot pepper cluster production were few to address the rest interested farmers, absence of clean and quality hot pepper seeds from known sources and the farmers participated on hot pepper cluster production were not managed their farm equally.

Similarly at Wayu Tuka district mini field day was organized having participates of 38 farmers, 5 district agricultural office expertise and 4 DAs. The implemented hot pepper cluster farms were visited, and discussion was done on the technologies implemented on hot pepper production. During discussion in comparison to their hot pepper production practice the participant argue that it was free of wilt disease, good crop stand, high yielder, market demanded variety and good experiences were shared. Opposing, late time of planting hence the variety was not early type and should be corrected, clean seeds producers and distributers were not appropriate for vegetables in general and hot pepper in particular in the area and the implemented project was grips lass number of farmers.
During the evaluation and discussion the farmers, DAs' and district experts discussed on quality of the pepper pod color, yield performance, Fusarium wilt occurrences, farmers field management and general production technology of hot pepper. Accordingly, quality of the pepper pod color very good, yield performance was medium, Fusarium wilt occurrences were very low,farmers' field management was satisfactory and general hot pepper production technology perception by the farmers were very good at both location.

Yield Preference of the Technology:
The average yield obtained from the cluster at Bilo Boshe district "Sintera" hot pepper cluster showed about 20 % yield advantage over the hot pepper yields of farmers' practice of the area. However, the average yield obtained from the cluster at Wayu Tuka district "Digo" hot pepper cluster showed about 25 % yield advantage over the hot pepper yields of farmers' practice of the area.
Plate 4: Hot pepper harvesting at Wayu Tuka district by implemanting farmer

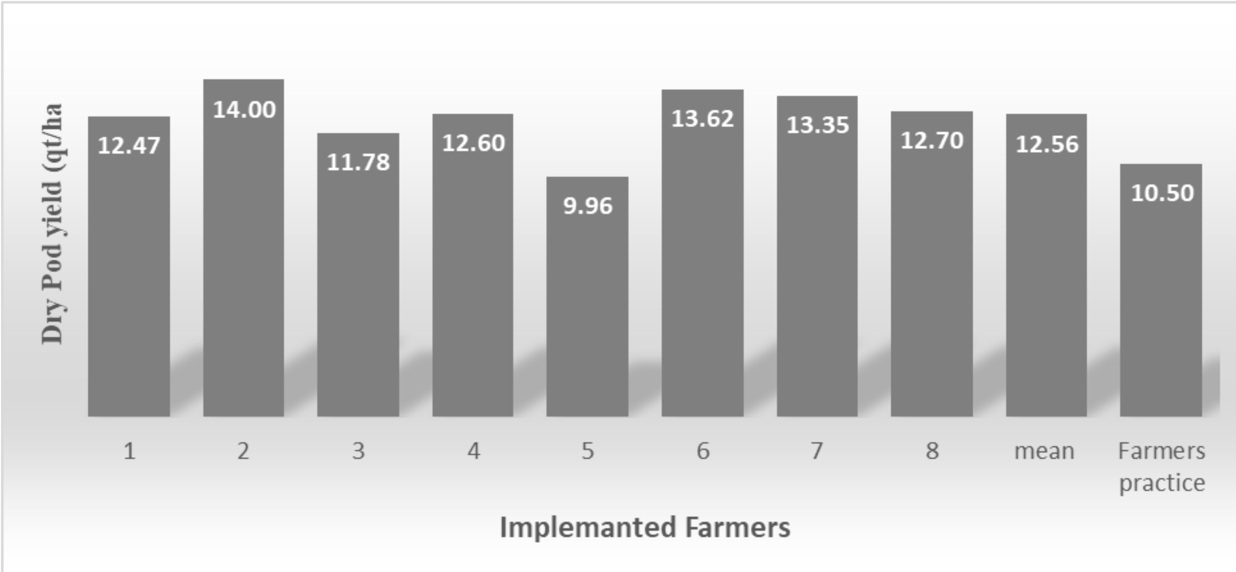

Figure 1: Yield performance of hot pepper clusters implemented at Bilo Boshe district

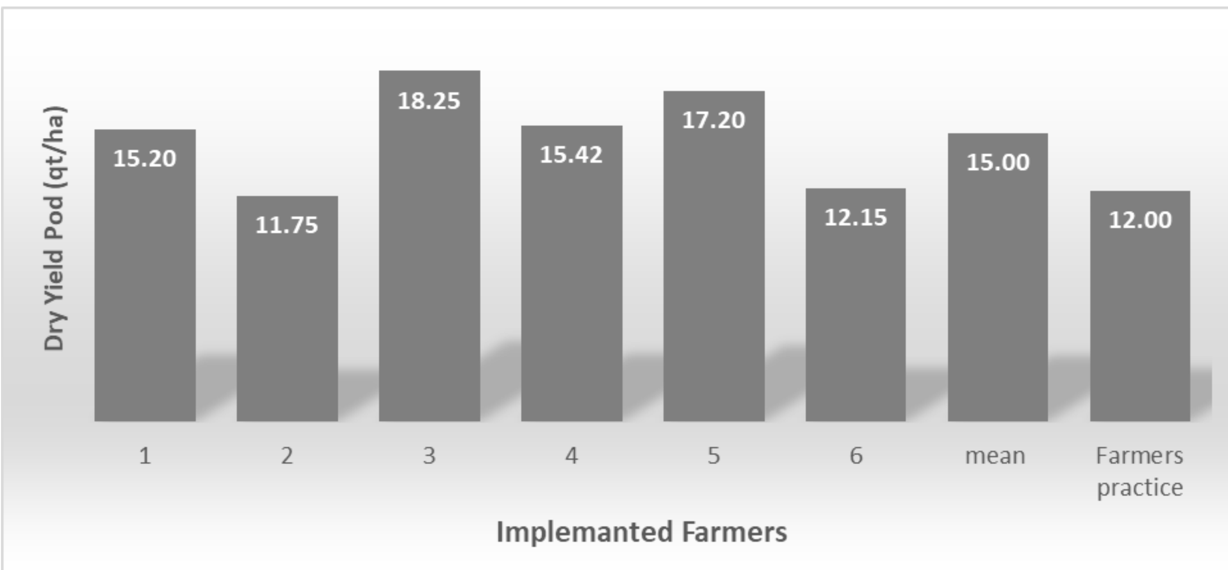

Figure 2: Yield performance of hot pepper clusters implemented at Wayu Tuka district

CONCLUSION AND RECOMMENDATION

Based on the evaluators' discussion and farmers evaluation hot pepper production technology were reduced Fusarium wilt diseases incidence, increased hot pepper dry pod yield and quality. Application of full hot pepper production technologies were increased dry pod yield about 20% at Bilo Boshe District and 25% at Wayu Tuka district. However, the project were conducted on small numbers of smallholder farmers.

The productivity of the technology was seen on the cluster fields and the evaluating farmers showed a great interest to use the technologies. Hence the crop has high price it will substantially increase the income as well as lived hood of the farming community. Therefore, it was recommended that the technology will be further conducted on several farmers in this district and other districts which have potential ecologies for hot pepper production. Also hence there were no any vegetable seed producers in western part of the country, there is a need for vegetable seeds in general and hot pepper seeds in particular for smallholder farmers; seed producing cooperatives and other seed producing organization will be organized and crucial to increase production and productivity of the crop.

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Cluster-based pre-scaling up of improved wheat technologies in western Oromia: Horo Guduru Wellega and East Wellega Zones

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ABSTRACT

Wheat is the most widely grown crop in the western Oromiya although production levels have not met the demand, price instability and need insurgence. Among the production gaps, modern varieties cover only a small fraction of the total area occupied by wheat and petite effort has made in popularizing and scaling up of bread wheat. The study was conducted to increase production and productivity of wheat through participatory, popularizationand pre-scaling up, and strengthen the skill of farmers on wheat technologies that led to its potential production. Pre-scaling up of two bread wheat varieties, Liban and Senate has been done at three zones of western Oromiya. A total of 147 farmers (128 male & 19 female) were addressed in ten kebeles and six districts of western Oromiya. Sites and farmers were selected purposively based on potential production of the commodity and other criteria. The total area addressed for pre-scaling up of wheat was about 81 hectares, out of this, Liban and Senate varieties covered 16 and 65 hectares, respectively. This work has been done in collaboration with different teams mainly researchers, extension agents and farmers. All farm activities were done by the farmers with technical support from researchers and extension agents. Extension services such as technical advice, inputs supply and training were delivered as well as organizing field day for the farmers to create awareness.Yield and disease data, and the farmers' perceptions and interest were collected. As a result, Liban variety was showed better performance for grain yield and disease reaction at both tested locations. The Average yield obtained for Liban variety was 50.7 and 45.9 quintals ha^{-1} from Horro and Hababo Guduru, respectively. A Low to moderate steam rust reaction (MR-MS) was recorded for Liban variety. Senate was showed high yield performances at JimmaRare (58.2 quintals ha^{-1}) followed by Horro(45.2 quintals ha^{-1})and Guduru(43 quintals ha^{-1})), however it has been susceptible to Fusarium head blight across the tested areas. Therefore, scaling out of Liban varieties for the wider community over locations should be strengthened and conducted by government sectors and non-governmental organizations for sustainable improving the productivity of the crop.

Keywords: Cluster, farmers, Pre-scaling up, wheat

BACKGROUND AND JUSTIFICATION

Wheat is the most widely grown crop in the world and occupies 13.64% of the total cultivated land in the world (MoA & FW, 2018), being grown in a wide range of environments. It ranks first in the world cereal production and is a stable food for about one-third of the world's population. China, India, United States, Russian Federation, France, Australia, Germany, Ukraine and Canada are among the largest wheat producing countries in the world (FAOSTAT, 2016). Ethiopia is also among top wheat producing country in sub-Saharan Africa following South Africa and covered about 1.7 million hectares of land and having 4.6 million tons of production volume (CSA, 2018). The four major wheat producing regions in

Ethiopia are Oromia, Amhara, SNNP and Tigray accounting about 99.7% of the total national wheat production and sharing of about 57.5, 30.3, 7.3 and 4.6 %, respectively (CSA, 2018). In the country, wheat can be grown in a wide range of environmental conditions. The most suitable areas for wheat production, however, fall between 1900 meter above sea level (m.a.s.l) and 2700 m.a.s.l in the highlands where rainfall distribution ranges between 600 mm and 2000 mm. It is one of the major staple crops in the country and ranks 4th in terms of production next to maize, tef, and sorghum and contributed for 15.17% of the total cereal grain production in Ethiopia (CSA, 2018). In terms of caloric intake, it is the second most important food in the country next to maize (FAO, 2014). Despite tremendous yield potential, wheat productivity in Ethiopia in general and western Oromia region in particular, is still low. The recent mean national and regional average yield of this crop is 2.6 (CSA, 2018), respectively which is far below by 32 % the world average yield (FAO, 2014b) and even 3-4 t ha^{-1} below the research experimental yield. There are a factors affecting wheat productivity in Ethiopia: shortage of released improved wheat varieties, inappropriate crop management technologies are the major factors contributing yield gaps. Thus, the purpose of this study was to increase production and productivity of improved bread wheat technologies through participatory, popularization, transfer and pre-scaling up and strengthen the skill of farmers on wheat technologies that led to its potential

MATERIAL AND METHODS

The pre-scaling up activity was conducted at three zones of western Oromia in six districts *via* Horro, Guduru, Hababo Guduru, Jimma Rare, Cheliya and Gidda Ayyana. The selected areas generally receiving reliable rainfall and characterized by extensive bread wheat production. From each districts 1-2 wheat growing potential village/s were selected based on their potential for wheat production. The total area addressed for the pre-scaling up of wheat was 81 hectares, out of this, 30, 20, 10, 10 6, and 5 hectares were in Jimma Rare, Horo, Guduru, Gida Ayena, Hababo Guduru and Cheliya districts correspondingly. From each districts 1-2 wheat growing potential village/s were selected based on their potential for wheat production. The total area addressed for pre-scaling up of wheat was about 81 hectares, out of this, Liban and Senate varieties covered 16 and 65 hectares, respectively. The participants with the composition of men, women and youth farmers were established in each village. The two varieties (Liben and senate) were planted on selected farmers' field in cluster with minimum of 5 hectare per cluster. The varieties were treated with full recommended wheat production and management packages. The seed rate has been 150kg/ha and fertilizer rate 100/100 kg/ha NPS/UREA with split application of nitrogen: 1/2 at planting time and 1/2 at tillering stage of the crop. After packaging and distribution of wheat technologies & other agricultural inputs, regular field visit by extension agents, joint field visit and supervision at different crop stage have been done. The evaluation has been done jointly by farmers, agricultural experts, development agents and researchers at crop milk stage. Some important data such as, diseases, yield data, and the farmers' opinions, ideas, perceptions, interest and views were collected.

RESULT AND DISCUSSION

Training of farmers

Participatory training consisting of theoretical and practical session was given by multidisplinary team of Bako Agriculture researchers (Breeder, Agronomist, Economist and Extensionists) in the selected 6 districts of western oromia. A total of 178 participants: 147

farmers and 30 development agents/ subject matter specialists participated on training. The training included with full packages of wheat production technologies such as site selection and preparation, fertilizer application rate and methods, seed rate and method of planting, spacing and depth, control of weeds, diseases and insect, and creating strong linkage among relevant stakeholders through multistakeholders approach to mitigate the problems in joint action taking immediate, short and long term measures.

Field day

At physiological maturity stage of the improved varieties, a mini field day was organized with participating relevant stakeholders such as zone and districts level agricultural development offices and participated farmers in the districts to create awareness about the importance of using improved wheat varieties and its agronomic, management practices and boosting the dissemination of the varieties through farmers to farmers. A total of 150 participants (80 farmers from trial, 10 development agents and experts, 50 researchers including higher officials of IQQO and 10 administrators (from each district and zones) participated in the mini field day. The participants shared their experience and discussed the condition of improved variety with trial farmers and identified the criteria such as grain yield, early maturity and resistance to diseases and pests. Based on the criteria, Liban variety was selected for further scaling-up in the districts.

Total production and productivity per unit area

The pre-scaling up of improved bread wheat varieties (Liban and Senate) were undertaken at 6 districts of Western Oromia zones in the 2019/2020 cropping year. The varieties were treated with full recommended wheat production and management practices. The result of the study revealed that the average yield obtained from Liban variety 3.8 t ha^{-1}, 4.6 t ha^{-1} and 5.1t ha^{-1}at Chaliya, Hababo Guduru and Horro, respectively, with the overall mean grain yield of 4.5 t ha^{-1} (Table 1). Generally, the overall average grain yield of Liban variety was 4.5 t ha^{-1}.Senate variety was showed better grain yield performance over the tested locations. Yield obtained from senate , JimmaRare (5.8 t ha^{-1}) followed by Horro(4. t ha^{-1}) and Guduru(4.3 t ha^{-1}) with over all grain yield of 4.9 t ha^{-1}. In spite of this, the production and productivity of wheat of the trial/participated farmers has increased in the study area as compared to local varieties because of its early maturity and high yielder. The average yield of pre-scaled up of Liban and Senate varieties were almost 1.5 times higher compared to the average zonal productivity of local wheat variety which was 22 quntha^{-1} tons.

Table 1: Grain yield of improved bread wheat varieties pre-scaled up at western Oromia

Zones	District	PA's	Variety	No of farmers addressed	Area Coverage (ha)	Grain ha^{-1}
	Horro	Doyyo-Bariso	Liban	12	10	5.1
		Kombolcha	Senate	13	10	4.5
	Jimma rare	Tarkanafata	Liban	-	10	5.6
Horro Guduru		Karra Konte	Senate	-	10	6.0
Wallaga		-		-	10	5.8
	Hababo Guduru	-	Liban	9	6	5.0
	Guguru	-	Senate	-	10	4.3
East Wallaga	G.Ayyana	Gaba Jimata	Senate	6	5	?
		Gute Gudina	Senate	6	5	4.0
West Shawa	Chaliya	Chobi Tulu Chori	Liban	11	5	3.8

Reaction to the Major Wheat Diseases and Quality Traits

In the pre scaling up of bread wheat , diseases is one of the major parameter used in the evaluation of varieties.. The evaluation indicates that Liban variety were showed better performance against major wheat diseases such as stem and yellow rust, Septoria tritici and Fusarium head blight(Table 2). Senate were showed better yield performance but had shown low performance against to a certain diseases such as yellow rust and Fusarium head blight(Table 2).

Table 2. The varieties reaction against major wheat diseases

Zones	District	Variety	Steam rust	Yellow rust	Septoria tritici	Fusarium head blight
Horro	Horro	Liban	-	-trR	32	2%
Guduru Wallaga		Senate	10R	S	32	25%
	Jimma Rare	Senate	5MS	5MR-15MS	32	20%
	H.Guduru	Liban	10R	5MS	22	15%
	Guduru	Senate	10R	10MS	22	30%
East Wallaga	G.Ayyana	Senate	-	10mr	32	30%

CONCLUSION AND RECOMMENDATIONS

The pre scaling of improved bread wheat varieties were conducted in 6 districts of highlands of western Oromia to increase production and productivity of wheat through pre-scaling up and strengthen the skill of farmers on wheat production technologies. The pre-scaling up results confirmed that improved wheat varieties with its full technology packages offered for better benefit in quality and quantity. There is strong demand for the technologies were popularized in the study area by farmers and other working in agricultural development endeavors. From the conclusions, Liban wheat improved cultivar with its full packages should be further scaled out to other similar agro ecologies. Likewise, seed producer and marketing cooperatives should be established and play vibrant role to make the technology multiplication and exchange system viable to satisfy the emerging technology demands.

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Cluster-based pre-scaling up of Onion technologies in Dire Dawa rural areas: Small holder farmers livelihood improvement

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ABSTRACT

Agricultural technology promotion is an indispensable option for small holder farmers' livelihood, food and nutrition security improvement at household level. Based on this central notion cluster based pre scaling of improved onion variety (Bombey red) was conducted in Dire Dawa Administration with the objectives of scale up the improved onion varieties for increasing the production and productivity for the improvement of small-scale farmers' livelihood and strengthens the linkages among stakeholders on the promotion of onion varieties. Accordingly, the Wahil cluster was selected for this research activity in which 64 farmers with 30% (19) women composition were participated and16 hectares of land was covered by irrigation-based production system. As a result, 22ton/ha tonnes obtained across all farmers at this off season and supplied to market with up and down price in which farmers earned 14250birr at cluster1, 20,072.7birr at cluster2 and 50,400birr at cluster3 individually. However, farmers raised challenges they have been facing during production season like early provision of inputs, disease occurrence, and market price fluctuation. Therefore, in addition to further promotion of this improved onion variety (Bombey red), research centre, other government's development organization, NGOs and other stakeholders should jointly work on early provision of necessary inputs, linkages strengthening among themselves by making farmers at centre and facilitation of market systems and plant protection.

Key words: Clustering, Livelihood, Onion

INTRODUCTION

Onion is considered as one of the most important vegetable crops produced on small scale in Ethiopia. It also occupies an economically important place among vegetables in the country. The area under onion is increasing from time to time mainly due to its high profitability per unit area and ease of production, and the increases in small scale irrigation areas. The crop is produced both under rain fed in the "Meher" season and under irrigation in the off season. In many areas of the country, the off season crop (under irrigation) constitutes much of the area under onion production (Aklilu et al, 2015). In Ethiopia these crop is produced in home gardens and commercially in different parts of the country at small scale commercial firms. From production point of view, onion is comparatively easy to produce, provided it is grown in the dry season when diseases are less prevalent.

Despite areas increase, the productivity of onion is much lower than other African countries. The low productivity could be attributed to the limited availability of quality seeds and associated production technologies used, among the others. For the supply of seeds, the informal sector is playing significant role in outreaching large number of farmers. Most of the demand for onion seed is either meets by local supplies unorganized market system and imported seeds informal trend. The formal sector, Ethiopian Seed Enterprise (ESE) is not generally supplying onion seed (Aklilu et al, 2015)

Onion, shallot and garlic are grown, traded and consumed in most countries. These are used for spices and condiments for flavoring various dishes. And also the main source of income for the local farmers since they are traditionally small farmer's crop. Onion, which was recently introduced different varieties for small scale irrigation users, is rapidly wide spreading for its high yield and contributing to the household income generation. Ethiopia has a great potential to produce the crop throughout the year. Unlike shallot and garlic, which are rain-fed, onions, are produced under irrigation during the dry season of the year (FAO, 2006; Werer, 2012) and helps to small holder farmers for enhancement of food security and income generation as other crops like sesame has crucial roles (Usmane and Umer, 2020).

MATERIALS AND METHODS

This cluster-based pre-scaling improved onion technology research activity was conducted in Dire Dawa Administration at Wahil cluster. This site was selected based on the potential onion production and accessibility of the market nearby the community residence and the site classified into different clusters. After site selection 64 (45 men) farmers in which 30% (19) women composition were selected by considering the experience they have the know-how of the technologies, land availability and other cost-sharing issues. Then, the important training concern to the onion technology production was given for the targeted farmers and classified them into cluster according to the following table 1.

Table 2: The cluster composition Dire Dawa at Wahil

Cluster1		**Cluster2**		**Cluster3**		**Total**
Female	Male	Female	Male	Female	Male	64
7	15	2	8	10	22	
Land coverage in hectare						16
5		4		7		

The research activity implementation

The site was prepared and all the recommended packages were applied that were: row stretching between plants and rows, fertilizer application, and other agronomic practices were undertaken at each stage of onion production to harvesting and marketing.

RESULT AND DISCUSSION

The total product obtained per cluster shows that as depicted on table 2 the technology has got more attention by farmers in which individually farmers got 14,250 birr up to 50,400 birr in average with 24 birr/kg in local price at that production time. This indicates that if farmers access with good price time and storage they can more benefit. Farmers used the obtained birr for different purpose in their livelihood strategies like food secures throughout the year, additional milk cow, fattening bull and small ruminants purchasing, schooling their children by covering all costs, and able to cultivate additional land for further production.

Table 3: Land coverage, productivity, incurred income and expenditures

Variables	Cluster1	Cluster2	Cluster3
Land coverage-ha	5	4	7
Productivity-ton/ha	22	22	22
Marketed-ton	18.4	21	19
Total Incurred benefit-birr by time market price	20,072.7	50,400	14,250
Expenditures they spent on	House construction at village level and Dire Dawa city, food secures throughout the year, additional milk cow, fattening bull and small ruminants purchasing, schooling their children by covering all costs…		

Field day Organized and publicity

Field day was organized at research site at time of the maturity stage; farmers, and other stakeholders suggested a couple of ideas and shared experience they have to one another concerned to the tomato varieties with its technology on the farmers land. The technologies exposed to different peoples by television, Radio FM, and written form of extension materials.

Table 4: Participants of field day

No	**participants**	**By gender**	
		Male	Female
1	Farmers	69	55
2	DAs	6	-
3	Experts and others	4	2
	Total	79	57

Constraints farmers faced during production season

Farmers suggested a couple of issues concerned to the technology as depicted on table 4 that they have been facing challenges through the production of tomato start from planting to marketing, accordingly delay of inputs, market price fluctuation, diseases at germination and vegetative stages, lack of support from nearby Development Agents, lack of infrastructure, and storage harvest to long shelf life span of the product. And they suggested that if these problems solved early, they would be more benefit from the technology and improve their livelihood in strategic ways.

Table 5: Constraints of onion production at research site

No	Constraints	No of Farmers suggested challenges	Challenges in percentage (%)
1	Lack of providing inputs early	15	23.4
2	Market price fluctuation	20	31.3
3	Diseases	10	15.6
4	Lack of frequent support from Development Agent and other bodies	8	12.5
5	Lack of centered station sell for vegetable production(infrastructures)	11	17.2

Exit strategy

The technology pre-scaling up process is a continuous process where the 'end' of pre-scaling up activity is the 'beginning' of the wider scaling up intervention by the public extension system. Hence, there was properly hand over for wider scaling up responsibility to the concerned bodies formally. As a result, emphasis was given to capacity building activities, value addition, community seed system and creation of market linkages to create fertile ground for smooth exit and sustainability of the work.

CONCLUSION AND RECOMMENDATION

This research cluster-based pre-scaling up of tomato technologies was conducted in Harari Region by three clusters with seventy five hectare of land resulted with total productivity in average 22ton/ha and average benefit farmers individually earned 14,250 birr up to 50,400 birr by local price at production time sixteen birr/kg. for this technology pre-scaling the field day prepared as good event for more promotion, as a result, farmers and other participants raised couple of issues as challenges –delay of input like pesticide, diseases appeared, market price and other; as experiences cluster form technology promotion is very appreciable and reach large farmers. Therefore, based on these all issues the following recommendation was derived: the inputs from concerned should be delivered in hand early to farmers, market opportunity should be access at this production and storages, and strengthening the cluster form technology promotion is very important and promoted to other areas.

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

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ABSTRACT

Pre-extension demonstration of improved Common Bean varieties was conducted in Ginnir and Goro districts of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Gobu) variety along with standard check. The demonstration was under taken on single plot of 10mx10m area for each variety with row planting, recommended seed rate of 100kg/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 identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Gobu variety performed better than the standard check (Nasir variety) with an average yield of 17.78qt/ha and 14.67qt/ha respectively. Gobu variety had 21.2% yield advantage over the standard check. Furthermore, this variety was selected by farmers. Thus, Gobu variety was recommended for further scaling up.

Key words: Common bean, Demonstration, Farmers' preference, Selection criteria

INTRODUCTION

Common bean (Phaseolus vulgaris L.) contributes to food and nutrition security, and income generation for smallholder farmers and enhances foreign exchange earnings in Ethiopia. The crop is one of the major pulses that serve as a rotational crop in cereal based cropping systems in the lowland areas. However, the gap between the potential and national average productivity remains high due to several production constraints. Limited availability of improved multiple stress tolerant varieties like diseases, insect pests, moisture stress and soil fertility problems are the major problems (Berhanu et al. 2018).

Among 1,598,806.51ha the pulse crops produced in Bale zone, 216,803.91 hectare of land was covered by red common bean and a total of 3,727,664.85 quintals were produced with average productivity of 17.19 quintal per hectare. In Oromiya 84,060.21hectare of land was covered by red common bean and a total of 1,597,865.00 quintals were produced with average productivity of 19.01quintal per hectare in 2017/2018 (2010) production season (CSA, 2018). In Bale a total of 4,025.99 hectare of land was covered with white bean and a total of 55,116.24 quintals were produced with average production of 13.69 quintal per hectare in 2016/17 (2009 E.C.) production season. (CSA, 2017).

However, local varieties are becoming low yielding and less profitable to subsistence farmers. To overcome this problem, researchers from Sinana Agricultural Research Center released Gobu variety of common bean. The yield advantage of Gobu over standard check is 19.33 %.

Thus, participatory on farm demonstration of this variety under farmers' condition and enhancing farmers to select variety/ies of their interest to their locality is a vital task.

METHODOLOGY

Description of the study area

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

Site and farmers selection

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

Materials used and Field design

Improved variety, Gobu was demonstrated with Nasir (standard check). Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full packages were applied in which, row planting with 40 cm b/n rows, Seed rate of 100 kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. Twice hand weeding was done.

Data collection

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

Data analysis

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

Farmers' variety evaluation and selection

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

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

Focused Group Discussion (FGD)

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

Table 1: participants of variety selection

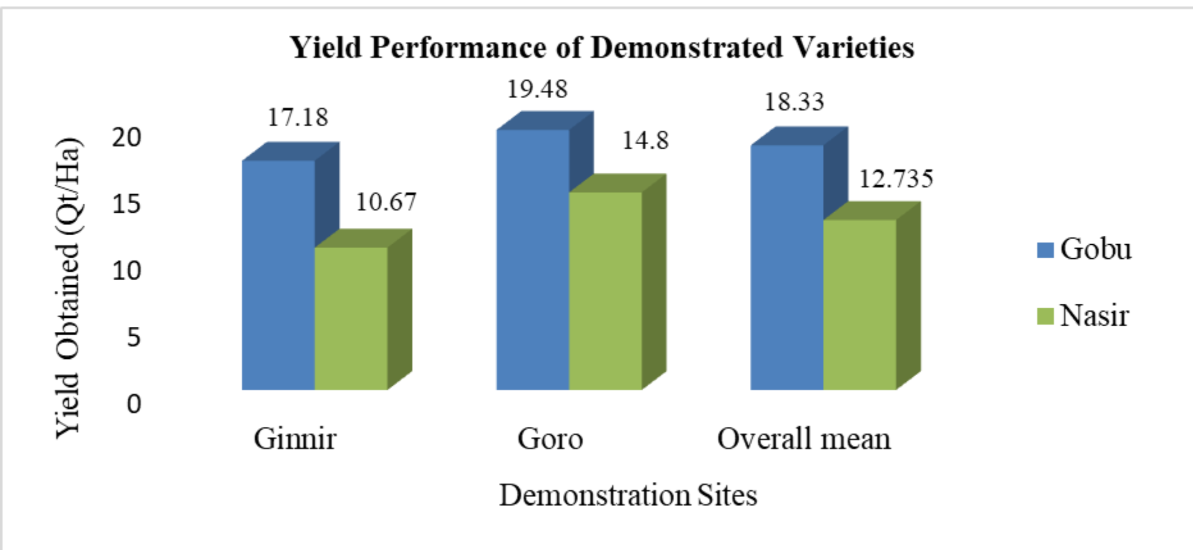
	Farmers					
Districts	**Men**	**Women**	**Youth**	**Total**	Others	Total
Ginnir	18	1	13	32	5	37
Goro	14	1	12	27	5	32
Total	32	2	25	59	10	69

RESULT AND DISCUSSION

Yield performance of Demonstrated varieties

The mean yield of demonstrated varieties of Common Bean collected from all sites was summarized in the following table.

Chart 1: Yield performance of the demonstrated varieties



The demonstration result revealed that, the new variety (Gobu) performed better than the standard check (Nasir variety) all over the demonstration sites. It gave higher yield at all locations. The mean yield of Gobu variety was 17.18qt/haand19.48qt/ha at Ginnir and Goro, respectively with all over mean yield of 18.33qt/ha. Similarly, the mean yield of Nasir variety was 10.67qt/ha and 14.8qt/ha at Ginnir and Goro respectively with all over mean yield of 12.735qt/ha (Chart 1). The yield advantage of Gobu over Nasir is 21.2%.

Comparison of yield advantage of improved varieties

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

Yield Advantage of **Gobu** over Nasir: $\frac{18.33-12.735}{12.735} = \mathbf{21.2\%}$

Table 2: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties	
		Gobu	Nasir
1	Yield obtained (qt/ha)	18.33	12.735
2	Sale price (ETB/qt)	2800	2800
3	Gross Returns (Price X Qt) TR	51324	35658
4	Land preparation	3800	3800
	Seed purchase	2800	2800
	Fertilizers purchase (NPS)	1600	1600
	Labor for weeding	2000	2000
	Insecticide purchase	300	300
	Labor for spray	200	200
	Labor for harvesting	1600	1600
	Labor for threshing	800	800
	Packing, Loading and store	190	130
	Store (bag purchase)	190	130
	Total Variable Costs TVC (ETB/ha)	13480	13360
5	Fixed cost	7800	7800
6	Total cost (TC)	21280	21160
7	Net Return (GR-TC)	30044	14498
8	Benefit cost ratio (NR/TVC)	1.41	0.67

As shown in the above table (table 2) the cost benefit ratio analysis showed that, the net return gained from Gobu and Nasir varieties was 30044 birr and 14498 birr per hectare, respectively. Gobu variety had higher cost benefit ratio (1.41) than Nasir variety (0.67). This means, Gobu variety is more profitable than Nasir variety with the same cost expenditure for both varieties per unit area.

Farmers' preference to demonstrated varieties

The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria. Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, pod/plant, Seed/pod and disease tolerance were the top four priority concern given by farmers (table 3).

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

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

A=yield, B= pod/plant, C=Seed/pod, D=disease tolerance, E=Early maturity, F=marketability,G=frost tolerance, H=suitability for consumption.

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

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

No	Variety	Rank	Reason
1	Gobu	1st	High yielder, higher number of pod/plant, higher number of seed/pod, more tolerance to disease, early mature, marketable, more tolerance to frost, suitable for consumption.
2	Nasir	2nd	Low yielder, smaller number of pod/plant, smaller number of seed/pod, less tolerance to disease, less tolerance to frost, but marketable and suitable for consumption.

CONCLUSIONS AND RECOMMENDATIONS

Pre extension demonstration and evaluation of common varieties was carried out on six (6) representative trial farmers' fields. Improved variety viz. Gobuwas demonstrated along with Nasir variety which is the standard check. Accordingly, Gobu gave higher yield than Nasir variety. Moreover, Gobu was selected by participant farmers in all districts due to it ishigh yielder, higher number of pod/plant, higher number of seed/pod, more tolerance to disease, early mature, marketable, more tolerance to disease and suitable for consumption. Based on these facts, Gobu variety was recommended for further scaling up.

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

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ABSTRACT

Pre-extension demonstration of improved Common Bean varieties was conducted in Ginnir and Goro districts of Bale Zone. The main objective of the study was to demonstrate and evaluate recently released (Doyo) variety along with standard check. The demonstration was under taken on single plot of 10mx10m area for each variety with row planting, recommended seed rate of 100kg/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 identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that Doyo variety performed better than the standard check (Brown Speckled variety) with an average yield of 22.35qt/ha and 17.93qt/ha respectively. Doyo variety had 24.65% yield advantage over the standard check. Furthermore, this variety was selected by farmers. Thus, Doyo variety was recommended for further scaling up.

Key words: Demonstration, Farmers' preference, Selection criteria

INTRODUCTION

Common bean (Phaseolus vulgaris L.) is an important pulse crop in Ethiopia and in the world. The crop ranks first globally while it stands second next to faba bean in the country. The major common bean producing regions include Oromia, Amhara and Southern Nations Nationalities and Peoples Region (SNNPR). Their share to the national haricot bean production is 51% for Oromia, 24 % for Amhara and 21% for SNNPR (Walelign, 2015) In Ethiopia common bean is one of the most important cash crops and source of protein for farmers in many lowlands and mid-altitude zones. The country's export earnings is estimated to be over 85 % of export earnings from pulses, exceeding that of other pulses such as lentils, horse (faba) bean and chickpea **(**Negash, 2007).

Common bean is also highly preferred by Ethiopian farmers because of its fast maturing characteristics that enables households to get cash income required to purchase food and other household needs when other crops have not yet matured (Legesse et al., 2006). It is also a major food and cash crop in Ethiopia as well and it has considerable national economic significance. It is often grown as cash crop by small scale farmers and used as a major food legume in many parts of the country where it is consumed in different types of traditional dishes (Kediret al., 2014).

Besides its importance, poor access to new improved varieties are an important impediment to improvement of common bean productivity in Ethiopia. The high seed price, non-availability of the desired varieties long distance from the farm to the source, poor seed quality and risk aversion are major problems farmers face to access improved common bean varieties

(E.Katungi, et al 2010). To overcome this problem, researchers from Sinana Agricultural Research Center released Doyo variety. The yield advantage of Doyo variety over standard check is 21.30%. Therefore, participatory on farm demonstration of this variety with standard check under farmers' condition and enhancing farmers to select variety/ies of their interest to their locality is important.

METHODOLOGY

Description of the study area

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

Site and farmers selection

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

Materials used and Field design

Improved variety, Doyo was demonstrated with Brown Speckled (standard check). Simple plot demonstration was used on area of $100m^2$ (10m x 10m) for each variety. Full packages were applied in which, row planting with 40 cm b/n rows, seed rate of 100 kg per hectare and fertilizer rate of 100kg of NPS per hectare was applied. Twice hand weeding was done.

Data collection

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

Data analysis

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

Farmers' variety evaluation and selection

Farmers have a broad knowledge based on their environments, crops and cropping systems built up over many years and do experiments by their own and generate innovations, even though they lack control treatment for comparison and statistical tools to test the hypothesis (Bänziger, 2000). The task of variety evaluation and selection was made by enhancing the participation of farmers and experts in which farmers were encouraged to reflect their preference to varietal attributes by setting their own varietal selection criteria. Consulting the intended end users to assess which quality/ies of a particular variety they desire is highly important. Because, it will not only be resource saving in terms of preferred variety promotion/dissemination, but also time saving and fast adoption (Dan, 2012). Accordingly, the task of variety evaluation and selection was carried out at Ginnir and Goro districts.

Focused Group Discussion (FGD)

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

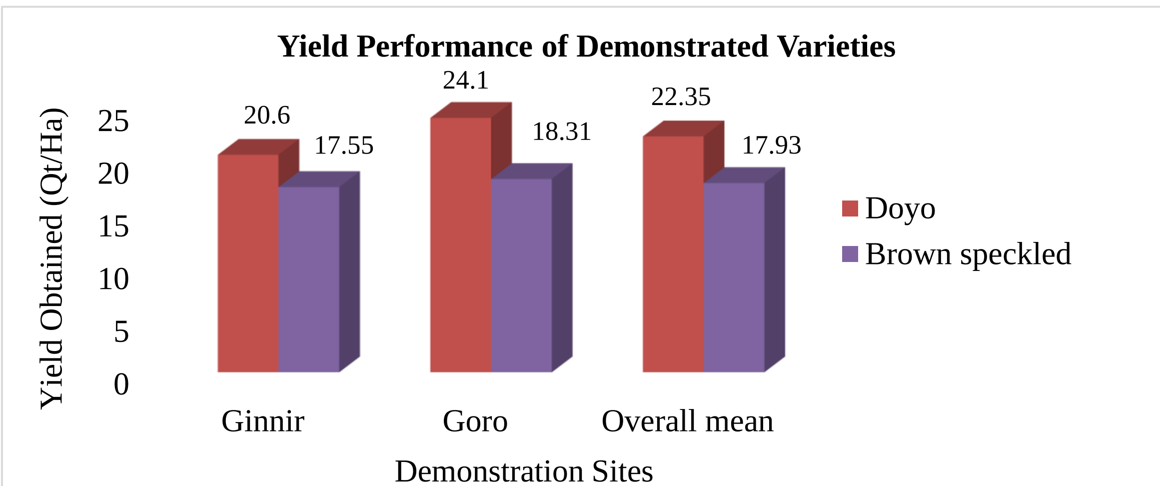
Table 1: participants of variety selection

	Farmers					
Districts	**Men**	**Women**	**Youth**	**Total**	Others	Total
Ginnir	17	1	12	30	8	38
Goro	12	1	11	24	8	32
Total	29	2	23	54	16	70

Result and Discussion

Yield performance of Demonstrated varieties

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



The demonstration result revealed that, the new variety (Doyo) performed better than the standard check (Brown Speckled variety) all over the demonstration sites. It gave higher yield at all locations. The mean yield of Doyo variety was 20.6qt/ha and 24.1qt/ha at Ginnir and Goro respectively with all over mean yield of 22.35qt/ha. Similarly, the mean yield of Brown Speckled variety was 17.55qt/ha and 18.31qt/ha at Ginnir and Goro respectively with all over mean yield of 17.93qt/ha (Chart 1). The yield advantage of Doyo over Brown Speckled is 24.65%.

Comparison of yield advantage of improved varieties

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

$$\text{Yield Advantage of } \textbf{Doyo} \text{ over Brown speckled: } \frac{22.35-17.93}{14.93} = \mathbf{24.65\%}$$

Table 2: Cost-Benefit Analysis of the Demonstrated varieties

No	Variables	Varieties	
		Doyo	Brown Speckled
1	Yield obtained (qt/ha)	22.35	17.93
2	Sale price (ETB/qt)	2800	2800
3	Gross Returns (Price X Qt) TR	62580	50204
4	Land preparation	3800	3800
	Seed purchase	2800	2800
	Fertilizers purchase (NPS)	1600	1600
	Labor for weeding	2000	2000
	Insecticide purchase	300	300
	Labor for spray	200	200
	Labor for harvesting	1600	1600
	Labor for threshing	800	800
	Packing, Loading and store	210	180
	Store (bag purchase)	210	180
	Total Variable Costs TVC (ETB/ha)	13520	13460
5	Fixed cost	7800	7800
6	Total cost (TC)	21320	21260
7	Net Return (GR-TC)	41260	28944
8	Benefit cost ratio (NR/TC)	1.94	1.36

As shown in the above table (table 2) the cost benefit ratio analysis showed that, the net return gain9ed from Doyo and Brown Speckled varieties was 41260 birr and 28944 birr per hectare, respectively. Doyo variety had higher cost benefit ratio (1.94) than Brown Speckled variety (1.36). This means, Doyo variety is more profitable than Brown Speckled variety with the same cost expenditure for both varieties per unit area.

Farmers' preference to demonstrated varieties

The farmers' preferences toward the demonstrated varieties were assessed by enhancing them to reflect their preference to varietal attributes by setting their own varietal selection criteria. Pair wise ranking was used to identify farmers' preference of variety traits. Accordingly, yield, pod/plant, seed/pod and disease tolerance were the top four priority concern given by farmers (table 3).

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

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

A=yield, B=disease tolerance, C=Pod/plant, D= Seed/pod, E=frost tolerance, F=seed size, G= early maturity.

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

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

No	Variety	Rank	Reason
1	Doyo	1^{st}	High yielder, more tolerance to disease, higher number of pod/plant, higher number of seed/pod, more tolerance to frost, bigger seed size, early mature.
2	Brown Speckled	2^{nd}	Low yielder, less tolerance to disease, smaller number of pod/plant, smaller number of seed/pod, less tolerance to frost,

CONCLUSIONS AND RECOMMENDATIONS

Pre extension demonstration and evaluation of common bean varieties was carried out on six (6) representative trial farmers' fields. Improved variety viz. Doyo was demonstrated along with Brown Speckled variety which is the standard check. Accordingly, Doyo gave higher yield than Brown Speckled variety.

Moreover, Doyo was selected by participant farmers in all districts due to it is high yielder, more tolerance to disease, higher number of pod/plant, higher number of seed/pod, more tolerance to frost, bigger seed size, early mature. Based on these facts, Doyo variety was recommended for further scaling up.

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Demonstration and Evaluation of Double Cropping Practice (Legume followed by Sorghum crop) in Selected AGP-II Districts of Harari Region and Dire Dawa Administrative Council

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ABSTRACT

Pre-extension demonstration and evaluation of double cropping practice to promoting and popularize improved double cropping technology and to create awareness through giving training and enhance stakeholders participation. A total of ten (10) trial farmers were selected from Dire Dawa administration council and Harari region. Two FRGs having 30 farmers were established at each kebele. Improved varieties of common bean (KATB-1 and Batu) and sorghum (Melkam and Local) were replicated on the plot of 10mx10m. . Training on which a total of 41 participants and field day on which 74 participants took part were organized at Dire Dawa and Harari region. The yield performance of the improved varieties (Batu, KATB-1, Melkam and Local sorghum) were 12.13, 13.43, 31.91 and 26.57qt/ha at Sofi, and 12.13, 13.66, 31.96 and 26.47qt/ha at Wahil, respectively.Batu,KATB-1 and Melkam combination preferred by farmers as they harvest twice and it is batter to be promoted on wider area and number of farmers. The double cropping practices preferred as it diversify the crop, more yield obtained, shorter crop cycle, better to cope up the dry spell, efficient use of land, reduce risks of striga and reduce risk of bird infestation therefore it is better to scale-up.

Key words: Demonstration, Double cropping, Sofi and Wahil

INTRODUCTION

Rain-fed agricultural areas of East Africa are often food insecure due to rainfall variability and ongoing soil degradation that negatively impacts crop yields. Agricultural activities and consequently the livelihoods of people reliant on agriculture will be affected by changes in temperature and precipitation conditions in large parts of Sub-Saharan Africa (Muller *et al.*, 2011). Under climate change, many areas in Sub-Saharan Africa are likely to experience a decrease in the length of the growing season, while in some highland areas rainfall changes may lead to a prolongation of the growing season (Muller *et al.*, 2011).What so ever, mono-cropping of sorghum whether it is long or early maturing is their usual practice which aggravates the infestation of *striga* in case of susceptible varieties and has risk of crop failure in most cases due to erratic and unreliable rainfall(Samuel *et. al.*, 2013).

Basically, the farming system should be revised in the cropping areas of Fedis, and similar dry lowlands of Hararghe. Since eight-month-cycle sorghum being rain-fed, is simply late maturing and too vulnerable to pests and dependent on rainfall patterns. A reorientation towards shorter cycle crops like early maturing sorghum, pulses and oil crops would help farmer's better cope with the climatic hazards of the area (Samuel et. al., 2013). The degree of climate change impacts on agricultural production differs among crops and agricultural systems (Fuad *et al.,* 2017a). Therefore, the farmers' choice of an adequate cropping system and crop cultivar, especially in precipitation-limited areas, might be an important adaptation strategy to changing climate conditions.

However, farmers in Fedis area are accustomed to sow the local varieties from end of March to the middle of April though they know the advantage of using improved sorghum varieties reduce risk of striga and yield. This is because farmers do not want to leave their land idle when the rain starts early in March/April until the right planting time of the early maturing striga resistant sorghum varieties. Whereas, these improved varieties are sown after the local varieties from middle of June to the beginning of July and farmers who are adopting improved sorghum varieties are forced to leave their land idle to synchronize its maturity with long maturing sorghum varieties to reduce the high bird infestation prevailing in the area (Fuad *et al.,* 2017a).

To alleviate this problem experiment have been done at Fedis on evaluation of suitable double cropping combination and mung-bean, haricot bean and cowpea were found to be economically and ecologically convenient in the area as preceding crops followed by early maturing sorghum in the area (Fuad *et al.,* 2017a). Therefore, farmers' participation in technology promotion is very important to be acceptance by the whole community of the areas through applying preceding and succeeding crops that conducted on station under the control of the researchers during 'Belg' and 'Meher' season as a result; this research activity was conducted with the following objectives.

MATERIALS AND METHODS

This pre-extension demonstration of double cropping practices was conducted selected districts of Dire Dawa administration and Harari Region.

Site and Farmers Selection

wo kebeles Wahil from Dire Dawa Kile from Harari and Wahil were selected while farmers were selected based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers. The selected farmers were grouped in the form of Farmers Research Group (FRG) with the member of 15 (3 male trial farmers and 2 female trial farmers) and 10 farmers work with trial farmers.

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

District	PAs	No. of trial and follower farmers	Area covered
Dire Dawa	Wahil	7	10mx 10m for each plots
Sofi	Kile	8	
Total		15	

Technology evaluation and demonstration methods/technique

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

Treatments

No.	Preceding crop	Succeeding crop
1	KATB-1	Melkam
2	Haricot bean var. Batu	Melkam
3	Local sorghum	Local sorghum stays

Experimental design/implementation procedures

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

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

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

Data Collection

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

Data analysis

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

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

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

Table 2: number of participants on the training

No.	Participants	Male	Female	Total
1	Farmers	24	6	30
2	DAs	3	-	3
3	District experts	3	2	5
4	Journalists	3	0	3
	Total	33	8	41

Source: Own computation 2018/19

Among the training participant stakeholders, 73.1% were farmers. From those farmers, 20% were female farmers' participants.

Table 3: number of participants on the field day

No.	**Participants**	**Male**	**Female**	**Total**
1	Farmers	40	20	60
2	DAs	5	-	5
3	District experts	5	-	5
4	Journalists	4	0	4
	Total	54	20	74

Source: Own computation 2018/19

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

Agronomic and yield performance

The following table describes the yield performances of the demonstrated Batu, KATB-1, Melkam and Local sorghum varieties across the study site. The yield performance of the improved varieties (Batu, KATB-1, Melkam and Local sorghum) were 12.13, 13.43, 31.91 and 26.57qt/ha at Sofi, and 12.13, 13.66, 31.96 and 26.47qt/ha at Wahil, respectively.

Table 3. Yield performance of improved varieties across districts

PA	**Crop**	**Varieties**	Std. Deviation	**Mean (qt/ha)**	**Maximum**	**Minimum**
Sofi	Common Bean	Batu	.931	12.13	13.00	11.00
		KATB-1	.940	13.43	14.50	12.00
	Sorghum	Melkam	2.949	31.91	35.50	27.60
		Local Sorghum	1.683	26.57	29.00	24.10
Wahil	Common Bean	Batu	.931	12.13	13.00	11.00
		KATB-1	1.015	13.66	15.70	12.50
	Sorghum	Melkam	3.020	31.96	36.00	27.60
		Local Sorghum	1.812	26.47	29.00	24.00

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

Economic Analysis

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

Financial analysis									
Location: Sofi					Location: Wahil				
Parameters	Varieties				Parameters	Varieties			
	Batu	KATB-1	Melkam	local		Batu	KATB-1	Melkam	Local
Yield qt/ha(Y)	12	13.5	32	29	Yield qt/ha(Y)	12.5	13.6	32	26.5
Price(P) per quintal	2000	2000	1000	1000	Price(P)per quintal	2000	2000	1000	1000
Total Revenue (TR)=TR=Y*P	24,000	27000	32000	29000	Total Revenue (TR)=TR=Y*P	25000	27,200	32000	26,500
Variable costs					**Variable costs**				
Seed cost	250	250	100	100	Seed cost	250	250	100	100
Fertilizer cost	283	283	1701	1701	Fertilizer cost	283	283	1701	1701
Labor cost	2,100	2,100	3000	3000	Labor cost	2,100	2,100	3000	3000
Total Variable costs(TVC)	2,633	2,633	4,801	4,801	Total Variable costs(TVC)	2,633	2,633	4,801	4,801
Fixed costs					**Fixed costs**				
Cost of land	2000	2000	2000	2000	Cost of land	2000	2000	2000	2000
Total fixed costs (TFC)	2000	2000	2000	2000	Total fixed costs (TFC)	2000	2000	2000	2000
Total cost (TC) =TVC+TFC	4,633	4,633	6,801	6,801	Total cost (TC) =TVC+TFC	4,633	4,633	6,801	6,801
Gross Margin (GM) = TR - TVC	21,366	24,367	27,199	24,199	Gross Margin (GM) = TR - TVC	22,367	24,567	27,199	21,699
Profit=GM-TFC	19,366	22,367	25,199	22,199	Profit=GM-TFC	20,367	22,567	25,199	19,699

Farmers' Opinion/Perception

Farmers in the study area selected the best performing double cropping practices by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were diversify the crop, more yield obtained, shorter crop cycle, better to cope up the dry spell, efficient use of land, reduce risks of striga and reduce risk of bird infestation.

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

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

Summary of Matrix Ranking of Farmers' Selection Criteria

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

Table: Direct Matrix Ranking

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

CONCLUSION AND RECOMMENDATION

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

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Pre-extension demonstration of improved sesame varieties in Harari National Regional State

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ABSTRACT

The activity was conducted during the 2019 main cropping season at Harari Region to evaluate and select farmers' preferred on sesame variety based on their selection criteria and to create awareness on the importance of improved sesame technologies. Two improved sesame variety Obsa and Dicho were evaluated and demonstrated on 10 farmers' fields on a plot sized 100 m2 along with the local check. In Sofi kebele, two FRGs comprising of 15 farmers were established to evaluate and select the better yielding variety. The yield performance of the improved varieties (Dicho,Obsa and local) were 3.85 qt/ha 3.65 qt/ha and 2.73 qt/ha at Sofi district respectively. The yield obtained has statistically significant difference at 1% probability level between improved and local variety. Obsa and Dicho varieties were preferred by farmers for its high yielding, disease tolerant, seed color and test. The result indicated that Dicho and Obsa varies have yield advantage (3.85 qt/ha) and (3.65qt/ha) when compared with local check. Therefore; both Obsa and Dicho varieties were recommended for further scale up/out in Harari Region to widen the horizon of the technology in the area and to reach more number of farmers.

Key words: Demonstration, Dicho, Obsa, Sesame

INTRODUCTION

Sesame (*Sesame indicum L.*) is an important crop and export commodity in Ethiopia, the production of both by small and large scale farmers; and. The total area, production and productivity during 2013 were 0.299 million ha, 0.220 million tonnes and 0.735 t ha-1, respectively; and the total area and production were increased by 61.23 % and 17.91 %, respectively, while the total productivity was decreased by 27.23 % when compared with in 2008 (CSA, 2008; CSA, 2013). Sesame ranks first in total area and production from oil crops during 2013; and Tigray, Oromia, Amhara and Benshangul Gumuz regions are the major producers in Ethiopia. Due to its importance as a major export commodity the area coverage and production has increased in the last consecutive years in Ethiopia. There is an enormous potential to expand sesame seed production in Ethiopia through cultivation of additional new land. The government is enhancing the investment in the oilseeds sector with an extended package of incentives. Through transfer of technology and the provision of inputs, the increment of production and yield will be achieved strongly (Geremew et al, 2012).

Availability of Virgin fertile new areas which can be cultivated on large scale, cheap and abundant labor is the key indicators of the future potential (Negash, 2015). Sesame seeds are not only used for culinary purposes due to their nutritive, preventive and curative properties but also used in traditional medicines. Sesame oil seeds are sources for some phyto-nutrients such as flavonoid, phenolic anti-oxidants, omega-6 fatty acids, vitamins and dietary fiber with presented anti-cancer as well as health promoting properties (Geleta *et al.*, 2002). Sesame is grown in hot and humid climate with temperature around 27 °c and annual precipitation of 625-1100 mm. The crop is intolerant to water logging or poor drainage and excessive rain fall.

Ethiopia has altitudes from below sea level up to 4500 meter above sea level with different climate zones which enables to grow a wide variety of oilseeds crops. Sesame is grown from sea level to altitudes of 1500 meters with uniformly distributed rainfall of about500-800 mm and temperature of 25- 30 Celsius (**MoRD, 2008**).In the study area lack of improved and high yielding varieties for different agro-ecologies with desirable agronomic qualities viz. non-shattering, diseases/pests resistance poor seed supply system lack of adequate knowledge of farming and post-harvest crop management affected production and productivity of sesame. Therefore, introducing improved sesame varieties (Obsa and Dicho) was indispensable by undertaking with the following objectives.

MATERIALS AND METHODS

This pre-extension demonstration of Obsa and Dicho varieties were conducted in selected districts of Harari Region.

Site and farmers selection

The Kebele as research site was selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop’s land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting, accordingly, Kile kebele was selected. And also, farmers were selected based on their interest, innovation he/she has, land provision for this demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile.

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

District	Kebele	No. of trial farmers	Area covered
Sofi	Kile	10	10mx10m for each plots
Total		10	

Research Design

Two improved (Obsa and Dicho) sesame varieties and one local check sown and replicated across ten trial farmers on10m*10m ha plot size of land from individual trial farmer for each experiment/ varieties were used. The recommended seed rate 5kg/ha, spacing 40cm between row and 5cm between plants and 50kg urea was applied.

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the trials were implemented on farmers’ fields to create awareness about the sesame varieties. The evaluation and demonstration of the trials followed process demonstration approach by involving Farmers Research Groups, development agents and experts at different growth stage of the crop. The activity was jointly monitored by Farmers Research Groups, researchers, experts and development agents.

Data Collection

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

Data analysis

Quantitative data was summarized using simple descriptive statistics (Mean, Frequency and Percentage), iindependent samples t-test to compare the mean of one sample with the mean of another samples to see if there is a statistically significant difference between the two, while the qualitative data were analyzed using narrative.

RESULTS AND DISCUSSION

Agronomic and Yield performance

The following table describes the yield performances of the demonstrated varieties across the study site. The yield performance of the improved varieties (Dicho, Obsa and local) were 3.85 qt/ha 3.65 qt/ha and 2.73 qt/ha at Kile kebele respectively. The yield obtained has statistically significant difference at 1% probability level between improved and local variety.

Table 2**.**Yield performance of improved sesame varieties at farmers' land level

PA	Varieties	Mean(Qt/ha)	Std. Deviation	Maximum	Minimum
Sofi	Dicho	3.85	.275	4.30	3.50
	Obsa	3.65	.201	3.90	3.30
	local	2.73	.469	3.60	2.30

Table 3: Independent t-test

	Test for equal variances		t-test for equality of means				
	F	Sig.	T	df	Sig.(2-tailed)	Mean difference	Std. Error Differences
Equal variances assumed	4.71	.044	5.69	18	.000	.920	.161

Yield Advantage

The result indicated that Dicho and Obsa varies have better yield (3.85 qt/ha) and (3.65qt/ha) when compared with local check.

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

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

Table 4: Summary of yield performance in study area

Varieties	**Average yield qt/ha**	**Yield difference qt/ha**	**Yield advantage over the local check (%)**
Dicho	3.85	1.12	41.1
Obsa	3.65	0.92	33.7
Local	2.73		

Source: Own computation 2018/19

Economic Analysis

Table 5: Financial analysis for sesame varieties at farm level

Financial Analysis			
Location : Sofi			
Parameters	Varieties		
	Dicho	**Obsa**	**Local**
Yield qt/ha(Y)	3.85	3.65	2.73
Total Revenue (TR)=TR=Y*P	14,630	13,870	7,371
Variable costs			
Seed cost	190	190	135
Fertilizer cost	565	565	565
Labor cost	2000	2000	2000
Total Variable costs(TVC)	2,755	2,755	2,700
Fixed costs			
Cost of land	2000	2000	2000
Total fixed costs (TFC)	2000	2000	2000
Total cost (TC) =TVC+TFC	4,755	4,755	4700
Gross Margin (GM) = TR - TVC	11,875	11,115	4,671
Profit=GM-TFC	9,875	9,115	2,671

Farmers' Perception/Opinion

The opinion of farmers on varietal preference was collected from participants during variety demonstration. Farmers in the study area selected the best performing improved sesame varieties by using their own criteria. Farmers set these criteria after having know-how about the variety. The selections of the varieties were done at the harvest time. The criteria were ranked using pair wise ranking to understand which criteria were the major one .Thus, the major criteria used by farmers were high yielding, disease tolerant, tolerant to insect, seed color and test. Based on the above criteria's; farmers evaluated the varieties and ranked Dicho is first and Obsa is second followed by local.

Table 6: Direct Matrix Ranking of the varieties based on farmers' selection criteria

Varieties	**Rank**	**Reasons**
Dicho	1st	High yield, diseases tolerant, tolerant to insect ,white in color, Good test
Obsa	2nd	High yield, diseases tolerant, tolerant to insect, white in color, good test
Local check	3rd	Medium yield, low diseases tolerant, tolerant to insect , red in color, bitter test

Table 7: Pair-wise ranking matrix result to rank variety traits

Code no.	Traits	Yield	Diseases tolerance	Insect tolerant	Color	Test	frequency	Rank
1	Yield		1	1	1	1	4	1st
2	Diseases tolerance			2	4	5	1	4th
3	Insect tolerant				4	5	0	5th
4	Color					4	3	2nd
5	Test						2	3rd

The highest average yield of the sesame varieties were recorded 3.85q/ha from Dicho and 3.65/ha from Obsa as compare to 2.73 q/ha of local varieties across the sites. This indicates that this variety is very adaptable and suit with the existing environmental conditions in these sites. And there was yield difference of the varieties across the research sites due to rainfall, soil type and other climatic conditions. In addition there was yield advantage of Dico and Obsa varieties over local check that is 41.1% and 33.7% respectively as depicted in table 4 since there was yield of 1.12 q/ha and 0.92q/ha respectively and statistically significance different at $p<0.01$, and economically feasible that obtained profit from Dicho variety 9,875 birr Obsa 9,115 birr and local variety 2,671 birr as depicted on table 5.

Moreover, farmers evaluated these three varieties (Dicho, Obsa and local) at different stages based at farm level based on their own criteria: to high yield, diseases tolerant, tolerant to insect, white in color, good test, accordingly, ranked Dicho variety on first rank as compare to local as shown on table 6, and even evaluated these criteria by pair-wise ranking, as result, ranked yield first with the rest as on table 7. Based on these above result and discussion the following conclusion recommendations were derived.

CONCLUSION AND RECOMMENDATION

The yield performances of the demonstrated Sesame varieties across the study sites were 3.85q/ha for Dicho and 6.29 ton/ha for local variety with 3.03ton/ha yield difference in which Dicho and Obsa has more yield advantage 41.1% and 33.7% over local variety respectively. As a result, farmers selected Dicho variety on first rank due to high yield, diseases tolerant, tolerant to insect, white in color, good test because in these areas there is an opportunity of underground water availability, suitable soil, and other suit climate conditions that help them to produce this Dicho variety in these and similar agro-ecology.

Therefore, from this research finding it is recommended to promote further Dicho variety in similar agro-ecology is very important by government, Nongovernment and other stakeholders through their program to small holder farmers for enhancement of food security and income generation for small holder farmers.

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Pre-extension Demonstration and Evaluation of early maturing sorghum varieties in the selected AGP-II districts of Harari region and Dire Dawa Administration

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ABSTRACT

Pre-extension demonstration and evaluation of early maturing sorghum varieties with the objectives of promoting and popularize improved lowland sorghum technologies and to create awareness through giving training and enhance stakeholders participation. A total of fifteen (20) trial farmers were selected from two potential sorghum growing kebeles of Dire Dawa administration council and one from Harari region. Four FRG having 60 farmers was established. Two improved sorghum varieties (Melkam and Dekaba) were replicated on the plot of 20mx20m. Training on which a total of 78 participants took part were organized at Dire Dawa Administration council. Lowland Sorghum varieties were evaluated based on their early maturity, yield, Disease tolerance, seed color, seed size, biomass, and stalk and food test. The yield performance of the improved varieties (Melkam and Dekeba) were 26.58 and 26.44 qt/ha at Dodota, 28.24 and 26.78 qt/ha at Bishan Bahe respectively. The average yield performance of Melkam somewhat higher than Dekaba at both location but statistically no significant difference between two improved varieties across the locations.Melkam variety preferred well and better to promote it on wider area and on a number of farmers

Key words: Dekeba, Demonstration, Melkam, Sorghum

INTRODUCTION

Sorghum (*Sorghum bicolor*) is one of the most widely grown cereal crops in Ethiopia. It is a staple food crop which the lives of millions of poor Ethiopians depend on. It has tremendous uses for the Ethiopian farmer and no part of this plant is ignored. Sorghum grows in a wide range of agro ecologies most importantly in the moisture stressed parts where other crops can least survive and food insecurity is rampant (Asfaw Adugna, 2007). Sorghum is also the most widely cultivated and consumed cereals in Ethiopia. According to (CSA, 2008), it ranks third after maize and tef in total production, after maize in yield per hectare and after tef and maize in area harvested. Currently sorghum is produced by 5million holders and its production is estimated to be 4 million metric tons from nearly 2million hectares of land giving the national average grain yield of around 2 tons per hectares (CSA, 2012). In fact sorghum is not only drought-resistant, it can also withstand periods of water logging (Taylor, 2010). It is an essential to diet of poor people in the semi-arid tropics where droughts cause frequent failures of other crops. Sorghum contributes to the food security of many of the world's poorest (FAO and ICRISAT, 1996).

Sorghum is primarily a crop of resource-poor small-scale farmers and is grown predominantly in low-rainfall, arid to semi-arid environments. The crop is typically produced under adverse conditions such as low input use and marginal lands (Masresha *et al.*, 2011). Its grain has slightly higher protein and lower fat than maize. In general, sorghum has about 95% of the nutritional value of maize. Moreover, sorghum (sorghum bicolor) is the fifth most important cereal globally and feeds around 500 million people. It is especially important for rural people in arid regions. It provides food for household consumption and produces amounts of fodder to support their livestock than other grains (Wortmann *et al,* 2006 cited Usmane et al, 2020). The criteria for selecting grain sorghum are, yield, maturity, stalk strength (stand ability), and disease resistance are all important (Usmane *et al*, 2020). Therefore, was developed to demonstrate and disseminate improved sorghum varieties through participatory full package technology dissemination.

MATERIALS AND METHODS

This drought tolerant and early maturing drought sorghum varieties demonstration research was conducted in selected districts of Harari region and Dire Dawa administration.

Site and farmers selection

Kebeles were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop’s land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting that is Dodota kebele from Erer Waldaya and Bishan Bahe from Biyo Awale were selected.

Farmers were selected purposively based on their interest, innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile with the participation of DAs and community leaders. The selected farmers were grouped in form of Farmers Research Group (FRG) with the member of 15 farmers per kebeles in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 4FRGs (2FRG/ kebele) from one PA 15 farmers and a total of 60 farmers were grouped in 4FRG at Harari and Dire Dawa. In the FRG 5 farmers were trial farmers (3 male trial farmers and 2 female trial farmers) and 10 farmers worked with trial farmers.

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

District	PAs	No. of trial farmers	FTCs	Area covered
Biyo Awale	Bishan Bahe	10	1	20mx 20m for each plots
Erer Waldaya	Dodota	10	1	
Total		20	2	

Research design

Two improved treatment (Melkam & Dakaba) sorghum varieties and one local variety were planted side by side with equal plot size. Melkam and Dakaba varieties with local check were used as treatments. Farmers were used as replications. The plot size was 20mx20m and with the seed rate of 10kg/ha. The space between plant and row is 30cm and 75cm respectively. Shallow planting of 2-4cm depth and fertilizer application (100 kg NPS) and the planting date was at late June to early of July for rain-fed planting.

Technology evaluation and demonstration methods/technique

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

Data Collection

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

Data analysis

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

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

Multidisciplinary research team; crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for the sake of publicity of the work done Development agents, experts and farmers were participated on the training given on improved sorghum production and management, post-harvest handling and marketing information. Training was also organized for more awareness creation.

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

		Bishan Bahe		
No.	Participants	Male	Female	Total
1	Farmers	35	26	61
2	DAs	5	3	8
3	District experts	4	2	6
4	Journalists	3	0	3
	Total	47	31	78

Source: Own computation 2017/18

Among the training participant stakeholders, 78.2% were farmers. From those farmers, 42.6% are female farmers' participant. For the participants, 45 leaflets and 30 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. During the training different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards improved sorghum technology production because of better yield and earned income by selling it for different stakeholders (neighbors' farmers and Non-Government Organizations). Generally, all farmers were very interested to have the technology for their future production. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Agronomic and yield performance

The following table describes the yield performances of the demonstrated sorghum varieties across the study site. The yield performance of the improved varieties (Melkam and Dekeba) were 26.58 and 26.44 qt/ha at Dodota, 28.24 and 26.78 qt/ha at Bishan Bahe respectively. The average yield performance of Melkam somewhat higher than Dekaba at both location but statistically no significant difference between two improved varieties across the locations.

Table 3. Yield performance of improved elephant grass varieties across districts on Farmers land

PA	Varieties	N	**Std. Deviation**	Mean (qt/ha)	Maximum	Minimum
Dodota	Melkam	10	1.443	26.58	28.40	24.20
	Dhakaba	10	2.259	26.44	29.70	22.90
Bishan Bahe	Melkam	10	2.349	28.24	32.30	25.10
	Dhakaba	10	2.369	26.78	30.30	23.60
Total			2.181	27.01	32.30	22.90

Economic Analysis

Table 4: Financial analysis for bread wheat varieties across the districts

Financial analysis					
Location: Dodota			Location: Bishan Bahe		
Parameters	Varieties		Parameters	Varieties	
	Melkam	Dekeba		Melkam	Dekeba
Yield qt/ha(Y)	26	26	Yield qt/ha(Y)	28	26
Price(P) per quintal	1000	1000	Price(P) per quintal	1000	1000
Total Revenue (TR)=TR=Y*P	26,000	26,000	Total Revenue (TR)=TR=Y*P	28,000	26,000
Variable costs			**Variable costs**		
Seed cost	100	100	Seed cost	100	100
Fertilizer cost	1,418	1,418	Fertilizer cost	1,418	1,418
Labor cost	3,000	3,000	Labor cost	3,000	3,000
Total Variable costs(TVC)	4,518	4,518	Total Variable costs(TVC)	4,518	45,18
Fixed costs			**Fixed costs**		
Cost of land	2,000	2,000	Cost of land	2,000	2,000
Total fixed costs (TFC)	2,000	2,000	Total fixed costs (TFC)	2,000	2,000
Total cost (TC) =TVC+TFC	6,518	6,518	Total cost (TC) =TVC+TFC	6,518	6,518
Gross Margin (GM) = TR - TVC	21,482	21,482	Gross Margin (GM) = TR - TVC	23,482	21,482
Profit=GM-TFC	19,482	19,482	Profit=GM-TFC	21,482	19,482

Farmers' Opinion/Perception

Farmers' in the study area selected the best performing improved sorghum varieties by using their own criteria. Farmers set these criteria after having know-how about the variety and using those criteria they could select the varieties at harvest time. The opinion of those farmers on varietal preference was collected from participants during variety demonstration. The major criteria used by farmers were Early mature, yield, Disease tolerance, seed color, seed size, performance throughout growing stage, palatability of stalk feed, good nutritional value and food test Therefore, most farmers selected both improved sorghum varieties to reuse on their farm for the future. The following table describes farmers' selection criteria and their perception (feedback) toward the varieties

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

Crop varieties	Farmers rank	Reasons
Melkam	1st	Early mature, Good in yield, Disease tolerance, Good seed color, Good seed size, Very good performance throughout growing stage, Very good palatability of stalk feed, Very good nutritional value and food test
Dekaba	2nd	Relative to early maturity, Good in yield, Relative to disease tolerance, Very good seed color, Very good seed size, Good performance throughout growing stage, Good biomass yield, Relative to good palatability of stalk feed, Relatively good nutritional value and food test

Table 6: Pair-wise ranking matrix result to rank variety traits

Code no.	Traits	Early maturity	Yield	Disease	Seed color	Seed size	Performance	Biomass	Nutritional	Frequency	Rank
1	Early maturity		2	3	1	1	6	1	1	4	2nd
2	Yield			3	2	2	2	2	2	5	1st
3	Disease tolerance				3	5	6	3	3	3	3rd
4	Seed color					5	5	7	4	1	7th
5	Seed size						5	5	5	3	4th
6	Performance							7	6	1	5th
7	Biomass								7	2	6th
8	Food test and Nutritional value									0	8th

The trial farmers in the three locations are aware of the physical characteristics and field performance of all the maize varieties. The major variety selection criteria of farmers in the two locations were almost similar as a result preferred based on traits nutritional value, early maturity yield, seed color, performance, disease tolerance, palatability of stalk and biomass which are very important for livestock feed as shown table 6. Accordingly, the economic benefit of the sorghum was feasible as shown on table 4 that is 12964 birr and 14964 birr for Malkam in Dodota and Bishan Bahe respectively.

CONCLUSION AND RECOMMENDATION

Before introducing these improved varieties, different smallholder growers have been using the planting material which has been obtained from their local markets, lack of appropriate agronomic practices and a little attention was given to the crop production makes the study area below average for producers, but after this technology is introduced in the study area, these all system changed to improved technology like improved varieties, with full packages start from site preparation to storing. As a result, the yield of the improved varieties Melkam showed statistically significant difference at 10% probability level between two improved varieties across the location, biomass/palatability of the stalk for livestock feed, good in food test and other related criteria. Therefore, Malkam variety is recommended for further scaling up in similar agro-ecology to improve small holder farmers' livelihood improvement and livestock feed security.

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Cluster-based pre-scaling up of Tomato technologies in Harari Region Rural areas: Small holder farmers' livelihood improvement

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ABSTRACT

Small-holder farmers' livelihoods basically depend on agricultural products and other related activities. Based on this impression, Agricultural Extension Research team conducted cluster-based pre-scaling up of improved tomato variety (Malka shola) at Harari region in two kebeles (Aradas) Kile and Dodota with objectives of scale up the improved Tomato technologies for increasing the production and productivity for the improvement of small-scale farmers livelihood and strengthen the linkages among stakeholders on the promotion of tomato technologies for one year (2019/2020). For this research activity, 100 farmers with 40% (pre-harvest to post harvest) women composition were participated by grouping them in three clusters, from land preparation to marketing of their products. As a result, 21.88ton/ha at cluster1 12.37ton/ha at cluster 2 and 14.59ton/ha at cluster 3 were produced from the total 75 hectares of land by irrigation system at off season in which Agricultural Extension Research team provided all necessary inputs to targeted farmers according to the land size they own and know how. Throughout this research activity implementation the disease occurrence, ups and down of market price, shortage of seed supply and non-frequent advices from immediate local development agents were raised by farmers as challenges. Therefore, research institutes, government's development organizations, NGOs, and other stakeholders should jointly focus on plant protection, market linkage strengthening, facilitation, capacitating, monitoring and evaluate on ground situation at field and farmers level.

Key words: Cluster- based LSD, Livelihoods, Tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most widely grown vegetable crops in the world (Mersha, 2008 cited in Tewdros and Negasi, 2014). It is widely cultivated in all parts of the world and it is the largest in volume of production after potato and sweet potato. Currently, tomato mainly recognized as quality product for both local and export markets and providing a route out of poverty for small scale producers who live in developing countries in general and in Ethiopia in particular (Tewodros and Asfaw, 2013). Tomato is a high value commodity which has the potential for improving the incomes and livelihoods of thousands of smallholder farmers in Ethiopia and diversifying and increasing Ethiopia's agricultural export exchange earnings (Lemma, 2001 cited in Tewdros and Negasi, 2014).

Tomato is the most frequently consumed vegetable in many countries, becoming the main supplier of several plant nutrients and providing an important nutritional value to the human diet. It is also important source of vitamin A and C as well as minerals. It is widely consumed

in every house hold in different modes including raw, as an ingredient in many dishes, sauce, salads and drinks (Tibebu *et al.,* 2011).Tomatoes can make people healthier and decrease the risk of conditions such as cancer, osteoporosis and cardiovascular disease.
People who ate tomatoes regularly have a reduced risk of contracting cancer diseases such as lung, prostate, stomach, cervical, breast, oral, colorectal, esophageal, pancreatic, and many other types of cancer. The studies show that tomatoes and garlic should be taken together at the same time to have its cancer preventive effects (Mebrat, 2014).

Despite the importance of this crop, the production and productivity is constrained by different biophysical and socio-economic reasons, such as lack of adapted and improved tomato technologies, land shortage, inadequate knowledge on production and management (processing) systems, poor extension services, poor marketing system and proper utilization of the crop are a few to mention (Mersha, 2008). To address those problems, technology introduction, development, promotion and evaluation with farmers as participatory approach could have a marvelous impact sustainable production and improved the livelihoods of rural households.

MATERIALS AND METHODS

This cluster-based pre-scaling improved onion technology research activity was conducted in Harari Region at Kile and Dodota kebeles. This site was selected based on the potential onion production and accessibility of the market nearby the community residence and the site classified into different clusters. After site selection 100 (60 men) farmers in which 40% (40) women composition were selected by considering the experience they have the know-how of the technologies, land availability and other cost-sharing issues. Then, the important training concern to the onion technology production was given for the targeted farmers and classified them into cluster according to the following table 1.

Table 6 the cluster composition Harari Region cluster

Cluster1		**Cluster2**		**Cluster3**		**Total**
Female	Male	Female	Male	Female	Male	100
10	15	12	23	13	37	
Land coverage in hectare						75
24		19		32		

The research activity implementation

The site was prepared and all the recommended packages were applied that were: row stretching between plants and rows, fertilizer application, and other agronomic practices were undertaken at each stage of onion production to harvesting and marketing.

RESULT AND DISCUSSION

The total product obtained per cluster shows that as depicted on table 2 the technology has got more attention by farmers in which individually farmers got 42651.42 birr up to 124,608 birr in average with 16 birr/kg in local price at that production time. This indicates that if farmers access with good price time and storage they can more benefit. Farmers used the obtained birr for different purpose in their livelihood strategies like food secures throughout the year, additional milk cow, fattening bull and small ruminants purchasing, schooling their children by covering all costs, and able to cultivate additional land for further production.

Table 7: Overall yield, benefit in birr and Expenditures

Variables	Cluster1	Cluster2	Cluster3
Land coverage-ha	24	19	32
Production-ton/ha	21.88	12.37	14.59
Marketed-ton/ha	19.47	9.33	13.61
Benefit in birr by time market price individually	124,608	42651.42	43552
Expenditures they spent on	House construction at village level and Harar city, food secures throughout the year, additional milk cow, fattening bull and small ruminants purchasing, schooling their children by covering all costs, able to cultivate additional land for further production…		

Field day Organized and publicity

Field day was organized at research site at time of the maturity stage; farmers, and other stakeholders suggested a couple of ideas and shared experience they have to one another concerned to the tomato varieties with its technology on the farmers land. The technologies exposed to different peoples by television, Radio FM, and written form of extension materials.

Table 8: Participants of the field day

No	Participants	Gender	
		Male	Female
1	Farmers	92	21
2	Das	12	-
3	Experts and others	5	-
	Total	109	21

Constraints farmers faced during production season

Farmers suggested a couple of issues concerned to the technology as depicted on table 4 that they have been facing challenges through the production of tomato start from planting to marketing, accordingly delay of inputs, market price fluctuation, diseases at germination and vegetative stages, lack of support from nearby Development Agents, lack of infrastructure, and storage harvest to long shelf life span of the product. And they suggested that if these problems solved early, they would be more benefit from the technology and improve their livelihood in strategic ways.

Table 9: Constraints of the Tomato production at research site

No	Constraints
1	Delay of providing inputs
2	Market price fluctuation
3	Diseases
4	Lack of frequent support from Development Agent and other bodies
5	Lack of centered station sell for vegetable production(infrastructures)
6	Lack of Storage technology

Exit strategy

The technology pre-scaling up process is a continuous process where the 'end' of pre-scaling up activity is the 'beginning' of the wider scaling up intervention by the public extension system. Hence, there was properly hand over for wider scaling up responsibility to the concerned bodies formally. As a result, emphasis was given to capacity building activities, value addition, community seed system and creation of market linkages to create fertile ground for smooth exit and sustainability of the work.

CONCLUSION AND RECOMMENDATION

This research cluster-based pre-scaling up of tomato technologies was conducted in Harari Region by three clusters with seventy five hectare of land resulted with total productivity in average 12.37 ton/ha 21.88 ton/ha and average benefit farmers individually earned 42651.42 birr 124,608 birr by local price at production time sixteen birr/kg. for this technology pre-scaling the field day prepared as good event for more promotion, as a result, farmers and other participants raised couple of issues as challenges –delay of input like pesticide, diseases appeared, market price and other; as experiences cluster form technology promotion is very appreciable and reach large farmers. Therefore, based on these all issues the following recommendation was derived: the inputs from concerned should be delivered in hand early to farmers, market opportunity should be access at this production and storages, and strengthening the cluster form technology promotion is very important and promoted to other areas.

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LIVESTOCK RESEARCH

Improving Women Farmers' Income Through Crossbred Heifers Distribution and Organization of Self-help Group at Dodola District of West Arsi Zone

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ABSTRACT

The study was conducted in Kata Barenda Kebele of Dodola district in West Arsi zone with one FREG comprising of 10 participating women household with relatively lower income. The distribution of 10 pregnant heifers done with the objective of improving income of rural women farmers and improving family nutritional balance through distribution of improved F1 pregnant heifers and increase milk production. Training and experience sharing was arranged before and after heifer distribution. On average, one household own minimum one (1) with the maximum of three (3) crossbred animals. On average, the current monetary value of calves born form distributed crossbred cows were estimated to be 7571.4± 2636.7ETB. Milk production increased from 1.75±1.21 liter/Cow/day to 6.8±1.47 liter/Cow/day. Milk consumption and sale increased from 1.62±1.31 to 3.1±0.99, 0.72±1.27 to 3.4±0.96 lit/day, respectively. On average one household generated additional 1640 ± 469.51 ETB per month from sale of milk after intervention. They cover their expense for purchasing agricultural inputs, miscellaneous household expenditures and student's school expense from the income generated. Meeting the demand for milk and milk products was the great success for the household after intervention not only meeting family nutrition but also minimizing the cost incurred for purchasing of milk and milk products.

Key words: F1 Crossbred heifer, Milk consumption, Women farmers

INTRODUCTION

Ethiopian agriculture is characterized by mixed farming system and the farmers practice both crop production and livestock rearing. Despite its large livestock base (99.4% indigenous and the rest crossbreds) in the country ecological setting suitable for dairy production yet not milk self-sufficient per capita milk consumption decline from 26 liters in 1980 to 16 liters in 2008 per annum (ELDMPS, 2007; FAOSTAT, 2012). Livestock productivity in Ethiopia is said to be poor due to a number of reasons among which is the low genetic capacity of the indigenous cattle (Mukasa Mugerewa 1989).

In order to improve the low productivity of local cattle, selection of the most promising breeds and crossbreeding of indigenous breed with high producing exotic cattle has been considered as a practical solution (Tadesse, 2002).The agricultural development led industrialization policy, development strategies and plans of Ethiopia emphasizes the need to bring about rapid agricultural development through the use of improved agricultural technologies (variety/seed/breeds, knowledge, information, management practices, farm equipment, tools, and machine) in a sustainable way as the main means of reducing poverty in the country (ATA, 2012). This would, however, bring the required impact if it properly addresses the needs of agriculture dependent men, women and young farmers in the rural Ethiopia (Amare, 2014). Farmers that are involved in seed system are not only men, but also women form a very large integral part of the agricultural activity (Dawit et al., 2010). Gender analysis indicates that about 88% of the Ethiopian women live in rural areas; nearly 85% of their labour is spent on farming as major sources of livelihood, which includes crop production and animal husbandry (Kaba, 2009).

On-farm studies conducted in East Shoa and West Arsi zones indicates that 50% crossbreds (Jersey*Borana; HF*Borana) produce more amount of milk (5.9 to 6.6 liters/cow/day) than local breeds (1.5liters/cow/day) (ATARC research achievements, 2015). Currently, there is high gap between the demand and supply of improved dairy cows in the study area in particular and in the country in the general. Therefore, this activity was conducted with the objectives of improving income of rural women farmers and improving family nutritional balance through distribution of improved F1 pregnant heifers and increase milk production.

METHODOLOGY

Description of the area

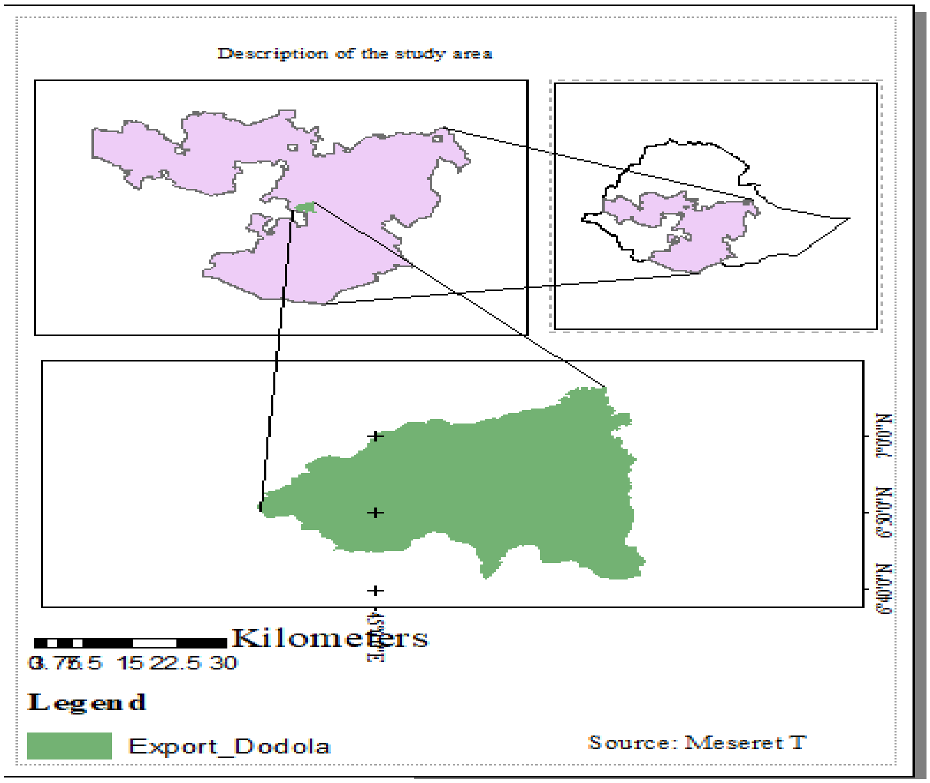
The study was done in Ketta Berenda Kebele of Dodola District, West Arsi Zone, Oromia National Regional State, Southeastern Ethiopia. Dodola district was one of AGP II District selected for intervention. It is located between 06^{0} 54′20″N and 06^{0} 54′3″N latitude and 39^{0}8′19″E and 39^{0}13′50″E longitude with an elevation ranging from 2490 to 3218 m a.s.l. the average temperature ranges from 3.6 to 24.3^{0}c (Digital soil and Terrain Data base of East Africa, 1997).

Site and Farmer's selection

Selection of participant women farmers was done in collaboration with District experts, development gents, Kebele administration and discussion held with the farmers. Checklist was prepared based on the selection criteria prepared and a group of researcher, District experts and Development agent together has a discussion on the criteria and went to the area and fill the checklist efficiently. Then, farmers were selected based on the primary data collected through prepared checklist. A total of 10 farmers with relatively lower income by giving priority for female headed household was selected. One FREG composed of 10 members (all Females) were established.

Selection criteria used to identify the farmers (women farmers)

- Willingness of the farmer
- Possession of adequate land for the cow management
- Number of family members (the larger the better)
- Relatively low income
- Previous experience on dairy cow management
- Willingness to manage the cross bred dairy cow as per the instruction of the researcher
- Experience on saving money
- Commitment to not to sale the F1cows till the completion of the project except for the recommendation of the researcher.



Picture 1. Map of the study area

Roles and responsibility sharing among actors

Table1**.** Stakeholder roles and responsibilities in implementing the activity

Stakeholders	Roles and responsibilities
Research (ATARC)	➢ Coordination and facilitation ➢ Selection and preparation of animals to be distributed ➢ Provision of inputs (F1 heifers and bulls , concentrate feeds, Veterinary medicines) ➢ Provision of training ➢ Organizing field days and visits ➢ Supervising, monitoring and Evaluation
Office of Agriculture and Natural resource of the district through Development Agent and assigned Focal persons	➢ Organize farmersand assist in site and farmers' selection ➢ Monitoring of activities of farmers ➢ Support in providing training, field days and visits ➢ Assist duringdistributionsof animals ➢ Providing animal health service to animals after distribution
Farmers	➢ Organize themselves in group ➢ Constructing house for animals ➢ Paying initial subsidized cost for animals distributed to them ➢ Producing and purchasing additional feed for animals, keeping and managing their animals as per researchers recommendation ➢ Data recording ➢ Participate in the training field days ➢ Share skills and experiences to neighboring farmers

Experimental animal preparation and distribution

Ten F1 Crossbred heifers (HFXA) were selected and inseminated from the nucleus herd at ATARC. After they were confirmed to be pregnancy positive the pregnant heifers were distributed to ten (10) selected farmer's individual by lottery method. Heifers were provided with subsidized price form the center. In addition to heifers, one (1) F1 crossbred breeding bulls distributed to the group to alleviate the problem of Artificial Insemination service and Inbreeding problem in the area. The distribution of heifers was done in presence of different stakeholders higher officials from Oromia Agricultural research Institute, West Arsi zone Agriculture and Livestock development office, Dodola District Administrative and the distribution get Media Coverage on Oromia Broadcasting Network.

Animal management

All households construct individual house for each animals from locally available animals. All animals were managed individually in semi intensive management system. Initially they were provided with concentrate feed from the center those feed not available in their area and supplement their animals with concentrate. All animals were hand milked twice a day with calf suckling. Few of them were also produced improved forages and used as a feed for their animals.

Capacity Building

Training was given to all participating farmers, DA, expertise of the respective districts and concerned bodies on improved dairy cattle management, feeding, housing, breeding, health and basic concept cooperatives both before and after heifer distribution. Experience sharing was arranged and they share experience from successful dairy groups previously organized at Kofale.

Data collected

Baseline data before and after intervention was collected by using Semi structured questionnaires. Milk production, consumption and marketing, breeding, sex of claves born, milk price, conventional management system, monthly income generated, amount and purpose for which income generated expend records were collected. Data record book was provided to each farmers on which they record daily milk production, consumption, marketing, monthly income and expense.

Data Analysis

Collected data through semi structured questionnaires, milk production, consumption, marketing, income and expenditures were entered into Ms-Excel. Processed data were imported and analyzed by using descriptive statistics of SPSS ver. 20.

RESULTS AND DISCUSSIONS

Sex, marital status, education level and religion of respondents

The result indicates that 40 of respondents were female whereas the remaining 60 were male and majority of respondents (80%) were married. Regarding their educational level 20 % of them where Illiterate and the remaining respondents were Read and write, primary, secondary and Diploma with equal 20 percentage share. All of the respondents were Muslims in their

Religion. On average they have an experience of 11.6±6.38 years of experience in livestock production.

Table 2. Family members with age category of respondents

Age category	Sex		Total
	Male	Female	
Overall total family members	3±0.9	3.2±1.9	6.2±1.93
Less than 15 year	1.8±1.13	1.3±1.3	3.1±1.19
15 to 45 year	1.1±0.56	1.4±1.07	2.5±1.35
Greater than 45 year	0.2±0.42	0.4±0.51	0.60±0.84

As indicated in table 1 above the overall family member in current study is 6.2±1.93. Regarding the age category of family members majority of them were children's less than 15 year followed by 15 to 45 year age category. This implies that the demand for milk and milk products were high for home consumption. so, increasing milk production per animals and per household is important and essential not only for meeting family home consumption and improving nutritional composition of family food but also it increase family income through reducing costs incurred for milk and milk products purchase whereby getting additional income from sale of milk and milk products.

Dairy cattle herd structure

As indicated on figure1 below the major benefit after intervention was improvement in dairy herd structure of the household intervened. All of the respondents (100%) indicated that their dairy cattle herd structure has changed after intervention. The number of crossbred animals were significantly increased after intervention on average one household own minimum one (1) Crossbred Cows with the maximum of three (3) crossbred animals. On average the current monetary value of calves born form distributed crossbred cows were estimated to be 7571.4± 2636.7ETB.

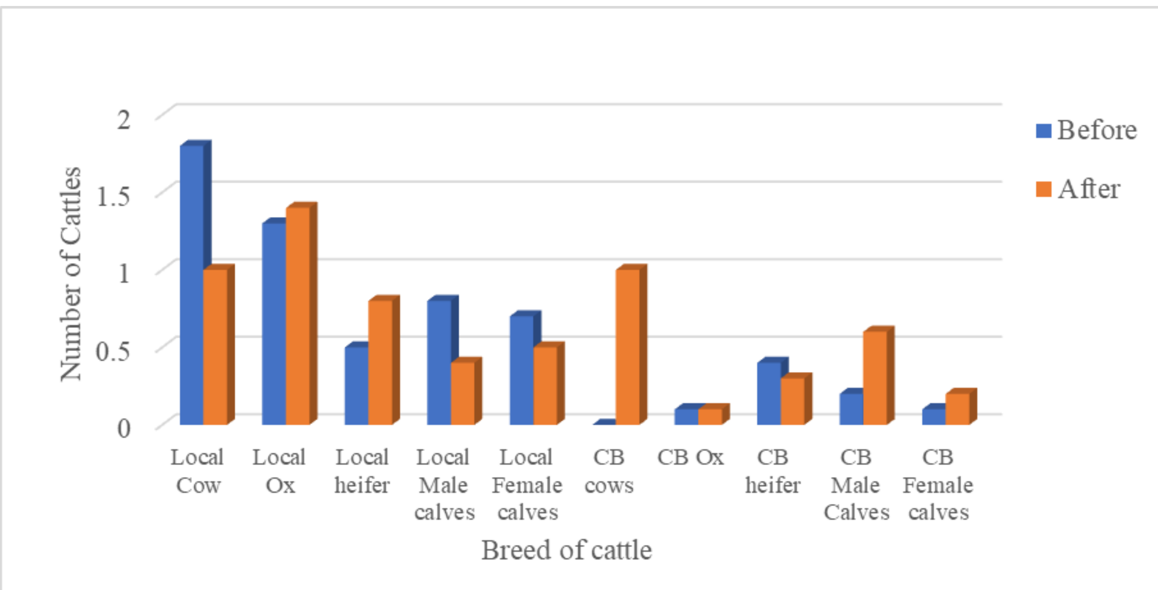


Figure 2. Dairy cattle herd structure before and after intervention

Milk production, consumption and marketing

Table 3. Average Milk production, consumption and marketing before and after intervention

Parameter	N	Before intervention Mean ± SD	After intervention Mean ± SD
Production lit /cow/day	10	1.75±1.21	6.8±1.47
Total Milk produced lit /day/hh	10	2.96±1.81	6.9±1.19
Consumption lit /day	10	1.62±1.31	3.1±0.99
Processed lit /wk	10	6.73±2.49	9.2±2.65
Sold lit /day	10	0.72±1.27	3.4±0.96

N= number of respondents

The result indicates that milk production, consumption and marketing was improved after intervention. Milk production increased from 1.75±1.21 liter/Cow/day to 6.8±1.47 liter/Cow/day. The current average milk yield result was almost comparable with the findings of (Estifanos and Girma, 2018) average milk yield of 6.59±0.065 L around Meki area. But it was higher than the result from Kersa Malima area which was 4.73±3.2L (Ketema, 2014). They indicated that only 20% of respondents sale milk before intervention since their production not sufficient to meet family consumption but all of the respondents start sale of milk after intervention beyond meeting their family milk and milk products consumption. Milk market was located at Heraro town which was around 4-5Km far from them and they transport on foot milk daily to the town and they sale to retail traders at the town. Average price was 23.1±1.4 ETB per liter of milk and they indicated that milk price was lower during rainy season and there was no sufficient demand. Milk price were higher than the report by (Estifanos and Girma, 2018) which reports 15ETB/liter around Meki area and the difference might be due to location and year difference in the study areas.

All of the respondents (100%) indicated that their household generated income was improved after intervention. On average one household generated additional 1640 ± 469.51 ETB per month from sale of milk after intervention. The purpose for which they expend the generated income from sale of milk indicated in table 3 below.

Table 4. Ranking purposes for which generated income expend

Purpose of expenditure	1st	2nd	3rd	4th	5th	Index	Rank
Agricultural input purchase	6	2	2	0	0	0.3	1
Household expenditure	1	5	4	0	0	0.26	2
Purchasing of Animal feed and health service	0	0	1	9	0	0.14	3
Purchasing livestock	2	1	1	0	0	0.12	4
House construction	2	1	0	0	0	0.09	5
Student school expense	0	0	1	1	0	0.03	6
Starting small scale business	0	0	1	0	0	0.02	7

Purchasing of agricultural inputs like fertilizer, seed, pesticides and herbicides were the major purpose for which generated income expend followed by drugs and household miscellaneous expense and purchase of concentrate feed and veterinary service and drugs. The average amount of expense they expend for different purpose was indicated in the following table 4.

Table 5. Average amount of expenditures they expend from generated income

Amount expend for type of expenditure	N	Average amount of expenseMean ± SD
Agricultural input	10	3193 ±1632
Miscellaneous household expenditure	10	2250 ±1002
Livestock Purchase	4	4550 ±3724
House construction	3	4333 ±1154

N= number of respondents

Family milk consumption improvement

All of the respondents (100%) indicated that their family doesn't get sufficient milk and milk products for consumption before intervention and vice versa after intervention. The milk consumption has increased on average from 1.62 ±1.31 to 3.1±0.99 liter/day/household. As indicated on table 1 the average number of family number was 6.2 ± 1.93 and majority of the age group were children's less than 15 years old which means the demand for milk and milk products for balanced family nutrition was high and meeting this demand was the great success for the house hold after intervention not only meeting family nutrition but also minimizing the cost incurred for purchasing of milk and milk products.

Organizing self Help group

Only 20% of respondents participate in any credit and saving groups before intervention but 70% of them has interest to participate in any credit and saving groups. Social institution (Muslim religion prohibit interest) vs support institution (OCSO to provide credit and saving) The major reason limiting them to participate in credit and saving groups are religious reason since all of respondents are Muslims in their religion. So, as a solution we organize one self-help group which was arranged in the manner that address their problem to provide credit and saving service free of interest and currently all of them including all husband and wives were members of the group. Organized self-help group has 18 (10 Female and 8 male) members. The group name was "**Garee Horsisa Horii Aannanii Doyoree**" each member will contribute 60 ETB birr per month and they contribute 100 ETB per person as initial. In addition to saving to the group in side they have Equb in which every member contribute 100 birr per month and one member get 1000birr month. All members get 1000 ETB form Equb and them purchase Sheep, start small scale business and expends for miscellaneous household expenditures.

Capacity building

Training and Promotional Events

Majority of respondents (80%) indicated that they didn't get any training on dairy cattle management and even participated ones reported that they didn't get enough awareness and knowledge. Meanwhile after intervention all of them both husband and wives has got training on improved dairy cattle management and indicated that they got enough awareness and knowledge. A total of 41 participants has got training on imp improved dairy cattle management, feeding, housing, breeding, health and basic concept cooperatives b interdisciplinary team from ATARC and Dodola District Cooperative promotion Agency.

Table 6. Training participants

Name of district	**Name of kebele**	**Participants**								**Total**
		Farmer		**DAs**		**Experts**		**Others**		
		M	F	M	F	M	F	M	F	
Dodola	Ketaberenda	12	11	3	0	3	1	10	1	41

Promotional events

A total of 74 participants attend on field experience sharing arranged with previous organized successful Dairy groups at Kofale district of West Arsi zone and both family members, DA's, and experts had participated.

Table 7. Experience sharing Participants

Name of district	Name of kebele	Participants								Total
		Farmer		**DAs**		**Experts**		**Others**		
		M	F	M	F	M	F	M	F	
Dodola	Ketaberenda	30	28	1	0	1	0	10	4	74

CONCLUSIONS AND RECOMMENDATIONS

The result of current study indicated that distributed pregnant crossbred F1 heifers to women through AGP II research wing project had brought significant increment in household milk production and production whereby improve family members access to source of animal protein which improve family nutrition through providing balanced nutrition. Not only milk yield household income was significantly improved after intervention through sale of milk. On the other hand they also cover their expense for purchasing agricultural inputs, miscellaneous household expenditures and student's school expense from the income generated. So, the current findings indicates that how one F1 crossbred heifer contributes to the improvement of family nutrition and livelihood of small holder farmers and further efforts has to be done to gap the demand for improved breed with reliable price for smallholder farmers and appropriate market should be linked for input supply and milk sale in in addition animal health and Artificial insemination service has to be available in the area.

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Improved Beekeeping Technologies as an Intervention for Unemployed Youth Group

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ABSTRACT

Beekeeping practice is an important income-generating activity, employment, and tourism. Its investment costs are relatively low which makes beekeeping a thriving business that can contribute invaluably to a household income. The main objective of this study is to evaluate the socio-economic contribution of beekeeping to youth by establishing beekeeping cooperatives of unemployed youth groups around the protected forest area. As to method, Ambo Woreda is selected purposively and two youth group which consist of 34 members established. Two round training on improved beekeeping management practices and business planning given for group members. Forty box hives with honey bee colonies, beekeeping equipment, and accessories delivered with technical support in the establishment and follow up of honey bee colonies during the study period. Planting and managing multipurpose tree seedlings undertaken around the apiary with group members. As to the result, on average of 85.5kg kg pure honey harvested per season and marketed in surrounding local market and 21,375 Ethiopian Birr per season obtained from honey sold. Improved beekeeping knowledge, skill, and awareness created on beekeeping as a business are nonfinancial results achieved as a result of the intervention. The overall finding of this study mainly underlined beekeeping can be used as an intervention tool for youth unemployment with the integration of other income-generating activities.

Keywords: Beekeeping, intervention, income generation, unemployment

BACKGROUND AND JUSTIFICATION

Unemployment is a worldwide challenge that has been rising steadily for the past years and will continue rising (Ndegwa,2016). Sub-Saharan Africa's unemployment rate is forecast to be 7.2 percent in 2018, unchanged from 2017. While the unemployment rate remains stable, the number of unemployed is expected to increase from 29.1 million in 2017 to 30.1 million in 2018 due to the region's strong labor force growth (ILO,2017). A high level of un-and underemployment is one of the critical socio-economic problems facing Ethiopia (Berhanu et.al.,2005). While the labor force grows, with an increasing proportion of youth, employment growth is inadequate to absorb labor market entrants. As a result, youth are especially affected by unemployment and it has several socio-economic, political, and moral consequences. (Berhanu et.al., 2005).

To reduce the problem of unemployment, livelihood strategies that integrate youth is critical. Beekeeping is one of the livelihood sources in most developing countries and plays a valuable part in improving rural livelihoods. Its success can be noted in countries like Ethiopia (Mazorodze, 2015). Many studies show the importance of beekeeping from different aspects. It can be viewed as a means of eradicating poverty (Goldenberg, 2004; Mickels, 2006; Ogaba, 2007; Lalika, 2009; Ayansola,2012). Others have shown that beekeeping practices as an important income-generating activity, employment, and tourism (Joni,2004; Workineh, 2007; Ajao and Oladimeji, 2012; Chazovachii et. al.,2012 Qaiser et.al., 2013; Azeez et.al., 2014; Wongelu,2014). Others demonstrated as it plays a major role in natural resource management and ecosystem service via pollination (Chazovachii et. al.,2012; Azeez et.al., 2014; Ndegwa,2016) and other studies demonstrated investment costs are relatively low being less than 50% of the income generated, making beekeeping a thriving business that can contribute invaluably to a household income(Saha,2002; Bradbear,2009; Ndegwa,2016, Wongelu, 2017). One of the fields benefitting from entrepreneurship is the beekeeping industry. Beekeeping is an age-old practice that creates sustainable livelihoods both locally and internationally. It is fairly easy to start and maintain with the right equipment and training (Ndegwa, 2014). Therefore, this project intends to evaluate the socio-economic contribution of beekeeping to youth welfare by establishing cooperatives of unemployed youth groups around protected forest areas.

Study design

For the implementation of the intervention, unemployed youths were selected and beekeeping cooperatives with the help of stakeholders. The beekeeping site was selected and used as a center for learning. Training, honeybee colony, bee equipment, and accessories delivered after the youth group was established. All members participated in the capacity building process for the establishment of beekeeping apiary, bee forage development, seasonal management, honey production, and marketing the output.

MATERIALS AND METHODS

Youth Selection and Coop Establishment

For this study, one AGP Woreda specifically Ambo Woreda selected as intervention Woreda based on the assumption of the high rate of youth unemployment, protected/demarked forest areas for implementation, the potentiality of the Woreda for beekeeping, and close follow up one Village Administrations /VA selected purposively based on floral resources of the forest areas and convenience of the sites for beekeeping and two youth groups as one cooperative established. Thirty-four youth selected purposively as a member of groups in close consultation with the respective Woreda level stakeholders. Dobi VA and selected area for beekeeping apiary used as a center for intervention, capacity building, learning, and data collection.

Approaches and Methods for Implementation

The two youth groups established for the intervention in the target area merged for the establishment of one strong honey producer cooperative and used for intervention tools. All the activities in the intervention process were undertaken with this coop. As to the method, group discussion at Woreda and VA level frequently arranged to introduce the objective of the study, roles and responsibilities of stakeholders, and expected output at the end of the study period. Consecutive training and capacity building activity conducted during the study period. Selected and organized youth actively involved starting from site selection for establishing to the marketing of the output.

Data collection
Primary data collected and documented using a data collection sheet, personal observation of the site, and group discussion. Secondary data also collected from respective Woreda livestock offices, literature, research reports, and internet searches.

Data Analysis
Quantitative data were analyzed descriptively by using statistical techniques such as frequency counts, percentages, arithmetic means, and tabulation. After analysis of the data obtained, the data was then presented using tables and for easy understanding and representation. The qualitative data was analyzed through an explanation of an idea, opinion, and concept explanation method.

RESULT AND DISCUSSION

Capacity Building

Training
The capacity of selected youth, DAs, and experts to apply improved beekeeping technology package built through two rounds of theoretical and practical training conducted at their beekeeping site, VA. In the first round of the training, practical training given is given for three consecutive days on-site selection, hive standing making, foundation sheet making, colony transferring, and follow up of established colony. The second round training also is given on improved beekeeping technologies and management practices, selection of materials for construction of chefeka hives, construction of chefeka hives, top bar preparation, seasonal management of honey bee colonies, protection of bee colonies from pest and predators, and value addition to beekeeping products and marketing aspects. Besides the basics of beekeeping practices, training on beekeeping business planning, saving and fattening of sheep and goat given to the members to diversify their income and save what they gain. As shown in table 1 below, 34 youth, two DAs, and 5 experts trained two rounds for three consecutive days at each round.

Table 1: Number of Youth, Development Agents, and Experts participated in training

No	**Category**	**Number of trainees**		
		Male	Female	Total
1	Youth	30	4	34
2.	Development Agent	5	0	5
3.	Expert	2	0	2

Technology Transfer and Skill Improvement
After first-round training, 40 set box hives with its equipment and accessories like honey extractor and casting mold 34 honeybee colonies, protective clothes such as jacket style bee veil, bee suit, and bee glove delivered for the coop and 34 honey bee colonies established in selected apiary during the first phase of the implementation. After establishment, regular honey follows up activities such as inspection, feeding, inserting/removing the partition, honey harvesting, and processing undertaken at each season with the active participation of each member on the queue base which is made obligatory and included in their bylaws. In improving the knowledge and skill of the youth, Development Agents (DAs) and Woreda

level experts participated with technical coaching and back up of Holeta Bee Research Center (HBRC) technical staff. In this process, five researchers and 11 technical and field assistants participated during the intervention period.

Apiary Improvement

Now a day plantation and management of multipurpose seedlings are critical. These plants play a major role in bee forage development of the apiary site. The availability of bee forage around the apiary has contributed to honey yield during the honey season and as a source of food for the honeybees during the dearth period. It also contributes to natural resource improvement and conservation activities in the village. As shown on the table below a total of 750 seedlings of different type multipurpose bee forages planted in the apiary site and photos taken during plantation and management are also shown on the photo below.

Table 2. Types and number of seedlings planted

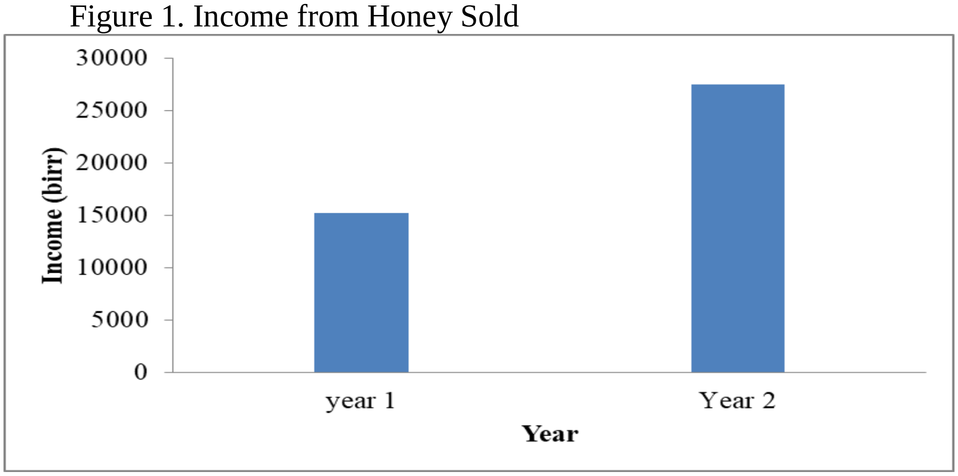
Botanical name	Common name	No. of seedlings planted	Survival %	Uses other than bee forage	Remarks
Becium grandiflorum	Tebeb	100	96	In local medicine, the herb is used against malaria	Indigenous
Callistemon citrinus	Bottle brush	200	86	Cultivated for ornamental purposes it is to some extent salt-tolerant and can grow on very poor dry soils	Exotic
Dovyalis caffra	Koshom	450	90	Used for fences	Exotic

Source: Own data, 2020

Honey Yield and Economic Benefit

Honey was harvested once every year from established colonies, extracted, and marketed. Accordingly, 61 kg pure honey harvested in the first year of the intervention and sold with 250 ETB/kg and a total of 15,250 ETB gained. In the second year also 110 kg pure honey harvested and sold with 250 ETB/kg and a total of 27,500 ETB gained. The annual income obtained from honey sell shown in the figure below.

Figure 1. Income from Honey Sold



Source: Own data, 2020

Opportunities and Challenges for Youth Engagement in Improved Beekeeping

To reduce the problem of unemployment, beekeeping can be a good entry business activity that can be integrated with other alternate income generating activity. This sector has a lot of opportunities if utilized with appropriate beekeeping technologies. The major opportunities identified were listed below.

- Availability of different flowering plant species makes beekeeping conducive for beekeeping practices,
- Availability of alternate beekeeping technologies that increase production and productivity per hive, assist product diversification and value addition,
- Governmental and NGOs attention to the sector as one of the potentials for youth job creation, natural resource conservation,
- Existence of closure areas and rehabilitated to carry honeybee colonies,
- High demand for honey at local, national and international markets and
- Better price for one kilogram of honey is the major.

There are also challenges for the active engagement of youth in beekeeping as alternate income. The first challenge is that the youth didn't have the patience to wait at least six months or a year to harvest honey and generate income. The other challenge is the initial investment cost for protective clothes, equipment, and accessories to start beekeeping is difficult for the unemployed youth.

CONCLUSION AND RECOMMENDATION

It can be concluded that the youth benefited financially by selling the output. They also gained nonfinancial benefits like improved beekeeping knowledge and skill of improved beekeeping management practices. To make the results long-lasting, continuous follow up should be given by DAs and experts and all concerned stakeholders. The overall finding of this study mainly underlined beekeeping can be used as an intervention tool for youth unemployment with the integration of other income-generating activities.

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Cluster based Pre-scaling up of Dolichos Lablab (Lablab pursuers) under sown in maize at Dugda district, East Shoa, Oromia Region, Ethiopia

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ABSTRACT

This activity was undertaken at Dude districts, East Shoa Zone to improve the farmer's livelihood by cooperation of AGP-II program and ATARC with the objectives of evaluating the cluster based pre-scaling up of Dolichos lablab-maize intercropping system, train and make awareness's of smallholder farmers in cluster form. The training was given theoretically and practically for 150 Participant including farmers, experts, DAs and others on crop and forage agronomy, production and utilization. At one selected Kebele from the district, one FREGwas established that includes 30 farmers and totally 5ha area of land was used for this activity. The gender was also considered in this activity. The 25kg/ha of maize and 15kg/ha of lablab seed rate were sown based on their recommendation. The input (seed, fertilizer, herbicide and pesticide) were distributed based on their farmland size. Close monitoring and evaluation was undertaken for management. The field day was prepared and 64 stakeholders were participated. Different data were collected and analyzed with simple descriptive statistics. The farmers have got 3.53t/ha DM of lablab and 18t/ha of maize Stover DM, totally 21.53t/ha DM was found for the improvement of animal feed resource availability. In addition, the maize yield also 8.1t/ha that was similar with the previous study. This result indicates that the intercropping of lablab purpureous-maize did not affect the crop yield and farmers can got benefit from both forage and grain of crops. Therefore, any land holder can practice to improve the animal feed resource availability for the product and productivity of livestock.

Key words: Dry matter, Feed resource, Forage

INTRODUCTION

A major problem facing livestock producers in tropical area is proper nutrition for their animals during the dry season when pastures, cereal residues and maize Stover are limiting in nutritional quality. Normally, it is during this season when problems such as sickness and weight loss due to a poor dietary profile arise. As grazing lands are gradually brought under cultivation, and thus livestock are forced mainly to graze on poor marginal areas and use low quality crop residues. Production constraints identification by AGP-II project also indicated that shortage of feed particularly during the dry season, limited access to concentrates and industrial by-products, and shortage of improved forages both in terms of quantity and quality were the constraints facing livestock production (Mengistu et al., 2016) in the districts of East Showa zones. To tackle these feed shortages, cultivation of improved forage crops is very crucial. One way of improving the utilization of such crop residues is by proper supplementation with leguminous forages (Poppi and McLennan, 1995). Among forage production strategies intercropping of improved forages legumes in cereal crops is useful practice in an area where land resource for forage production is very critical. Mixed cropping especially with legumes can improve both forage quality and yield because legumes are good source of protein. Forage legumes intercropping improve soil fertility by fixing nitrogen, reduce pest incidence and improve forage quality by increasing crude protein yield of forage (Lithourgids et al., 2011). One of the most common benefits of mix cropping is to produce a higher yield on the same land by more efficient use of the available growth resources that can't be utilized by each single crop grown alone (Ghosh, 2004). Growing maize in mixture with lablab is one of the legumes crop intercropping strategy to improve forage feed quality and quantity. Growing maize in mixture with lablab produced more fresh weight, dry weight and CP than their sole planting (Chellaiah and Ernest, 1994). Maize (Zea mays L.) being the most important food crop intercropped with a minor/ companion crop for various reasons. Increasing the light interception in the intercrops reducing the water evaporation, and improving the conservation of soil moisture are some aspects of intercropping maize with legumes as compared with the maize alone (Ghanbari et al., 2010). Similarly, maize-forage legumes intercropping experiments have been conducted at different areas and promising results of cereal crops and forage legumes intercropping were obtained (Diriba and Lemma, 2003, Gbaraneh et al., 2004). Among the forage legumes, Dolichos lablab was identified as the best forage legume produced good yield in intercropping with maize system.

However, this intercropping systems is not yet evaluated at farmer's condition and demonstrated to the farmers/ end users in the mid rift valley of Oromia National regional state. Hence, in order to promote adoption of this technology, demonstration of intercropping lablab with maize at on-farm condition is very crucial. Therefore, the cluster based pre-scaling up of maize lablab intercropping was done at Xepho coroqe kebele of Dugda district with the following objectives.

MATERIALS AND METHODS

The Dugda district is found in the East Shoa zone, Oromia national regional state. It is located between 7^{o} 58' N and 38^{o} 43' E in the central part of Rift valley and the altitude ranges from 1600 to 2100masl. The district shares boundary line with: - Bora woreda in the North and North West, Arsi in the East, Adami Tullu Jiddu Kombolcha district in the south and Southern Nation Nationalities and Peoples of Ethiopia (SNNP) in the west. The Capital town of the district is Meki, which is located 134k from Addis Ababa (the capital of the country) and 88km west of Adama (the capital of East Shewa Zone) before reaching Batu town, along the same main asphalt road. The annual rainfall was erratic, unreliable and low, averaging between 500 and 900 mm per annum and temperature 22-28 ^{o}C.

Farmers Research and Extension Group (FREG) establishment

One kebele was selected from the district based on the livestock population potential, severity of feed shortage and cropping system (maize dominant) area. The activity was carried out using Farmers' Research and Extension Groups (FREGs) of smallholder farmers. Then 30 farmers (20 male and 10 female) who have **w**illingness to accept and disseminate the technology and possess adequate farmland in cluster for forage scaling up were purposely selected and established as FREGs in collaboration with development agents and expert of the district.

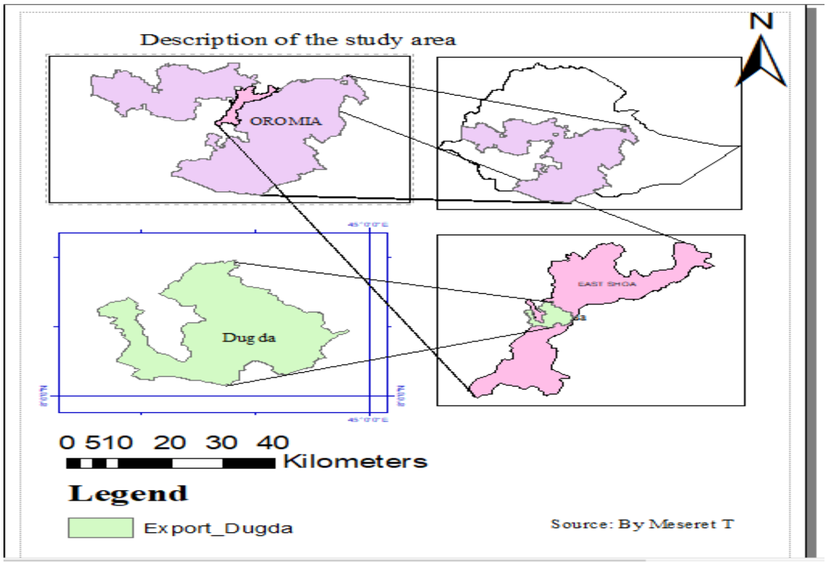

Figure 3. Description of the study area

Detail analysis of the problem and potential benefits of improved forage production in cluster with maize and method of establishing was discussed with farmers. The 8 trial farmers were selected from FREGs based on the criteria including willingness of the farmers in producing forage in cluster with maize intercropping on his/her land, farmer having enough land for forage production. Minimum 50m*50m farm land or cropping land was expected from one farmer in the clusters. However, the farmers gave as his/her potential and around 5ha of land was used for cluster based scaling up activity.

Dolichos lablab was used for intercropping with maize (BH-540 variety). Lablab was intercropped with maize after two weeks of maize planting. The recommended seed rate i.e 25kg/ha for maize with 75cm of spacing between the rows and 25 cm among the plant were used.The recommended seed rates of lablab in mixture form will be 15kg/ha and applied in the two adjacent maize rows. All recommended agronomic practices were done for all farmers field uniformly. The land was ploughed well and prepared for sowing. Different input (fertilizer, seed, pesticide and training) were given for farmers and experts respectively. The NPS fertilizer was sown with maize and the urea were by splitting into two based on the recommendation.

Capacity Building

Training was given for group of members on forage production with maize intercropping before establishments by multidisciplinary team of researchers from ATARC. A neighbor was well encouraged in attaining the training. The training was address the crop establishment, cutting method for quality hay production, importance of intercropping than sole farming of maize, general management, harvesting and method of feeding and time of utilization for their livestock. Different input (fertilizers, crop and forage seed and pesticide) were given for farmers within the given time. After packaging and distribution of maize technologies and other agricultural inputs, regular field visit by extension agents, joint field visit and supervision at different crop stage was carried out. Field day and popularization were organized and the varieties were pre-scaled up and evaluated jointly by farmers, agricultural experts, development agents and researchers to show performance of intercropping practices at crop maturity stage.

Agronomic, yield data and the farmers' opinions, ideas, perceptions, interest and views were collected. Then farmers were given the chance to express his ideas on intercropping improved forage in maize based on the performances of forage and yield of maize crop. Both female and male farmers had been incorporated so as to avoid gender bias during farmers' selection process.

Data management and analysis

The data was collected and organized. The organized data was organized and interred to Microsoft excel and simple descriptive analysis was undertaken.

RESULT AND DISCUSSION

Input distributed and yield obtained

As indicated on the following, different activity was undertaken to improve the farmer's livelihood with the maize forage intercropping by cooperation of AGP-II program and Adami Tullu Agricultural Research Center. Understanding of farmer's willingness, was able to strive their life, if they have few assistance from any organization and expert with in cash or kind. Therefore, the pre scaling up of cluster based improved forage (lablab) intercropping with maize was undertaken at Dugda district Xepho coroqe kebele.

The inputs were given for trial farmers based on their land size and their contribution for cluster based forage production. However, all farm operations land preparation, planting, first and second weeding, cultivation, harvesting, threshing were carried out by hosting farmers with close supervision of researchers and Agricultural experts with practical orientation prior to planting until harvesting of the crop

Table 10. The description of cluster based forage maize intercropping

Commodity	Varieties	Name of district	No of cluster	Size of cluster	No of farmers participated in FREG
Intercropping	Maize-lablab	Dugda	1	5ha	30

Capacity building

The different stakeholder were participated including farmers grouped for FREG as indicated on the following table (2).The practical and theoretical training were given for farmers before establishment of this activity for awareness creation for the communities. Practical training was focused on how to produce and manage forage under maize crop, time of forage harvesting, method of feeding and related issues.

Table 11. Number of farmers participated on training before establishment of the technology.

No	**Participant**	**Sex**	**Number**
1	Farmers	M	95
		F	31
2	Expert	M	2
3	DA	M	1
		F	1
4	SMS	M	4
5	Others	M	15
		F	1
	Total		150

Capacity building training was given for a total of 150 participants by ATARC multidisciplinary team of researchers as summarized on the above Table (2) on improved maize technology, dolichos lablab production and intercropping practices and other varieties total package production system training has been given. All important information including farmer's opinion toward the technology, forage agronomic parameters and biomass yield were collected.

Table 12. Type of input used for pre scaling up cluster based forage intercrop with maize

	Input type used			
	Seed kg/ha	NPS kg/ha	Urea kg/ha	Pesticide lt/ha
Maize	25	100	100	1
Lablab	15			

Field day result and farmers feedback

Different stakeholders were participated from IQQO, Zonal and woreda expert, AGP focal person from zone and the district, woreda finance, researcher and farmers.

Table 13. Number of stakeholder participated on field day of cluster based lablab-maize intercropping.

No	**Participant**	**Sex**	**Number**	Total
1	Farmers	M	30	36
		F	6	
2	Expert	M	6	6
		F	0	
3	DA	M	2	4
		F	2	
4	SMS	F	2	2
5	Other	M	16	16
		F	0	
Total				64

The frequent joint supervision and on field day program were undertaken for biological and physical challenges. Therefore, different pest incidence was occurred and the pesticide was used to control it based recommendations.

The participant have shared their feeling as to be maize intercropping is appropriate for improvement of animal feed shortage and wise utilization of resources (land) without reducing the yield of major crop (maize) and encouraged for the futures to participate in the improvement of farmer's livelihood. The performance of lablab maize intercropping was estimated by field day participant as to be higher than sole cropping practices. Even though, the participant were inspired of what they have seen on the field day and have learnt how to improving the animal feed shortage with forage intercropping with cereal crops.

Biomass and crop yield of intercropped maize-lablab

Table 14. The yield of Dolichos lablab and maize intercropped

No	Commodity	Yield ton/ha	Forage biomass ton/ha
1	Lablab	-	3.53
2	Maize	8.1	18
	Total	8.1	21.53

The intercropping cluster based forage biomass is 21.53ton/ha including maize Stover as indicated on the above table (5). This refers that, the intercropping of lablab maize does not affect the maize yields and yield components of crops and improvement of feed shortage through forage development by integrating cereal crops is the best practices. Mixed crop-livestock farming system is a typical characteristics of developing countries (Mpairwe et al., 2003). Cereal crops such as maize, sorghum and millet, and keeping of livestock (sheep, goats and cattle) and poultry are the main components of this type of mixed crop-livestock farming system (Hassan, et al., 2014).

CONCLUSION AND RECOMMENDATION

This paper was concluded from the result as to be intercropping of improved forage with cereal crop is appropriate to reduce the shortage of animal feed resources. Therefore, cluster based pre scaling up was under taken to evaluate and promote the improved forage (lablab) with maize intercropping practices. This activity also refers as to have not negative impacts on the crop yield and high biomass to improve shortage of animal feed resources. Therefore any land holder can practice to incur the product and productivity of livestock by improving the animal feed resource availability.

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Cluster Based Oat-vetch Mixtures for Forage Production in Dodola District of West Arsi Zone, Ethiopia

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ABSTRACT

The present activity was conducted at Keta Berenda kebele of Dodola district of West Arsi Zone of Oromia in 2019 cropping season with the objectives to evaluate cluster based pre-scaling up fodder oat mixture with vetch, collect farmers' opinion on the performance of the technology, improve farmers' knowledge and skill of application of the improved technology through training and increase local capacity for future scaling-up**.** Keta Berenda kebele was purposively selected from the district based on the livestock population potential and accessibility. Thirty one farmers (24 males and 7 females) who had willingness to accept and disseminate the technology and possess adequate land for forage production were selected in cluster form and established as 1 FREGs in collaboration with development agents of the Kebele. Fourteen trial farmers were nominated from the members for forage establishment. The technology was established on land size of 2.945 ha with all recommended agronomic practice. Training was given for 20 farmers and 3 development agents on; forage production, management and utilization practices. 8.01 t ha^{-1} biomass yields were obtained from oat-vetch mixture. Hence, the technology should be further promoted in wide scale to address feed shortage scarcity of the study area.

Keywords: Biomass yield, Cluster, Forage, Oat-vetch mixture

INTRODUCTION

In the central highlands of Ethiopia (2500-3000 meters above sea level), grasses, and cereals straw are major sources of animal feed. However, these feed resources are characterized by high fiber (>55%), low digestibility, low crude protein (<7%) contents, and poor mineral composition (Dereje et al, 2010). One way to optimize utilization of available feed resources is strategic supplementation of crop residues with plant protein sources such as leguminous forage crops, which have the potential for alleviating some of the feed shortages and nutritional deficiencies experienced in the dry season on smallholder farms (Hove et al, 2001). Oat is the most important well-adapted cereal fodder crop grown in the midland and highlands of Ethiopia mainly under rain fed conditions. Oats are important in feeding ruminant animals for their high dry matter(DM) production and low cost, are very palatable (softness), good in protein as compared to the other grains, and considered as an excellent feed for all livestock. Regarding to high feed costs of protein supplementations, legumes can be used in livestock nutrition for their high protein content and, thus, providing cost saving. Since legumes have a low DM yield, acceptable forage yield and quality and yield can obtained from mixing of oat and vetch as compared with their sole. Vetch is one of the most important improved forage legumes, which are a high nutritional quality as animal feed containing between 25.8 and 26.0% crude protein as well as an excellent source of vitamins and minerals (Getnet et al., 2014).

Intercropping of cereals and legumes is widely used in low-input agriculture because the mixture of nitrogen (N)-fixing and non-N-fixing crop species provides complementarities in the utilization of resources (Hauggaard-Nielsen et al., 2003). Intercropping cereals and legumes also significantly increased protein levels and reduced fiber concentrations (Mosebi et al., 2018).Combinations of forage produce high yields, forage quality and minerals when planted along with other legume crops (Erolet al., 2009). Previous studies have shown that intercropping of vetch withoats have a great potential for improving nutritive value and high total biomass yield of the forage as compared to sole cropping, this farming system practically protect soil from erosion, improve the nutritive (protein) and limit weed population. Association of Vetch and Oat produce 8.93 t ha^{1} and pure stand oat of produced 8.01 t ha^{1} (Nabi et al., 2019). Farmers show an enormous interest to exercise further this cheapest technology as the view of the farmers collected indicated during demonstration of this technology.

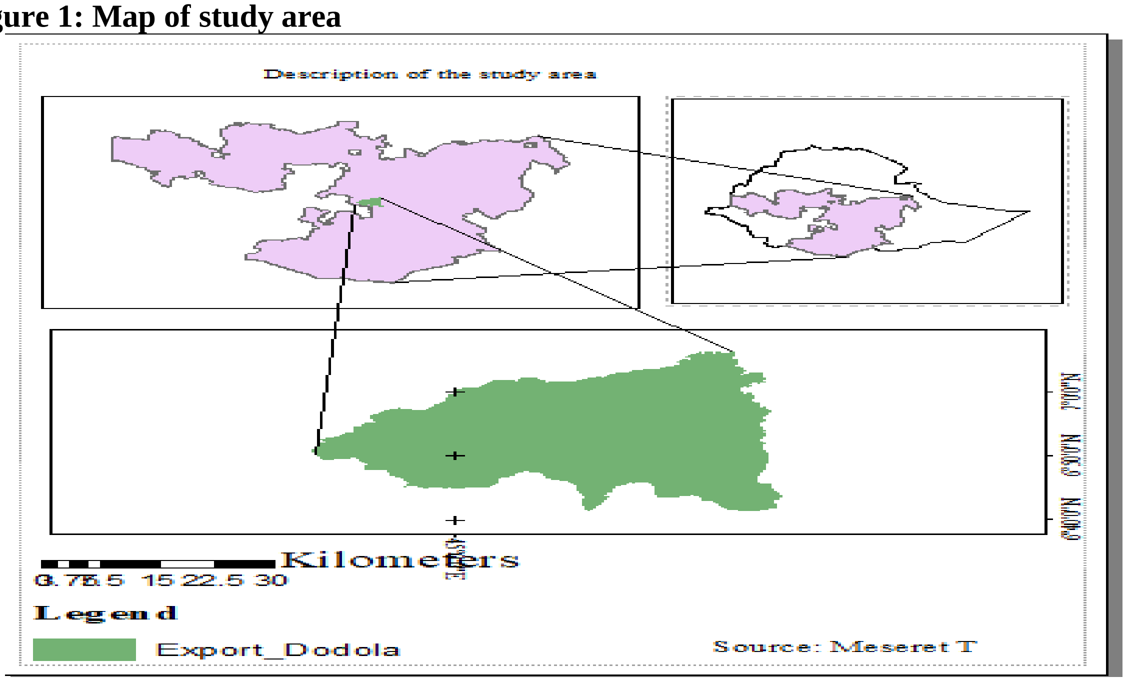
Hence, this technology is very essential for small-scale farmers to produce high quality forage with high biomass yield in cluster to solve the feed scarcity affect livestock production and productivity of the district and increase grain yield from this farmland in succeeding cropping year. The objectives of this study were to evaluate cluster based pre-scaling up of Oat-vetch mixture, to collect farmers' opinion on the technology, to improve farmers' knowledge and skill on oat-vetch mixture technology usage through training and to increase local capacity for future scaling-up or out of the technology.

METHODOLOGY

Description of the study sites

The study was carried out at Keta Berenda kebele of Dodola district of West Arsi Zone Oromia National Regional State at Keta Berenda kebele. Dodola is a town in southeastern Ethiopia. Located in the West Arsi Zone of the Oromia Region, this town has a latitude and longitude of 06°59′N 39°11′E, with an elevation ranging from 2362 to 2493 meters above sea level. Keta Berenda kebele is found between Dodola and Adaba districts.

Figure 1: Map of study area



Farmers Selection and FREG establishment

One livestock potential rural Kebele from Dodola district was selected with the participation of livestock expert and development agents in the district. Farmers who have **w**illingness to accept and disseminate the technology and possess adequate farmland in cluster for forage scaling up were purposely selected. Farmers Research and Extension Group (FREGs) were established in collaboration with development agents of the district.

Capacity development

On clustering approach oat- vetch mixture for quality feed production, important training was provided before and after beginning the activity. Extension events such as field visits, field days and experience sharing were also provided for farmers and other stake holders.

Developing Forage

Improved forage of Oats (Bonsa) and Vetches (Vicia vilosa) were established on farmer's field. Seed rate used was 40 kg ha^{1} for oats and 15 kg ha^{1} for vetches with spacing of 25 cm and Fertilizer (DAP) was applied at a rate of 100 kg ha^{1}.

Biomass Yield Determination

Forage sample were taken to estimate the biomass yield from the center of experimental land at dough stage for oats and at about 50% flowering for vetch. The harvested forage samples was manually chopped into small pieces using sickle and a sub-sample of 250 gm fresh weight were taken and oven dried at 65C^{o} for 72 hrs for herbage dry matter yield determination.

DM yield (t/ha) = (10 x TFW x SSDW) / (HA x SSFW) (James et al., 2008).

Where: 10 = constant for conversion of yields in kg/m^2 to tone/ ha;

TFW = total fresh weight from harvesting area (kg);

SSDW = sub-sample dry weight (g);

SSFW= sub-sample fresh weight (g).

The data collected including agronomic parameters, herbage dry matter yield, farmer's perception towards the technology, and total number of participant on the field day/training, challenges, possible solutions and opportunities of the technology were organized and summarized by excel sheet.

RESULT AND DISCUSSIONS

Farmers Research and Extension Group (FREG) establishment

As indicated in table (1), about 20 farmers (15 males and 5 females) were participated on training about cluster based oat-vetch mixtures technology for forage production. Accordingly, farmers who were willingness to accept and disseminate the technology and possess adequate farmland in cluster for forage scaling up were purposely selected and 12 farmers were established as FREGs in collaboration with development agents of the district.

Training of farmers and development agent

Training was given to all participating farmers, development agent (DA), expertise of the respective districts, stakeholders and other concerned bodies on how to produce high biomass yield and high quality forage, management practices like weeding, time of harvesting, way of curing for quality hay production, method of curing, place of conserving and feeding.

According to the opinion of trained farmers, they were appreciated to this cluster based Oat-vetch technology for quality forage production.

Table 1. Number of participant on training

Name of district	Name of kebele	Participants								Total
		Farmer		DAs		Experts		Others		
		M	F	M	F	M	F	M	F	
Dodola	Ketaberenda	15	5	2	1	1	-	8	2	34

Improved forage oat-vetch mixture was established in cluster form at farmer's field on land size of 2.945ha for quality forage production with high total biomass yield.

Table 2. Land size and input used

Number of cluster	land size (ha)	Seeds kg/ha		Fertilizer kg/ha	Number of participants	
		Vetch	Oat	DAP		
					M	F
1	2.945	15	40	100	10	2

Forage agronomic performance

Forage agronomic parameters and dry matter yield of oat-vetch mixture for fodder production collected were shown in table 3. For quality forage production by cluster based oat-vetch mixtures technology, a total of 8.01 t ha^{1} dry matter yield were produced. The current result was similar with Lithourgidis et al. (2011)that reports simultaneous cultivation of two or more species on the same physical space, presents some possible benefits including increased biomass yield (8.93 t ha^{1}) and improved forage quality and soil fertility (Nabi et al., 2019). The other agronomic parameters were indicated in the table 3.

Table 3.Agronomic performances oat-vetch mixture practices

Practices	Plant height (m)		Number of tiller/plant		Leaf to stem ratio		Dry matter yield (t/ha)
	Oat	Vetch	Oat	Vetch	Oat	Vetch	
Oat-vetch mixture	1.202	1.294	13	18	1.93	1.02	8.01

Field days

Field days is used for creating awareness about oat-vetch mixture technologies for quality forage production with better biomass yield for participants specially farmers with new interests and new concepts of what is possible after seeing what their neighbors have been able to accomplish in their line of work. This helps the participants for conducting the activity on the method of sown, time of utilization for animals, method of production, feeding methods and curing methods. Thus, a total of 45 Participants attended field day in the course of implementing the activity.

Table 4. Number of field day participants and their role

Name of district	Name of kebele	Participants								Total
		Farmer		DAs		Experts		Others		
		M	F	M	F	M	F	M	F	
Dodola	Ketaberenda	27	4	2	1	1	-	8	2	45

Participants' feedback

All participants were interested on the performance of the technology for solving feed shortage which affects livestock production and productivity. Draft power animal (oxen) are mostly affected at the time of cropland cultivation due scarcity of feed. This problem was solved if this quality forage was established and prepared as hay.

Lessons Learned

Development of grass and legume mixed is one of the recognized strategies to enhance the feed resource development in quality and quantity. Integration of legumes and grass forage improves forage quality and lowers the cost of production and also improve soil fertility of the farm land. Participants were learned about the importance of oat- vetch mixture, importance of clustering improved forage, method of sowing, feeding methods, curing methods, conservation methods and place of conservation. The better performance observed from oat-vetch mixed practice attracts the smallholder farmers to choose and further endorse the technology.

CONCLUSIONS AND RECOMMENDATIONS

Experiments were conducted during the growing seasons of 2019in Keta Berenda rural kebele of Dodola district on 2.945 ha. Training and experience sharing was provided for 79 participants and the technology was appreciated by participants. From oat-vetch mixture forage productions practices, 8.01 t ha^{1} biomass yields were obtained. The better performance observed from oat-vetch mixed practice attracts the smallholder farmers to choose and further endorse the technology. Hence, the technology should be further promoted in wide scale to address feed shortage escalating from time to time with dairy and fattening as a commodity in the study area. Moreover, strengthening the linkage among forage producers and other stakeholders is also paramount to address feed shortage.

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Pre-extension demonstration of feeding Fodder Oat (Avena sativa) and Vetch (Vicia sativa) to improve milk yield of crossbred dairy cows in Dodola district, Oromia, Ethiopia

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ABSTRACT

The on-farm study was conducted to demonstrate the effect of substitution of fodder oat and vetch as protein supplements on milk production of crossbred cows and evaluate the cost-benefit of feeding fodder oat and vetch on lactating cows. Ten crossbred cows (HF X Arsi), in early lactation were allocated to two diets as follows:2kg Wheat bran + 30 kg wilted fodder Oat (4kg DM) + 3.5kg Vetch hay (3 kg DM) (T1) and 4kg Wheat bran + 2kg Nougseed cake + grazing (control). Randomized Complete Block Design (RCBD) was used to conduct the experiment. According to the result, Substituting oat and vetch as protein supplement increased milk production by 29%, equivalent to 1.2Kg milk/day. Similarly, the PED work returned positive results, supporting the hypothesis of economic advantage in using oat and vetch in milk production in the area.

Key words: Fodder oat, lactating cows, PED, supplementary feed

INTRODUCTION

The low levels of livestock productivity in many smallholder farms in Africa are largely attributable to inadequate fodder of good quality (Manaye et al. 2009). In the mixed crop-livestock systems of Ethiopia, livestock feed supply is mainly dependent on crop residues, natural pastures, and other agricultural byproducts such as thinning and leaf stripping from crops such maize and sorghum, enset leaves and sweet potato vines depending upon the locality. However, both the quantity and quality of the available forage is drastically low during the dry season (Adugna et al., 2012).The use of agro-industrial by-products is very limited due to predominance of subsistence-oriented production and scattered settlement of the farmers.

To improve lactation yields, cows require access to enough nutrients (Lukuyu et al., 2012). In smallholder dairy in developing countries, feeding accounts up to 70% of the costs (Odero-Waitituh, 2017). As such, using technologies that can increase milk yields and lower production cost would be preferable. An alternative to feed supplements is to use a complementary forage crop during period of pasture shortage. In Ethiopia the demonstration and development of selected forage species into the farming system is important to solve the severe forage deficit that the country is presently facing (Alemayehu and Asefa, 2002).

Fodder oat is preferred feed of all animals and is also valuable feed for dairy cows (Ahmad et al., 2014). Oats are grown for use as grain as well as fodder. It is an important winter fodder, mostly fed as green but excess is converted into silage or hay for animal feeding during fodder deficit periods (Suttie & Reynolds, 2004). It is obvious that the farmers have to face fodder shortage problem in winter when they have only dry stalks of summer cereal fodders or dry summer grasses. In order to increase productivity per unit area, there is a need to develop promising cultivars having high forage yield potential and quality (Ahmad et al., 2014). Suitable Fodder combinations i.e. grass-legume combinations such as oats + vetch and oats + peas), commercial dairy farmers and resource poor farmers have greatly reduced the feed shortage problem and reduced the cost of feed to a great extent (Pariyar, 2005). Interest in oat hay for the dairy, feedlot industries has grown in recent years. The common vetch (Vicia sativa) is also an important legume that can be successfully grown in both mid-land and highland areas and it is noted for its ability to fix large quantities of nitrogen that is about 110 kg N per hectare. It is grown for hay, pasture, silage, seed, or as interim cover on disturbed soil. Common vetch provides palatable forage (fresh, hay and silage) and grain to livestock. It contains high levels of crude protein (Sattell et al., 1998). Therefore, this project has been initiated to improve milk yield of dairy cows through supplementing of improved forage and evaluate the profitability of feeding improved forages to lactating cows.

METHODOLOGY

Site, farmer's selection and training

The study was conducted at Ketta Berenda Kebele of Dodola district, West Arsi Zone, Oromia National Regional State, Southeastern Ethiopia. A total of 10 farmers, out of which 5 are female headed households, who own a crossbred cow in early to mid-lactationand willing to cooperate with data collection from their cows were selected to demonstrate and evaluate the feeding trial. The study was also linked to the Farmers Research Extension Group (FREG) which was formerly established and supplied with ten improved heifers by Adami Tulu Agricultural Research Center (ATARC) through the support of the Agricultural Growth Programme (AGP-II).

Capacity Building

After farmers selection, training was given to farmers, DA's and district experts on forage development strategies, management and utilization of the forages theoretically and practically, on field and at farmer training center.

Production of Oat and Vetch for feeding trial

Oats–vetch hay was obtained by intercropping oats (Avena sativa) and vetch (Vicia sativa), mixed in a ratio of 3:1 by weight and planted at a seed rate of 100 kg/ha. The mixture was harvested at milk stage of oats grain, which coincided with 50% flowering stage of vetch in the mixture. The materials were left in the field for 1 day to dry and were turned over once in a midday. After a day, the wilted materials were heaped into small bunches in the field for feeding.

Experimental animal management and feeding protocol

Prior to the commencement of the experiment, a total of 10 crossbred cows (Bos taurus and Bos in-dicus) on mid to late lactation stages were selected from farmers herd. The animals were divided into two equal groups (5 cows in each groups) based on the level of milk yield, parity, body weight and condition. Cows were hand milked twice daily, and on each milking time calves were allowed to suckle a quarter of teat after milking.

The feeds were evaluated through feeding trials having two treatments which compare feeds supplemented with quality forages consisting of:

- Treatment 1 (T1).2kg Wheat bran + 30 kg wilted fodder Oat (4kg DM) + 3.5kg Vetch hay (3 kg DM)
- Treatment 2 (T2). 4kg Wheat bran + 2kg Noug seed cake + grazing (control).

The rations were formulated in such a way that the formulated ration was assumed to fully meet the requirement for major nutrients of target animals as described in NRC, 2001. Furthermore, adjustment of the supplemental feed was made weekly based on the milk yield of each cow at the rate of 0.5kg/kg of milk production/day.

Data collection

Starting December 2019, data was collected on milk production and body weight measurement for 105 days. One development agent (DA) was assigned to collect data from the selected 10 farms on a daily basis. Amounts of morning and evening milk produced (kg) were recorded. Amount of feeds fed to the cows was quantified where possible with a spring balance and recorded.

Data analysis

Feed intake and milk yield were subjected to analysis of variance using the General Linear Model Procedure of SAS (SAS, 2008). Significant treatment means were separated using Tukey's HSD. The economic evaluation was based on calculations of the total cost of supplemental concentrate and the basal diet. The milk price was fixed, based on the local market price in the study area, which was 25 ETB/liter. The price for the concentrate, wheat straw and milk were obtained from the local market price. To come to the final conclusion of economic analysis, calculation of partial budget analysis was done. This step includes calculation of total cost of production/cow/day, mean milk yield/cow/day, price of milk/cow/day, cost of production/liter of milk and return/cow/day. Return was calculated as the product of mean milk yield/cow/day and price of milk/cow/day. Net return was calculated as the difference of return/cow/day and the cost of production/cow/day.

RESULTS AND DISCUSSIONS

Feed intake and milk yield

There was significant difference ($P<0.001$) between treatments (T1 and T2) in daily total dry matter intake (Table 1). Intake of feed by dairy cows can be improved through quality forage supplementation (Solomon et al., 2018).Addition of CP supplement also stimulate efficient rumen fermentation, more passage rate and intake(Beigh et al., 2017). This implies the presence of direct relationship between CP content of feeds and feed intake. Previous report (Tekeba et al., 2013) showed improvement in the daily total DM intake due to supplementation. This may be attributed to the ability of the supplements to provide nitrogen and energy for the cellulolytic microbes upon degradation in the rumen and increases the nitrogen content of the total diet, which in turn is likely to increase feed intake and the rate of degradation of the basal diet in the rumen (Ranjhan 1997).When the rate of breakdown of digest increases, feed intake is accordingly increased (Van Soest, 1982).

Table 1. Effect of intervention diet on daily feed intake and milk yield (Mean ±SE)

Independent variables	Dependent variables		
	TDMI (kg)	Daily milk yield (Liter)	
		Before feeding	After feeding
Treatment 1	9.0 ± 0.74^{a}	4.3 ± 0.25	5.3 ± 1.2^{a}
Treatment 2	6.5 ± 0.36^{b}	4.2 ± 0.36	4.1 ± 0.55^{b}
SL	***	ns	***

[ab] Means in the same column sharing different letters of superscripts are significantly different ($P<0.001$); SE=standard error; TDMI= total dry matter intake, SL = significance level, *** = $P<0.001$, ns= non-significant

Daily milk yield of dairy cows after and before feeding with improved forages are indicated in Table 1. Dairy cows supplemented with fodder oat and vetch mixture had highly significant difference ($P<0.001$) compared to non-supplemented cows. Dairy cows supplemented with forages had increased milk yield of 1.2 litters/day compared to non-supplemented cows. Dairy cows supplemented with mixture of oat/vetch showed increasing trend in milk yield than the control group. In Ethiopia, crossbred cows fed on oats/vetch diet produced on average 1.4kg/day more milk than those fed grass hay diet only (Solomon et al., 2018).

Economic evaluation of treatment feeds

The cost-benefit analysis of this study is indicated in Table 2. The cost-benefit analysis was based on calculations of the total cost of forage production, concentrate feeds, the basal diet and labor costs. The supplementation of ration formulated from different feed in the study area proved to be economically beneficial (Table 2). Feeding both rations to lactating cows increased net profit to dairy producers while supplementing T2 to lactating cows appeared more cost effective since it had a numerically lower cost/liter of milk and high net return.

Table 2. Cost benefit evaluation of feeding rations formulated from oat-vetch and concentrate feeds for lactating crossbred dairy cows

Variables	Treatment 1	Treatment 2
Total revenue from sale of milk ETB	13912.5	10762.5
Costs		
Seeds ETB	750	-
Fertilizer ETB	150	-
Cost of wheat bran, ETB	1470	2940
Cost of nougseed cake	-	5040
Cost of land for forage production/0.25ha ETB	2000	-
Cost of grazing land ETB	-	700
Labor cost ETB	300	-
Total variable cost, ETB	4670	8680
Cost/cow/day ETB	44.47	82.66
Net return/cow/day, ETB	88.02	19.83
Net return over T2/cow/day, ETB	68.19	-

ETB = Ethiopian birr (1 USD = 35.2 ETB)

CONCLUSION AND RECOMMENDATIONS

In conclusion, our results show feeding improved forages has the potential to increase milk production and daily income for smallholder farmers. Cost-benefit analysis also indicated that improved forage-based feeding is more profitable than noug seed cake-based protein sources. Awareness creation is vital coupled with strengthening the forage seed systems.

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Participatory Evaluation and Selection of Bracharia Grass Cultivars for Forage Production in Kofale District of West Arsi Zone, Ethiopia

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ABSTRACT

The experiment was conducted with the objective of identifying and selecting Brachiaria grass cultivars with high forage dry matter yield and recommend the best performing ones for smallholder farmers. It was conducted at Farmers Training Center (FTC) of Hulabera rural kebele of Kofale district of West Arsi Zone under rain fed conditions in 2019. Farmers Research Extension group (FREG) that comprises 20 members (15 male and 5 female) was organized. Training on improved forage production and utilization system was given for farmers and development agents. The experiment was arranged in Randomized Complete Block Design (RCBD) with three replications using three Bracharia grass cultivars. Prior to harvesting the grass cultivars, FREG members were participated on variety evaluation and selection. Farmers determined their own selection criteria. All relevant agronomic and yield data including plant height, number of tiller per plant and biomass yield were collected and analyzed. The results of agronomic and biomass yield of the grass cultivars indicated a significant ($p<0.05$) differences among the cultivars with respect to the plant height, number of tiller per plant and biomass yield. Maximum plant height (68.23cm), number of tiller per plant (178.36) and biomass yield (1.43 t ha^{-1}) were recorded from Mulato-II. The highest biomass yield of Mulato-II as compared to the other cultivars could be due to the highest number of tiller per plant, which contributes to biomass yield. Variations in biomass yield among the tested cultivars could be due to the differences in growth rate and growth habit, which were mediated through the genotypic and phenotypic differences. According to the farmer's evaluation criteria, Mulato-II scored the highest average point and selected as first mainly due to its better performance in coverage, uniformity, tillering ability, and biomass yield as compared to the other cultivars. Therefore, this cultivar was selected as superior grass due to its better performance and hence, it is recommended for further demonstration and promotion in Kofele districts and areas with similar agro-ecologies.

Key words: Biomass yield, Bracharia, cultivars

INTRODUCTION

Ethiopia is endowed with the largest livestock population ranking 1st in Africa and 10th in the world. This could enable the country to gain from the growing global markets for livestock products if production and productivity is improved (CSA, 2013). The estimate of livestock population in the country stands at about 59.5 million cattle, 30.70 million sheep, 30.20 million goats, 2.16 million horses, 8.44 million donkey, 0.41 million mule, 1.21 million camels, 56.53 million poultry and 5.92 million beehives (CSA, 2017). Despite high livestock population and the existing favorable environmental conditions, the current livestock contribution is below its potential due to various reasons associated with a number of complex and inter-related factors such as feed shortage, disease, and drought (Yadessa et al., 2016; Abule, 2015; Berhanu, 2009). According to Gelayenew et al. (2016) and Ulfina et al. (2013), seasonal feed shortage and inefficient utilization have been identified as the major problems affecting livestock production and productivity. This creates a challenge to provide the ruminant with good quality forages over extended periods and often animals have to cope with poor quality feeds (Sampaio et al., 2010).

One approach of alleviating the feed problem is the identification and development of forage grass species suitable for the existing climatic condition. Production of good quality fodder is of a great importance for the economical ruminant production. Both quality and quantity of fodder are influenced by plant species (Kaiser and Piltz, 2002), stage of growth (Ghanbari and Lee, 2003) and agronomic practices (Ghanbari and Lee, 2003, Rehman and Khan, 2003). In the study area, livestock feed is based on natural pastures, fallow and stubble grazing and crop residues which are poor in quantity and quality. Thus, the existing feed resources do not meet the nutrient requirements for growth and reproduction of animals. Hence, evaluation and selection of improved forage species like Bracharia grass cultivars with high herbage yield and adaptability to the areas are very important in tackling feed shortage through cultivating such improved forage species and then rehabilitating degraded natural pasture/grazing lands.

Brachiaria is a perennial forage grass of high forage yield potential and adaptability to different agro-ecologies. It also produces more dry matter yield than most tropical grasses during the dry season and has been widely used as quality pastures for animal production and for grazing land improvement. This grass is very important because of its high productivity under intensive use, its tolerance to low fertility, relative freedom from pests and disease and in remaining green long into the dry season. Brachiaria species produce high yields, show excellent response to fertilizer, and are persistent. Data on nutritive value indicate that forage from Brachiaria is highly palatable to stock, leading to high intake, whether fed fresh or grazed in situ (Ndikumana and Leeuw de, 1996). There is a considerable literature showing that Brachiaria species can give high yields of forage under good climate and management. Yields range between 5 and 36 t DM/ha/year depending on soil fertility, moisture and fertilizer application (Bogdan, 1977). Studies also indicated that animals which consume Brachiaria grass produce higher yields of milk and their manure emits smaller amounts of nitrous oxide. The deep-rooted, productive Brachiaria grasses can capture atmospheric carbon on a scale similar to that of tropical forests thus having a further advantage in mitigation of climate change Regardless of the importance of this grass, widely adaptable and high yielding cultivars have not been identified for forage production in the study areas. Hence, the experiment was conducted to evaluate and select Brach aria grass cultivars for high dry matter yield under the farmer management conditions and recommend the best performing ones for smallholder farmers in the area.

MATERIALS AND METHODS

Site and farmers selection

The experiment was conducted at Hulabera rural kebele of Kofale district of west Arsi Zone under rain fed conditions. Kofale districts is located at 280 km south of Addis Ababa and located at 7° 19'N to 7° 40'N and 38° 30'E to 38° 53'E.The area is about 1187 km^2 with a mean monthly rainfall of 102.6mml. The mean monthly minimum and maximum temperatures are about 5.40C^o and 19.80C^o, respectively (Umer Seid et al., 2015).The experimental site was selected in collaboration with district office experts as well as development agents. Livestock potential and feed shortage were considered as criteria for selection of the kebele. From selected rural kebele, a farmers' group, which comprises 20 members (15 male and 5 female) was selected, and organized as a farmers' research and extension group (FREG).

Farmers training

Prior to conducting the experiment, training on improved forage production and utilization system was organized for the farmers and development agents. The training was focused on routine activities in improved forage production including site selection, land preparation, forage establishment, forage management, harvesting and feeding to animals. Relevant information on Bracharia grass production and utilization system was also given for the participants. Farmers also raised questions regarding on the production, utilization and advantage of improved forage in general and Bracharia grass in particular and responses were given accordingly. Challenges and opportunities of improved forage production were raised, and discussed with the farmers group.

Experimental procedure

The trial was established at FTC using three Bracharia grass cultivars collected from Bako and Melkasa Agricultural Research Centers. The Bracharia cultivars were Brachiaria decambus, Mulato-I(Brachiaria brizantha x Brachiaria ruziziensis) and Mulato-II(Brachiaria ruziziensis x Brachiaria decumbens x Brachiaria brizantha). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The grasses were established by splitting on plot size of 5m*3 m with spacing between plots and rows of 1.5m and 50cm respectively. All other cultural practices including weeding was kept at normal and uniform for all plots.

Forage evaluation and selection

Prior to the harvesting, all Farmers Research and Extension Group (FREG) members carried out participatory variety evaluation and selection. Farmers determined their own selection criteria. Accordingly farmers considered plot coverage and uniformity, tillering ability of the grass, plant height, biomass yield, tolerance to disease/ frost, regenerating/re-growth ability and greenness and leafiness of the grasses, as their evaluation and selection criteria.

Data collection and analysis

All relevant agronomic and yield data including plant height, number of tiller per plant and biomass yield were collected. Three plants were randomly selected from each plot and plant height was measured from the base of the plant to the flag leaf. The mean plant height was then calculated. Number of tiller per plant was determined by direct counting of the tillers from three plants that were randomly selected and the average was taken. Forage biomass yield was estimated by harvesting the forage at 50% flowering stage. Plants in the middle row of the plots were harvested and weighed immediately to obtain fresh yield. The harvested forage samples were manually chopped into small pieces using sickle and a sub-sample of 300 gm fresh weight were taken and oven dried at 65C^o for 72 hrs for determination of herbage dry matter yield. Forage DM yield (t/ha) was obtained by using Jameset al. (2008) formula which is DM yield (t/ha) = (10 x TFW x SSDW)/ (HA x SSFW). Where; 10 = constant for conversion of yields in kg/m^2 to tone/ ha, TFW = total fresh weight from harvesting area (kg), SSDW = sub-sample dry weight (g), SSFW= sub-sample fresh weight (g). The collected data including agronomic parameters and biomass yield were subjected to SAS 9.0 software while data on farmers evaluation of the technology were organized and summarized by excel sheet.

RESULT AND DISCUSSIONS

Plant height, number of tiller per plant and biomass yield

The result of agronomic and biomass yield of Bracharia grass cultivars are indicated in Table 1. There were significant ($p<0.05$) differences among the cultivars with respect to the plant height, number of tiller per plant and biomass yield of the grass. Significantly maximum plant height (68.23cm), number of tiller per plant (178.36) and biomass yield (1.43t/ha) were recorded for Mulato II, followed by Mulato I, with plant height of 53.46cm, number of tiller per plant of 121.93 and biomass yield of 0.87t/ha. On the other hand, Brach aria decambus had showed the least plant height (35.86cm), number of tiller per plant (73.43) and biomass yield (0.46t/ha). Plant height and number of tillers per plant are the major factors that can influence the herbage yield of forage plants. Variations in biomass yield across the cultivars can also be attributed to the differences in growth rate and growth habit, which are mediated through the genotypic and phenotypic differences. This is a common phenomenon in grasses (Mganga K. 2009, Ogillo 2010). In this study, the highest biomass yield of Mulato II as compared to the other cultivars could be due to the highest number of tiller per plant, which contributes to biomass yield. Tiller density is an important attribute of grasses as it increases the chances of survival and amount of available forage (Laidlaw, 2005).

On the other hand, the agronomic and biomass yield results indicated that all cultivars tested recorded lower performances as compared to other studies (Mutimura and Everson 2012, Clara M. 2013). The low performance of this grass was mainly due to the water logging problem that occurred in the experimental site. Other studies also indicated that Bracharia grasses are not able to tolerate water logging (FAO, 2016). Moreover, the variation in agronomic and biomass performances could be due to the temperature, rainfall, soil type, fertilization level, and stage of harvesting (Huhtanen et al., 2006). Most of the grasses perform more at altitudes ranging from sea level up to1750 m.a.s.l. and at temperature ranges between 30-35°C (FAO, 2016).

Table 1: Agronomic and biomass yield of Bracharia grasses

Cultivars	Plant height (cm)	Number of tiller per plant	Biomass yield (t/ha)
Brachiaria decambus	35.86^{b}	73.43^{c}	0.46^{c}
Mulato-I	53.46^{a}	121.93^{b}	0.87^{b}
Mulato-II	68.23^{a}	178.36^{a}	1.43^{a}
Mean	52.52	124.57	0.92
CV	14.49	5.23	18.54
LSD (0.05)	15.21	13.03	0.34
Sig.level	**	***	**

Means with different superscripts within a column and ** in rows are significantly different ($P<0.05$)

Training

Theoretical and practical training on improved forage production and utilization in general and on Bracharia grass in particular was given for FREGs and development agents at FTCs. Accordingly a total of 20FREG member farmers (15 male and 5 female) and 2 development agents participated on the training. Practical training was given for the group at the spot (on-farm sites) during forage establishment and harvesting time. Farmers have raised their opinions and questions regarding the production and utilization system of improved forages including Bracharia grass. They were very much interested to use the improved forages and get benefits from the forages. However, they raised their worries as to from where they can get adequate planting materials/seeds.

Participatory evaluation and selection of Bracharia grass

As indicated in Table 2, farmer's research and extension groups (FREG) identified their own criteria for evaluation and selection among the Bracharia grasses.Accordingly, farmers considered plot coverage and uniformity, tillering ability, plant height, biomass yield, tolerance to disease/ frost, regenerating/re-growth ability, greenness and leafiness of the grasses as their evaluation and selection criteria. Studies conducted by Tewodros and Meseret (2013) also indicated that the major forage species selection criteria were based on its biomass yield, tillering capacity and the like.

According to the farmer's evaluation, Mulato-II scored the highest average point (4.14) and selected as first. Followed by Mulato-I with average score of 3.71 while Brach aria decambus obtained the least score for the evaluated parameters. Most of the participant farmers appreciated the performances of Mulato-II and given the highest point mainly for parameters such as coverage and uniformity, ability of tiller and tolerance to disease/frost. The performance of Brach aria decambuswas the lowest in most farmers' selection criteria including plot coverage and uniformity, tillering ability, plant height, biomass yield and tolerance to disease/ frost. The performance of Mulato-II and Mulato-I in terms of plant height and biomass yield was similar. On the other hand, all tested Bracharia grasses did not differ in regenerating/re-growth ability, their greenness, and leafiness according to the farmer's evaluation.

Consequently, Mulato-II was selected as superior grass due to its adaptability and best agronomic and yield performance in the study area. Hence, this Bracharia grass cultivar (Mulato-II) was recommended for further demonstration and promotion in Kofele districts and areas with similar agro-ecologies.

Table 2: Farmers group preference for the brachariagrasses

	Score given for Bracharia grasses (1-5)		
Selection criteria's	Brachiaria decambus	Mulato-I	Mulato-II
Coverage and uniformity	2	3	4
Tillering-ability	3	4	5
Plant height	3	4	4
Biomass yield	3	4	4
Tolerance to disease/ frost	3	3	4
Regenerating/re-growthability	4	4	4
Greenness and leafiness	4	4	4
Overall score	22	26	29
Average score	3.14	3.71	4.14
Rank	3	2	1

* Ranking of Bracharia grasses wasbased on a scale of 1-5, 1 being very poor and 5 being very good

CONCLUSION

The result of agronomic and biomass yield of Bracharia grass cultivars indicated significant ($p<0.05$) differences among the cultivars with respect to the plant height, number of tiller per plant and biomass yield of thegrass. The maximum plant height, number of tiller per plant and biomass yield were recorded from Mulato-II followed by Mulato-I. The least agronomic and yield performance were recorded from Brach aria decambus. Theoretical and practical training on improved forage production and utilization in general and on Bracharia grass in particular was given for a total of 20 member of FREG farmers (15 male and 5 female), 2 development agents. Practical training was given for the group at the spot (on-farm sites) during forage establishment and harvesting time. According to the farmer's evaluation, Mulato-II scored the highest average point and selected as the first. As compared to the performance of other cultivars, most of the participant farmers appreciated the performance of Mulato-II cultivar and given it the highest point with regard to plan coverage and uniformity, tillering ability and biomass yield.Generally, Mulato-II was selected as superior grass due to its adaptability, best agronomic and yield performance. Hence, it recommended for further demonstration and promotion in Kofele districts and areas with similar agro-ecologies.

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Economic empowerment of rural women: access to improved beekeeping technologies package through self-help grouping in walmara district, oromia region, ethiopia

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ABSTRACT

Beekeeping is an important economic activity that helps rural communities to raise additional income to improve their livelihoods though women have been excluded from the sector. However, women are conscious and interested to expand their economic activities. With this regard, the project was implemented at Wolmera, Guduru, and Ababo guduru districts to improve the livelihood of rural women through involving them in a beekeeping activity through self-help women's group. FRG based apiary site establishment for pre-existent women's self- help groups (SHG) were used as an entry point that addresses about 160 participant members with about 80% female participants. With this intervention, each group member has obtained on average about 2000-9500 ETB though 50% of the groups were saving their income in the group account. In the apiary management practices, more than 70% of the households were attained on a good level of awareness on the beekeeping management even though depending on the funding organization persisted. However, due to the investment is an asset for at least 10 years, it is important to enhance the sustainability of the group at least for 5 years. However, group financial management, business-oriented attitude, group fragmentation, internal conflict, and systematic group exclusion is a critical challenge that need focus.Generally, capacity building related to bookkeeping, queen multiplication, colony multiplication, and formalizing the existing SHG adds a flavor value to sustainability andgrowth.

Keywords: Apiary, Beekeepers, FRG, SHG

BACKGROUND AND JUSTIFICATION

In Ethiopia, women perform most of the agricultural activities. Even though they play major role, they end up receiving a fraction of the income generated. There is a discrepancy between males and females on development participation rates in rural areas of the country.

These grounds women are limited to take control of their own lives, self-reliance, gaining skills & knowledge, increasing their power to make decisions, have their voices heard, and able to negotiate and challenge societal norms and customs.Therefore, looking for somedoings,which can match with their socioeconomic circumstances, appears improved the opportunity to make use of a resource and the power to decide how a resource is used & who has access to it. Beekeeping is an important economic activity that helps rural communities to raise additional income to improve their livelihoods but it is one that women have been excluded from.InEthiopia, beekeeping has often been a male-dominated enterprise however; the activity can be done by all ages and gender. This is due to: **S**et back social perception linked to traditional practice that the activity is not convenient for women and lack of opportunity involved in the activity with the improved technology. However, with intervention from development agencies, a change in this practice can be occurred. For instance: in Kenya, modern beehives supported by ICIPE having 70% of women participants, resulted in significantly improved women's empowerment (Peter Mburu1, et al.,2015).

Women and women's groups of the study area are conscious and interested to expand their economic activities. Currently, there is four self-help group (SHG) women in Walmara district of the Oromia region. The group seeks some intervention to react in income generate activities. They can be in good positions to participate and step forward on empowering themselves on multi-dimensional development. However, their interest is on bare of technical skill on how to get a bee colony, multiply, feed, manage, harvest, process, pack, and market the product. In addition, the group has a lack of assets like equipment and input for starting the activity. So, this activity was initiated to provide a full package of beekeeping technologies to the SHG women to bring socioeconomically empowered women.

MATERIALS AND METHODS

Study area

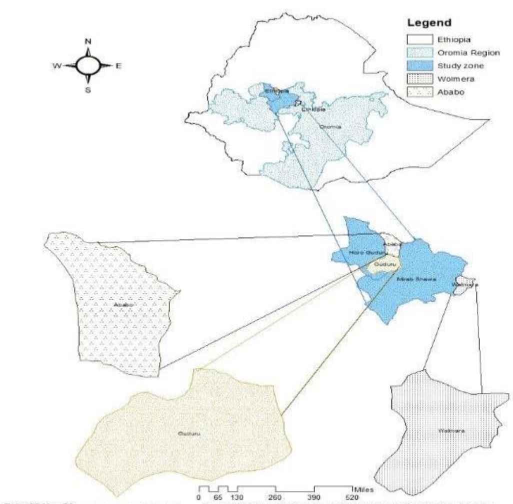

Figure 4. study area

The project was implemented at Wolmera district from Oromia Special zone, which is located at about 32km from Addis Ababa in the western direction. Additionally, the project was replicated at Ababo Guduru and Guduru districts of Horro Guduru Wollega. The zone which found 280 and 250km, respectively, in a westerndirection.

Sampling selection and approach

Group formation

In the FRG group formation, women from a similar background with a willingness to participate in the beekeeping activities were selected. In the group selection, the respective district level experts, Researchers, PA level administration unit, and PA level women affairs participated. However, at Horo Guduru Wollega, the FRG members are members of the saving association group organized by Gurmu NGO.

In the FRG organization, the focus is to enhance the participation of females with the target to enhance their income. However, to overcome the challenges in female members selection, 'multipurpose women' primary cooperatives (MPPC) were used as an entry point. This gives hope for the continuity of the project if they are provided with access to inputs and services. Cooperative members can also be members of informal groups or self-help groups (SHGs) that make no need of pushing to insert into the activity. Then, the cooperatives were provided with site/place of activity by government bodies focusing on especially for increasing women's economic empowerment and social improvement. Finally, 8 SHG are composed of largely females of which 86 and 37 were from Horo Guduru Wollega and Wolmera Woreda, respectively. In their organization, female members constitute 90% of the member whereas male constitute only 9%. Currently, 94% of the FRG members have been continued with the

FRG membership whereas other members were withdrawn due to social engagement.

Table 15. Group Size

District	PA	Colony status		Member status			
		Initial	Current		Initial		Current
				Male	Female	Total	
Wollmera	Tulu Harbu	10	8	2	8	10	7
	M/guddina	11	11	2	8	10	7
	G/kuyu	10	7	1	9	10	10
	B/Wolmer	10	6	2	8	10	8
Guduru	Gobu	18	8	0	20	20	20
	Yeroo amma tole	19	14	0	20	20	20
Ababo guduru	Ilamu malole	15	13	2	18	20	20
	Guddanne dadu	15	12	3	23	26	26
Subtotal		108	79 (73%)	12	114	126	118 (94%)

Training

Training is one of the important components of the FRG approach that helps to introduce a new way of doing things and/or to fill observed gaps in performance or undertaking some agricultural activity. In this study, training was given to FRG members on the following themes theoretically.

- Business Planning and entrepreneur skills, Introduction to Beekeeping
- Kenya Top Bar (KTB) Construction
- Establishment of the colony and follow up
- Seasonal colony management
- Bee product processing and handling and
- Honey bee diseases, enemy control, and poisoning

Generally, out of 142 training participants, 78% were female beekeepers.

Table 2. Training participants

District	Training themes	Participants					
		Youth		Elder		Experts	Total
		Male	Female	Male	Female		
Habobo Guduru	Seasonal colony management and KTBconstruction	2	15	2	27	9	55
Wolmera		3	4	2	25	4	38
Guduru		-	5	-	35	9	49
Guduru and HababoGuduru	SAMS beekeeping technology	-	10	1	29	6	46
Total participants		5	34	5	116	28	188

Moreover, the theatrical theory was also proved practically in different sub-group based.

Apiary site establishment

Good apiary site with pollen plants grow abundantly and long blooming season is important. Though it is difficult to such environment in all condition, it demands combining with skill in colony management with migratory practices in order to provide his bees with good, productive foraging environments. More generally, the important parameters in apiary selection could include presence of natural vegetation, presence of fresh water, and availability of native honeybees, good weather condition and 750m-2400m altitude. Moreover, the environment should have low exposure to disease, pests and predators, chemical poisoning and pollution. With this regard, apiary sites were selected at all FRG site based to the willingness of the FRG member with the consideration of the above parameters.

Method of data collection

The report is primarily composed of the data generated from FRG members using different checklists. Moreover, feedback during field visits and training was also used as an input for organizing the report.Additionally, a feedback collection and FGD were also conducted to evaluate their status, skill, awareness, and future sustainability as part of the input for this paper.

RESULT AND DISCUSSION

Socio-economics characteristics of the sample households

Human capital is an important resource that enables to organize other resources for efficient allocation. Particularly, in the beekeeping business labor is an important input for frequent apiary management. In a rural area, even though several skilled family labors are investing their time on agriculture is low, family members are the dominant labor sources. Hence, family size could be a blessing or swear based on the management of the household head.In this activity, FRGme mbers have on average about two males,3female swith an average of 5 family members.The age of sample households ranges 26-70 years with a mean of 43 years (Table 3).

Table 16.Family Size, Age, Education Level, And Beekeeping Experience

Number of members	N	Minimum	Maximum	Mean	Std. Error
Age	25	26	70	43.40	2.497
Beekeeping experience	25	2	22	4.92	1.146
Education level	14	4	16	8.86	.889
Total family size	26	1	10	4.58	.419
Male family size	25	1	6	2.24	.260
Female family size	25	1	6	2.60	.277

Source: Own FRG members survey, 2020

Besides beekeeping practices, the FRG members also have on average 5 cattle, 4 sheep, 4 goats, and 1 donkey. However, their land size is not adequate to feed their family-owned to production which demands interventions that need less land to enhance their income beyond their production (Table 3). Thus, beekeeping is the best option particularly to enhance their income for family expenditure. It is also unhittable that it can contribute to the food and nutrition security of the households. Before the intervention, fewer number of households had been practicing beekeeping owned to their limited beekeeping know-how with the average of 4 years' experience.

Table 17. Size of Livestock Owned

Size	N	Minimum	Maximum	Sum	Mean	Std. Er
Cattle	16	1	10	77	4.81	.770
Sheep	4	2	8	18	4.50	1.50
Goats	2	2	5	7	3.50	1.50
Equines	2	1	1	2	1.00	.00
Land size	21	0.13	7.00	24.68	1.18	.45

Source: Own survey, 2020

Return to investment

In the past two years, six FRG were harvested at least once whereas the two new FRG, Ababo Guduru, were not harvested yet. During the feedback collection, 75% of the FRG members were not yet shared their dividend owned to the hope for enhancing the financial capacity for further investment diversification. However, other FRG members were shared some parts of the revenue by saving the remaining amount for future apiary maintenance.

Generally, their revenue from the FRG was increased by 36% over year one which shows improvement in their skill in beekeeping.

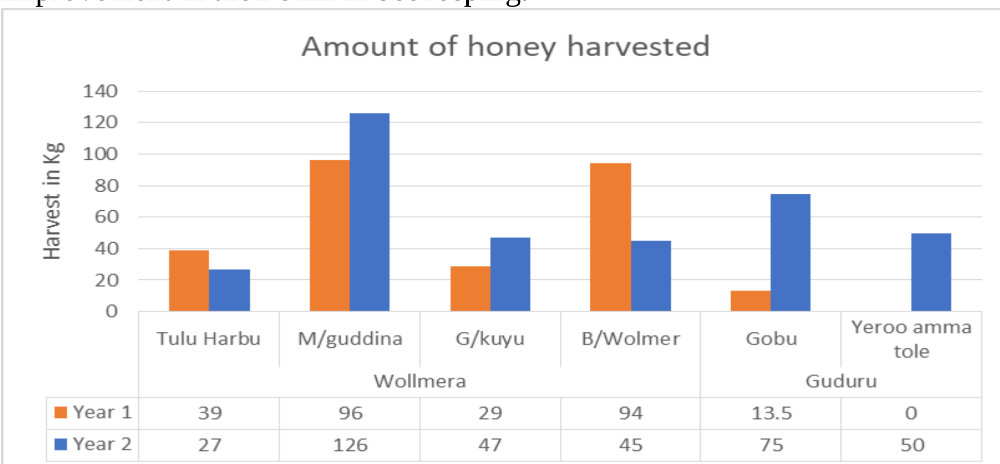

Figure 5. Revenue from FRG Beekeeping

In the past two years, FRG were harvested about 9000.00ETB to 66600.00 ETB in group and share 2,000.00-9,500.00 ETB per individual on average. Though it is not a big miracle, it is an indication for further hope.

Perception on Gender role in beekeeping

Beekeeping is generally accepted as a job of men's family members may be due to the context of the traditional beekeeping practices. However, after interventions, them embers receive an ample experience to operate the apiary site (Figure 5).

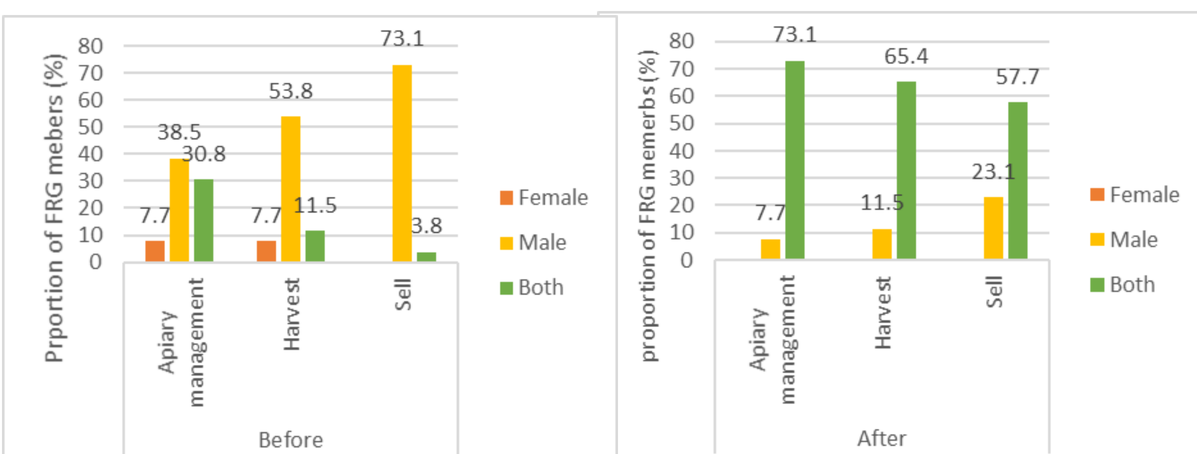

Figure 6. Perception of FRG's members on the role of gender on beekeeping activities

As a result of the interventions, the members' feedback indicates that the perception on the role of gender on beekeeping was changed totally from 55% to 14% as a sole role of male whereas the perception of both genders' job changed from 15% before intervention to 65% after intervention. This indicates that the women in FRG where acquired basic skill and knowledge on beekeeping practices.

Knowledge attained from FRG Experience

In the past operation, the FRG members have been obtained a hopeful skill and experience in beekeeping sectors beyond their expectations even though they could improve their skill through further experiences. In their experiences they were grasped ample experience on basic beekeeping operation including how to transfer bee, when to transfer bee, how to harvest, how to feed, when to feed, what to feed, the benefit of supper, the importance of beekeeping, beekeeping as a low-cost venture, and beekeeping as an easy business.

Even though still there is a knowledge gap among FRG members, the feedback indicate that their skill has changed. Even though still there is an imbalanced participation among the FRG members, on average larger proportion of the members (70%) are on a good stage to operate the beekeeping by their own.

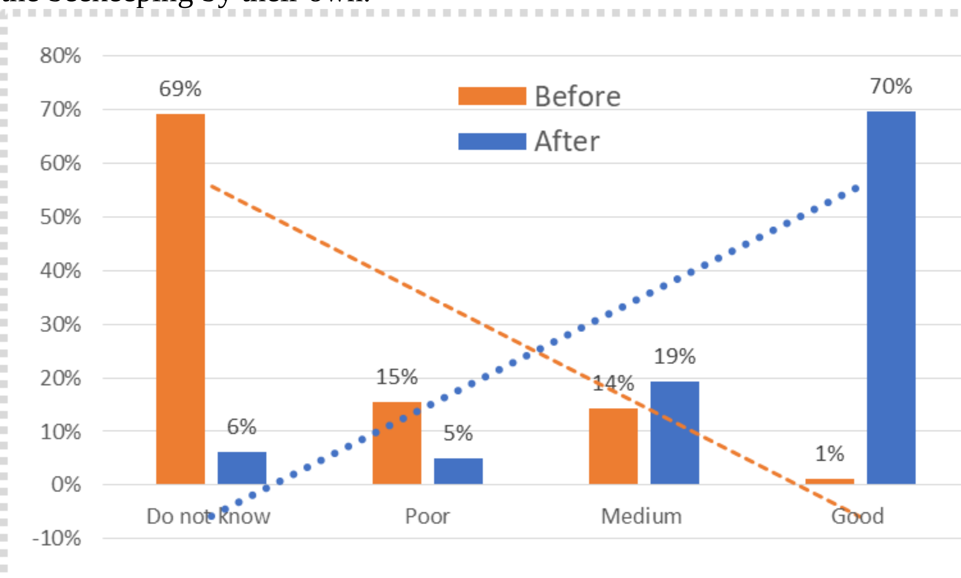

Figure 2. Skill improvement

Onaverage, the know-howofthefarmersisinareversestatebeforeandafterthetraininggivento the FRG member in beekeeping management. Before the training, a larger percentage of the members are hardly aware of the beekeeping practices where only about 15% have relative knowledge of the sectors.Reversely,after training less than11% of them embers have little knowledge about beekeeping sectors, which shows the relative impacts of the interventions (Figure2).

Lesson learned

Leadership

Leadership is an important factor that determines the unity, success, and sustainability of the FRG group as a beekeeping business. However, though 81% of the FRG members reported that members elected the FRG leaders, about 46% have a reservation on the regular election of the leaders, which could lead to corruption and conflict among the members. However, in their monthly meeting, in most cases, they have a minute on their major decision, rules, and group by law, which they were, agreed (81%) on. However, thegroupby-law is hardly enforced even though around 58% of the members were aware of their group bylaw.

Table 18. Leadership

Leadership factors	Yes		No	
	N	%	N	%
Elected positions	21	80.8		
Regular elections	14	53.8	7	26.9
Decisions documented	21	80.8		
Rules clear and agreed	21	80.8		
Rules enforced	13	50.0	8	30.8
Written constitution	15	57.7		

Similarly, even though 65% of the reported as they have a clear goal, it is difficult to conclude that they have a clear goal due to their educational background, business skill,and poor management skill. Moreover, the financial management system was hanged on the income generated from group saving and bee-product selling at a time of harvest. As a result, they have no savings and credit schemes to enhance the income of the group from credit interest.

Table 19. Financial Management

Group coalition	Yes		No	
	N	%	N	%
Clear business goals	17	65.4	4	15.4
Trust established	15	57.7	6	23
Cred and saving Scheme established	5	19.2	16	61.5
Support individual production	14	53.8	4	15.4
Anticipation for sustainability	21	80.8	5	19.2
Enhance Saving culture	21	80.8		
Own group account	15	57.7	5	19.2
Financial management transparency	19	73.1	2	7.7
Financial records in order	21	80.8		
Savings generated	21	80.8		

Even though 60% of ¾ of the FRG members have reported as they have an account, the trust in the financial management is very low due to poor reporting culture. However, the financial transparency on the withdrawal of finance from the saving, the reporting habit is not common which raises the question of trust of the group on the leaders.

A marvelous lesson derived from this experience could be in FRG group establishment, it is important to include lesson on group management, group saving, financial management scheme and leadership practice to their level of capacity. Otherwise, a sort of conflict, doubt and group breakage would be occurred.

FRG Group Self-Reliance

Building sustainable groups take time though some indicators to measure their progress could be used (CRS and MEAS. 2015). These include:

- The regularity of group meetings and level of member attendance
- Shared leadership and member participation in group decision making
- Continuous growth in group savings
- Increasing re-investment
- Group problem-solving.
- Effective links with development services

Accordingly, about 69% of the FRG member were selected by their interest whereas about 65% have a similar background. However, the unity of purposes with a strong sense of ownership of the beekeeping is also viewed among the members.

Table 20. Members' Relationship

Relationship variable	Yes		No	
	N	**%**	**N**	**%**
Self-selected	18	69.2	3	11.5
Similar backgrounds	17	65.4	4	15.4
Strong unity of purpose	19	73.1	2	7.7
Strong sense of ownership	20	76.9	1	3.8
Regular meetings	21	80.8		
Clear understanding of relationship	17	65.4	4	15.4
Members evaluate performance	**16**	**61.5**	**5**	**19.2**

Saving culture

Saving is all about the future, about anticipating and preparing for possible risks and emergencies, preparing for upcoming events, expenditure, or starting a new business or expanding an existing one (FAO, 2002). In this intervention, even though the FRG members have various cultures of traditional saving such as Idris, Iqqub, and Mahiber, the formal saving practice in the official financial institute is very limited and fragmented to the individual basis.

However, beside the beekeeping business the project also assisted them to practice saving as a group and individually. From sample of FRG members, eventhough individual saving is limited, the group saving outweighs the members saving.

Table 21. Amount of Saving

Saving culture	N	Minimum	Maximum	Mean	Std. Error
Effective months	20	12.00	24.00	19.25	0.99
Members' contribution	20	1470.00	5000.00	2866.75	233.43
Saving from Sale	20	900.00	16000.00	7762.50	1257.00

The beekeeping tools are a costly material with long service life that has been demonstrated to the farmers using FRG as a model. However, this has been raised a conflict of interest among group members which even surpasses the social disturbance in the community. Thus, group size, mode of demonstration and create a transparent rule of law after a project phaseout as a learning ground for further operation. Otherwise, the conflict among the group members can be a further cause for affecting along historical relationship among neighbors that further affects the demands for the technologies in the area. Thus, this lesson provides caution on costly technology demonstration. Similarly, stakeholders are an important ingredient in attaining the expected outcome. Particularly, back-pro linkage with other stakeholders such as input suppliers, technical followers, financial institutes, and outputreceivers may ensure the sustainability of the group.

Finally, beekeeping technology is long-term productive materials that can provide in come to the group. However, the futurity of the groups is dimly targeted to create sustainable beekeepers with enriched technology. Thus, a lack of tie-up of the group with future business stunted the beekeeping sectors relative to the technology demonstration.

CONCLUSION AND RECOMMENDATION

Women perform most of the agricultural activities in Ethiopia even though their control over resources is limited. However, beekeeping is an economic activity that women have been excluded from due to set back in social perception linked to traditional perception that it is not convenient for women. Owned to these discrepancies, this activity was working with women organized into eight (8) self-helping group (SHG) in three districts of the Oromia region with the objectives of improving the livelihood of rural women through involving them in beekeeping activity. In order to enhance their awareness and skill on beekeeping, the training theme includes both practical and theoretical on business planning, beekeeping, KTB Construction, apiary establishment and inspection, seasonal colony management, bee product handling, and apiary protection from the enemy were delivered. Along a line, the intervention was directly addressed 126 members FRG self-help groups from which 91% are female. Currently, from these FRG members, only 6% of the members were dropout due to different internal conflicts, poor commitment to group work, and social problems such as death and marriage. Even though the honey harvesting was not adequate to dramatically shift the livelihood of the women, the members were shared obtained from 2000-9500ETB in the past two years even though the honey harvest was not satisfactory as compared to recommendation on the ground. Besides the financial reward, the members have been also adapted to saving culture and beekeeping management for better in come. However, the critical challenge of beekeeping technology demonstration causes conflict among the FRG members even to the level of disturbing their social unity. Thus, in long-life technology demonstration, such as beehive, optimal group size, mode of demonstration and effective ways of demonstration remains a research gap. Moreover, to overcome the conflict among groups, it needsto device better strategies that need to be addressed also. Moreover, in technology demonstration, particularly, with technology that generates income must supported with adequate bookkeeping skill to create financial transparency among the groups.Additionally, it is important to enhance the sustainability of the group for honey production that will have a significant effect on their economies of scale.

REFERENCE

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FAO, 2002. The group savings resource book: A practical guide to help groups mobilize and manage their savings, Rome, Italy.

Appendix

Annex 1. Material Distributed

District	PA	Hives with super	Vielle	Glove	Tuta	Smoker	Bee brush	Fork	Queen excluder	Chisel	Queen catcher	Sprayer	sieve	honey extractor	Honey container
Welmera	Tulu Harbu	10	6	5	3	2	2			1	2	1			1
	M/guddina	10	4	5	4	2	2	2		1	2	1	1	1	1
	G/kuyu	10	5	5	3	2	2			1	2	1			1
	B/Wolmera	10	4	5	3	2	2			1	2	1			1
Guduru	Gobu	19	2	2	2	1	2	2		1			1	1	2
	Yeroo amma tole	18	2	2	2	1	2	2		1			1		2
H/Guduru	Gudane Dadu	15	4	4	4	2	2	2					1	1	
	Ilamu Malole	15	4	4	4	2	2	2					1	1	
		107	31	32	25	14	16	10	0	6	8	4	5	4	8

Annex 3. Lists of FRG members in Wolmera District

	Maddi Guddina kebele			Galgal kuyu Kebele		
No.	Name	Sex	Role/Position	Name	Sex	Role/Position
1.	Warqiye Shumiyye	Female	Group leader	Hirphe Gonfa	Female	Group leader
2.	Hirut Ummata	Female	Secretary	Jamanesh Abbaba	Female	Secretary
3.	Aselefech Tezera	Female	Cashier	Burtukan Mikael	Female	Cashier
4.	Genet Yimar	Female	Member	Alemitu Gudato	Female	Member
5.	Fantu Takle	Female	Member	Lomi Bangaa	Female	Member
6.	Tsige Mamo	Female	Member	Lalise Abarra	Female	Member
7.	Alem Tadesse	Female	Member	Yisma Naannessaa	Female	Member
8.	Sintayehu Kajela	Male	Member	Dharra Lamma	Female	Member
9.	Zewdinesh Mamo	Female	Member	Alemi Chala	Female	Member
	Burqa walmara kebele			Tulu harbu kebele		
1.	Baqalu Balcha	Female	Group leader	Alemtsehay Takalign	Female	Group leader
2.	Lotorii Baayisaa	Female	Secretary	Bekele Indalew	Male	Secretary
3.	Baqalech Dibaba	Female	Cashier	Mesgebu Lema	Male	Member
4.	Ababo Milkecha	Female	Member	Darge Dabale	Female	Member
5.	Wubitu Tefera	Female	Member	Aselefachi Tsegaye	Female	Member
6.	Admasu Manguday	Male	Member	Alemnesh Tsegaye	Female	Member
7.	Ababo Baqale	Female	Member	Sintayehu Magado	Female	Member
8.	Sisay Manguday	Female	Member			

Annex 7. List of FRG members in Hababoo Guduruu district, Dadu Guddanne PA

	Dadu Guddanne kebele			**Ilamu malole kebele**		
No.	Name	Sex	Role/Position	Name	Sex	Role/Position
1.	Ambaru Dhabasa	Female	Group leader	Badhassa Dasalegn	Male	Group leader
2.	Admasu Bekele	Male	Secretary	Hafte Nafabasa	Male	Secretary
3.	Sicale Tolowaq	Female	Cashier	Misgane Baca	Female	Cashier
4.	Badhassa waqgari	Male	Member	Gennet Takele	Female	Member
5.	Dombe Nuguse	Female	Member	Gobe Gadisa	Female	Member
6.	Gode Kabbe	Female	Member	Baje Nafbasi	Female	Member
7.	Marartu Shambel	Female	Member	Aregash Lami	Female	Member
8.	Rose Guta	Female	Member	Daksisee Alemayehu	Female	Member
9.	Lome Baqana	Female	Member	Asagane Abdisa	Female	Member
10.	Tolashi Warqu	Female	Member	Zenebu Gutama	Female	Member
11.	Tolani Mirkana	Female	Member	Gudaye Yadata	Female	Member
12.	Tolani Dhaba	Female	Member	Gonfe Gurmesa	Female	Member
13.	Gode Dhaba	Female	Member	Alemitu Jabesa	Female	Member
14.	Birqi Beyena	Female	Member	Necho Benya	Female	Member
15.	Balanesh Ali	Female	Member	Sukare Nugari	Female	Member
16.	Rude Taressa	Female	Member	Kebebush Kebeda	Female	Member
17.	Gonfe Misgana	Female	Member	Likitu Lema	Female	Member
18.	Dessistu Dejene	Female	Member	Fire Desisa	Female	Member
19.	Waqitefe Liki	Female	Member	Batu Tadasa	Female	Member
20.	Buze Biyansa	Female	Member	Kuli Camada	Female	Member
				Alemitu Gechoo	Female	Member
				Gode Nagasa	Female	Member
				Gizeshe Dhaba	Female	Member
				Marartu Marga	Female	Member
				Tarike Maqaa	Female	Member
				Badhasa Camada	**Male**	**Member**

Annex 8. List of FRG members in Guduruu District, Gobbuu PA

	Gobu			Yeroon amma tole		
No.	Name	Sex	Role/Position	Name	Sex	Role/Position
1.	Damitu Raggasa	Female	Group leader	Shibire Bayisa	Female	Group leader
2.	Tamanuu Madana	Female	Secretary	Giditu Fuxe	Female	Secretary
3.	Shashee Nigatu	Female	Cashier	Alemitu Gala	Female	Cashier
4.	Dharra Goja'a	Female	Member	Giditu Gutata	Female	Member
5.	Martu Fedhi	Female	Member	Abelu yadata	Female	Member
6.	Burtukan Mirresa	Female	Member	Biyenshe Alemu	Female	Member
7.	Siccale Ganatii	Female	Member	Warqe malasa	Female	Member
8.	Bungule Mirressa	Female	Member	Bayise Amante	Female	Member
9.	Baaccuu Dirribaa	Female	Member	Tarike kabita	Female	Member
10.	Zannii Bultoo	Female	Member	Bashu Inkosa	Female	Member
11.	Dadhitu Tigree	Female	Member	Almaz Belay	Female	Member
12.	Akkashee Hailu	Female	Member			
13.	Shibirree Bocaa	Female	Member			
14.	Chaaltuu Tashoomee	Female	Member			
15.	Dombee Raggasaa	Female	Member			
16.	Daadhitu Waqoo	Female	Member			
17.	Suufee Bayyanaa	Female	Member			
18.	Dirribe Hangasa	Female	Member			
19.	Imbushee Fiixee	Female	Member			
20.	**Wubitu Waaggarii**	**Female**	**Member**			

Pre-extension demonstration of stingless bee keeping *(meliponiculture)* through participatory approaches

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ABSTRACT

This study was conducted in Toke kutaye and Wolmera districts of West shoa zone in 2018 & 2019. The two districts were selected purposively based on the stingless bee (meliponiculture) abundance. The objective was to evaluate and demonstrate stingless beekeeping practice (domestication) with farmers" participation. Three Farmers research & extension groups (FREG) with 10 beekeepers each (6 male and 4 female) were established at Toke kutaye and Welmera districts. Three stingless bee apiaries were selected at each FREG for stingless bee (Meliponiculture) domestication. Both practical and theoretical Training was given for 41 beekeepers, 6 Woreda experts and 3 DAs. Out of the training participants 19 were female. A total of 31 pot hives were constructed by local potteries following the appropriate design. 20 queen right stingless bee nests from Toke kutaye and 9 from Welmera agro-ecologies were collected and domesticated at each apiary site. One shade was constructed at each apiary and pot hives were constructed for all FREG members. FREG members were participated in all works (colony hunting from the forest and transferring, shade construction, feeding and other managements). The transferred colony (31 pot hives) were domesticated/persisted at all FREG site. About 620 mL of pure honey per pot per period was harvested from Toke kutaye site. FREG members and other neighboring farmers appreciate the technology particularly for honey quality, simple inspection, colony not absconded and etc. Therefore, the technology should be further promoted in stingless bee production potential areas.

Key words: Demonstration, nest, pot hives, stingless bee

BACKGROUND AND JUSTIFICATION

There are two groups of highly eusocial insects in the world. Apinae bees and Meliponinae bees. More species of both groups have been used in the beekeeping industry, apiculture and meliponiculture, owing to the specific characteristics of eusocial insects.
Stingless bees (Hymenoptera; Apidae; Meliponini) are living in tropical and subtropical regions of the world where they are abundant in species and numbers. Because of their biodiversity and co-evolved with vegetations, they are among potential pollinators in various tropical ecosystems. Stingless bees are of economic importance as key contributors in ecosystem support services vital to the survival of several forest plant species as well as crop through pollination (Richards, 1993; Roubik, 1995; Heard, 1999; Slaa et al., 2006).

Several hundred species of stingless bees assumed to exist worldwide (Michener, 2007), where about six genera comprising twenty species, are known to occur in Africa (Eardley, 2005; Pouly and Zewdu, 2013). Only the existence of 5 species is recently identified in Ethiopia using population survey and its taxonomic work of which *Meliponula beccarii* was the most frequent specimens (Pouly and Zewdu, 2013). In a few years worldwide decline/absence of bee populations and species diversity has raised global environmental and economic concerns, as pollinator loss will negatively affect global human diet and health and crop market economies, as well as the livelihood of farmers and beekeepers (e.g., Biesmeijer et al. 2006; Berenbaum et al. 2006; Potts et al. 2010, 2016).

Meliponula beccarii ("Damuu") bees live by harboring underground soil in perennial colonies composed of a few hundred to several thousand workers and utilize the resins of more than one hundred different plant species for food, nest construction, and chemical defenses (Sakagami, 1982; Wilms *et al*., 1996; Leonhardt *et al*., 2009). *M. beccarii* species are very docile and their non- stinging behavior helps for easy management and adaptation around home gardens.

The honey produced by stingless bees (*M. beccarii*) is a valuable bee product with a long consumption tradition, to which several medicinal uses are attributed. Honey produced by stingless bees is aromatic, sweet-sour in taste with a fruity tint. It contains more water (about 20-35%) and is more liquid than the honey produced by honeybees (Vit et al., 2004).In Ethiopia, honey produced by stingless bees is considered to be important in traditional treatments of wound, respiratory ailments, surface infection, diarrheal and various other diseases in line with other treatments (Andualem 2013; Lemma *et al*. 2013). As a result, stingless bee honey has been known as a product with high market demand, achieving higher prices than the honey produced by bees of the Apis genus, commercialized in different regions of Ethiopia.

Despite their ecological value and highly demanded honey, less attention has been given to these valuable bee species in Africa in general, and in Ethiopia in specific. As a result, honey harvesting system from feral colonies for example, is absolutely traditional and destructive that endangered the species diversity and reduces honey quality standard. Few attempts have been initiated meliponiculture as new opportunity for source of income generation in African countries like Ghana, Kenya, Botswana and South Africa (Laurino *et al*., 2006). It is the first successful stage that domestication and management of stingless bees in pot hives has been done at HBRC apiary site in Ethiopia.

Therefore, taking this domestication and management practices of stingless bees to the small scale farmers is very important for the production of improved honey quality, income generation and species conservation. This study was conducted to evaluate and demonstrate stingless beekeeping practice (domestication) at farmer's level, awareness creation on stingless bee keeping technologies, to produce improved honey quality/quantity for income generation, medicinal value and nutrition and to generate sustainable species conservation strategies.

MATERIALS AND METHODS

Description of Study area

The pre-extension demonstration was conducted in two districts West shoa Zone of Oromia regional state namely, Toke kutaye and Wol Mara.

Toke Kutaye district: is one of the West Shewa Zone district, is bordered on the east by the Ambo Zuria, on the north by Midakegn, on the west by Cheliya, the largest town is Guder. It is found at distance of about 137 Km away from Finfinne on the Finfinne –Nekemte main road.

Wol Mara district: Is one of Oromia special Zone surrounding Finfinne, its bordered on the South by the Sebeta Hawas , on the west by West Shewa Zone, on the north by Mulo, on the northeast by the Sululta, and on the east by the city of Addis Ababa.

Selection of target PAs and farmers

Two districts were purposively selected based on potential for stingless bees (*Meliponula beccarii*) abundance and three representative PAs, one from wolMara and two from Toke-kutaye were selected.

The activity was carried out using Farmers' Research Extension Groups (FREG) formed of small holder farmers. Experienced farmers with indigenous knowledge on nets finding and interested were selected by DA and Woreda experts. Three farmers research Extension Groups (FREGs) with 30 (6 male and 4 female at each site) were established at Toke kutaye and Wol Mara districts. The groups contain 40% women and they assign the leader and they can talk together on different issues and work in close relationship with researchers and technical assistances.

Farmers Training

Theoretical and practical training was given for FREG members, Woreda experts and DAs on stingless bee (*M. beccarii*) demonstration technology. Three apiary sites were selected from two districts of three PAs. After organization of FREG, training was provided on the stingless bee keeping (Meliponiculture) from colony hunting up to honey harvesting and finally all necessary input was delivered to the farmers from Holeta Bee research center (tin for shade construction, pots, sugar etc.) and farmers transferred colonies in their apiaries and follow ups and essential advices from respective researchers has been taken place. The training also includes the decline of stingless bees because of different factors and we save the species around home by this technology. Farmers were evaluated the demonstration apiaries three times (i.e., at transferring, feeding and honey harvesting).

Table 1: List of training participants (by gender) before demonstration. Source: Own Data, 2019

No.	**District**	**Demonstration site**	**Participants**						
			Beekeeper		Experts		DA		Total
1	Toke kutaye	Group one	Male	Female	Male	Female	Male	Female	
			9	5	1	1	1	1	18
		Group two	5	3	2	0	0	0	10
2	Wal Mara	Group one	6	4	1	1	0	1	13
Total			20	12	4	2	1	1	41

Colony transfer and establishment

After investigation, the nest of stingless bees were excavated with great care and transferred in to the new pot hives. After removing the lids, brood combs with bees and the queen were placed in the hive and covered by the lids, and then all the gaps were sealed by plasters. Accordingly, queen right colonies of the commonly available spps (*Meliponula beccarii*) were transferred to new hives with in order not to squeeze and damage the broods. A total of 31 queen right colonies were established at all apiary sites of FREGs groups. All the colonies were kept under the shades. All necessary managements such as: feeding, controlling hive temperature and protecting against the attack of enemies (pests) were regularly performed.

Method of Data Collection and Analysis

Data collection

Both qualitative data (farmers' opinions, challenges) and numeric data were collected. Number of colonies transferred to pots, shade construction, number of absconded colonies, number of colonies successful, number of farmers participated on training, farmers' opinion, honey harvested were collected during pre -extension demonstration.

Statistical analysis of data

The collected data were statistically analyzed using descriptive statistics such as percentages, mean. Some information that could not be taken through quantitative analysis was analyzed qualitatively based up on Key Informant Interview and group discussion with extension workers, and farmers.

Colony adaptation success per hive type was caculated by the following formula:

$$\textit{Colony adaptation rate} = \frac{\textit{number of colonies lived in the hive for one year}}{\textit{all the number of colonies transfered in to the hive type}} X\ 100$$

RESULTS

Stingless beekeeping production system

In honey bee keeping production system before other honey bee production system technologies adapted and demonstrated back yard honey bee production system is known under farmer's beekeepers level. Then in stingless bee keeping system no backyard or around home keeping of the colonies in the study area except, honey harvesting with destructive nest and destroying colonies was practiced. For this reason the number of nests and colonies decreased when compared with the ancient time.

Characteristics of Modern stingless bee (*Meliponula beccarii)* Pot hives

Modern stingless bee pot hives is the pot which can assist singles bee colonies. Stingless bee colonies (*Meliponula beccarii)spp* by nature live underground so this pot is made as the behavior of their nests. It provides all essential living facilities for colonies. It simple for management (inspection, cleaning in and around pot), close, open, feed the colony and cheap which was verified during demonstration evaluation.

Training

Training is an important knowledge and develops skill of farmers to adapt new practices. Therefore, in order to utilize the technology successfully, farmers, DAs and experts need training. A total of 38 target individuals were participated during training. Among them, 17 farmers, 3 DAs and 6experts were involved. Out of trained participants 12 females were involved to keep the gender balance in activity. Of the total trainers 39.4% were female and 60.5% were male farmers. The training has been given on stingless bee keeping technology (management, shade construction, colony hunting from the environment, transferring to pots, feeding colonies, inspection, and honey harvesting method) as well as its information exchange. Unless weak participation was present among them, all the beekeepers in FREG members were participated until the final work.

No.	District	Demonstration site	Participants						
			Beekeeper		Experts		DA		Total
1	Toke kutaye	Group one	Male	Female	Male	Female	Male	Female	
			6	5	1	1	1	1	15
		Group two	5	3	2	0	0	0	10
2	Wal Mara	Group one	6	4	1	1	0	1	14
Total			17	12	4	2	1	1	38

Table 1: List of training participants (by gender), after demonstration. Source: Own Data, 2019

Shade construction

Stingless bee colonies nest holes most of time found in forest. The collected bee colonies were keeping under the shade/roof / of the constructed house from the tin established by Holeta Bee Research center team. The arrangements between the pot hives under the shade were not specific. Partially the wall of the shade inters the sun light gently.

Colony Establishment and survived

FREG members and HBR team were found the nest in forest and collected the stingless bee colonies from forest to establish the initial colony to demonstrate and conserve the species. Farmers use different methods to find the bee colony in traditional way, after locating any colonies in the ground. They simply dig around the nest safely and bring the colony to the prepared pot hives. More of stingless bee colonies were survived in three apiary sites. Only some colonies were absconded. 95% and 80 % colonies were survived from Toke kutaye and wol Mara sites respectively.

Table 2: Number of stingless bee colonies transferred and survived by pot, source own data 2018&2019

Apiary	Number of colonies transferred	Number of colonies survived	Number of colonies absconded
Toke group one	10	9	1
Toke group two	11	11	0
Wal-Mara	10	8	8
Total	31	28	9

Honey Yield

Although the colony sizes of these bees are much smaller than those of the (Apis mellifera) honey bee the per-bee productivity can be quite high. Honey harvesting is done only once in a year, after the establishments of the initial colony. In stingless bee colony honey is stored in spherical pots made by "cerumen" which are distributed surrounding the brood combs. The amount of honey produced by stingless bee colony depends on the strength of colonies, and the availability of resources (flowers). We simply open the pot and collect the honey in pots by syringe without damaging the broods, but a little portion is left as the food for bees, during dearth period. From the demonstration average of 620mL of honey per pot /period was harvested at Toke kutaye. On the other hand one FREG site (wol Mara) was fallen after the stingless bee colonies was adapted in good performance and stayed for one year, due to unknown reason. All data were collected except honey yield data.

Pots	Site	Honey harvested per pot/period	
	Toke Kutaye	Ml	Average
Po 1	Group 1FREG	730	
Pot 2		400	620
Pot 3		600	
Pot 4		650	
Pot 5		716	
Pot 6		625	
Total		**3721**	

Table3: Honey yield per pot, by one season.

Pest and predator's infestation

Due to the lack of a functional stinger and characteristic nonaggressive behavior they can be reared without problems in densely populated environments, around home. Stingless bees like all other animals are attacked by various parasites, pests, predators and enemies. Different factor's Human being was one of the enemies of stingless bees as you were distractive its nest and colony when harvesting honey. After the domestication of stingless bee (*Meliponula beccarii*) in pot hives some pest and predators were reported. Wasps reported from Toke kutaye and, mice/rat/ were reported from Wol Mara site. Wasps hunted by sitting on pot cover in day the worker of stingless bees.

Participant's feedback on the technology

From stingless bee colony nest finding up to honey harvesting time FREG members suggested different feedback like: - if we transferred the colony at any time when the nest is available what problem argue against. For this idea the researchers suggested that, colony transferring only possible at active season (availability the resource) of the area.

CONCLUSIONS AND RECOMMENDATION

Domesticating and managing colonies of ground-nesting bees using artificial (pot) hives is simple, because the pot hive prepared from clay soil, so colonies obtained heat from under naturally and for this reason adapted to pot hives. The adeptness of stingless bee keeping in pot hives at farmers' level depends on the availability of the stingless bee nests in the forest, known time of the transferring from the natural nest to pot hives, strength of the colony and full package of management. It is not unexpected that the local people have somewhat important indigenous knowledge about stingless bees nesting in their local forests. Farmers hunting the nest of stingless bee in their environment and harvested honey by destructive the nest, colony and not quality honey in study area. This process declines the stingless bee species in natural environment and decreases the productive of agricultural products which pollinated by those insects. But by this technology (with pot hives) stingless bee colony species which are declined from the environment were saved and transferred to new generation, both species conservation and the advantage obtained by this bee (hive products, pollination of agricultural and other flowering plants were) survived for the future generation. Owner ship of the apiaries of the stingless bee agrees the management to obtain knowledge of the biodiversity of the area.

Demonstration of stingless bee keeping and management in pot hives was accepted at FREG members. Due to their docile colonies and safety for beekeepers and guests, they can be used in areas where stinging insects/honey bee/ are not desirable, as in green houses, cities and etc. So this technology should be more demonstrated for farmers at were this stingless bee species found in different parts of the country.

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Pre-Extension Demonstration of an Integrated Fish-Poultry-Horticulture-Forage and Cattle Fattening in Ada'a District, East Showa Zone, Oromia

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ABSTRACT

Integrated fish-poultry-horticulture-forage-cattle fattening is a method of diversified food production system for combating nutritional insecurity at small-scale farmers' level under low cost. The technology is based on the motto 'there is no waste', because waste from one component is recycled as input to the next component. Pre-extension demonstration of the integrated farm was conducted at Godino Kebele of Ada'a district between the years 2018 and 2020. The objective of the study was to demonstrate an integrated farming system of fish-poultry-horticulture-forage-fattening. One farmer research extension group (FREG) that had 16 farmers member, considering gender participation, was formed. From the FREG members, four potential farmers were selected and the technology was demonstrated on their irrigated land. Four earthen fish pond with an area of 100 m^2 each was constructed and stocked with Oreochromis niloticus for each farmer. For egg production, thirty Lohmman brown pullets breed of poultry with three months of age were purchased and stocked into the houses that suspended on the top of the pond; then the poultry litter fertilized the pond for fish and horticulture production. The chicken starts laying eggs at 20 weeks of age with the mean egg production of 79.6 percent per day. Fingerlings of the fish reached table size with an average weight of 235 grams within six months. The average yield of forages obtained from Brassica oleracea and Allium cepawere 6183 and 28,000 kg ha^-1 respectively. Forage variety of Pennisetum pedicellatum and Pennisetum purpureum were planted on the top of the dike and the dry matter yields of the forage were 9,934 and 22,233 kg ha^{-1}, respectively. Training on the importance of an integrated farming system and its management was given to the farmers before and after establishing the integrated farming system. This technology was found to be profitable and it needs further scaling up as one of the strategies that should be adopted by smallholder farmers of the country to increase farm returns from per unit area of land.

Key Words: Demonstration, Fattening, Fish, Forage, FREG, Horticulture, Integration, Poultry, Waste recycle and vegetable

INTRODUCTION

Nowadays, providing adequate food for rapidly increasing human population is one of the greatest global challenges. It is particularly acute in countries like Ethiopia where population explosion, natural and man-made calamities have further aggravated the problem. In addition to increasing food production from terrestrial agricultural ecosystem, it is necessary to sustainably exploit the aquatic ecosystems under their high productivity to contribute towards the effort of food security. Ethiopia's fish resources could undoubtedly offer one of the solutions to the problem of food shortage in the country.The ecological diversity and climatic variation of the country are to a large extent explained by its highly variable topography. These altitude extremes imply that Ethiopia is a country of enormous habitat diversity; with its different geological formations and climatic conditions, the country is endowed with considerable water resources and wetland ecosystems, including river basins, major lakes, many swamps, floodplains, and reservoirs. Hence, the water bodies support a diverse aquatic life, for example, more than 200 fish species (Redeat, 2012). However, all these potentials ended in vain contributing little to the well-being of the nation. Capture fisheries is very common practice in most parts of the country, leading to over exploitation of fish due to open access to the resources. Hence, aquaculture technology is an option that needs to be intensified to alleviate the over fishing problem.

Aquaculture is a part of agriculture, which means rearing aquatic organisms, plants, and animals that includes fish under controlled conditions. Fish culture can be integrated with livestock and crop, especially vegetables using waste out put from one as input for another, which enable them to produce organic production. Pond management with fish, poultry, and vegetables proofed to be an excellent approach for sustainable production, income generation, and employment opportunity for resource-poor rural households (Lemma, 2013). The addition of organic fertilizers like poultry litter to a fish pond increases the water nutrients for better fish production that solves the problem of fish feed faced in aquaculture by integrating poultry farms with fish.

In the integrated farming system, waste from one component is used as input in the next component. As such, waste from poultry is used to fertilize the fish pond substituting feed supplement for the fish, and improve the nutrient of the water that in turn is used as a fertilizer to irrigate the horticulture and forage production during the water exchange; and the latter is used for fattening animals.

Hence, provided the advantages of the technology, there is a need to find a suitable agricultural system to meet the increasing demand for food, and maximize the utilization of the limited resources without wastage. The objective of the activity was, therefore, to demonstrate the technology and maximize aquaculture-agriculture integration by way of synergic interactions with each other on the same piece of land.

METHODOLOGY

Description of the study area

The activity was conducted in Ada’a district, which is one of the districts found in the Esat Shoa Zone of Oromia, located in the Great Rift Valley, It is bordered in the south by Dugda Bora, in the west by the West Showa Zone, in the northwest by Akaki, in the northeast by Gimbichu, and in the east by Lume. The district has an altitude that ranges from 1500 to 2250 meters above sea level (CSA, 2005). The minimum and maximum temperatures are 13 ^{0}C and 25 ^{0}C, respectively (DZARC, 2017 unpublished data). The farming system of the district is characterized by a mixed agriculture. Irrigation is mainly practiced and the main source of the water is the “Wodecha” river.

Farmers’ group formation and selection

An integrated farming system with different commodities was conducted following a Farmer Research Extension Group (FERG) approaches. Many formal and informal discussions were conducted with the beneficiaries, development agents, and local government officials to select participant farmers, who were selected purposively based on their interest, an innovation he/she has, land provision for this pre-extension demonstration, interest in cost-sharing, willingness to share experiences with other farmers, and studying their history of participation with DAs and community leaders. In addition, various factors were considered in farmers selection. Some of these factors were attention to physical factors, including environmental conditions of the farm area (continuous source of water supply and water quality, type of soil, weather condition, etc.), adaptability of commercial fish species, different horticultural crops, beef, and poultry breeds and availability of local materials/inputs for the integration, and market accessibility.

Roles and responsibilities of participants

Each member was responsible for looking after the integrated farming system (Poultry, fish, horticulture, forage, and fattening). Batu Fish and Other Aquatic Life Research Center (BFOALRC) provided materials for poultry house construction, pond, poultry feeding troughs, medicaments, poultry feed, and technical support during the entire activity of integration.

Poultry house construction and production

A poultry house was constructed for the selected farmers from locally available materials after the fish pond was constructed. Walls of the house were built from eucalyptus timber and plastered by mud (Fig 1). The roof of the house was covered by an corrugated iron sheet. The house had two compartments: the first half with 1.5 m X 6 m area founded on the ground was used as a night time resting place for the chicken and was used as a place to lay eggs. The second half of the house with 1.5 m X 6 m area was open to air and light, hovering over part of the fish pond and used as a feeding and drinking place for the chicken during the day time. This part of the house hovering over the pond was covered by mesh wire to protect chickens from different predators.

After the house was constructed, 30 Lohman brown breed of poultry pullets with three months of age were purchased and stocked. The poultry is also used for the production of the litter as the main feed for fish in the pond and fertilizer for horticulture when the water is exchanged. Information on the volume of poultry litter per animal and the relation between fish and litter load is available in Hopkins and Cruz (1982) and was used in this study.
As a management, the chickens were fed adlib the commercial feed based on their growing phase that was purchased from an animal feed processing company at Bishoftu. Health inspection was also monitored daily throughout the activity period. The chickens started laying eggs at the age of 5 months. The eggs were collected every day, stored for sale, and used for household consumption in the family. Finally, aged hens were sold at the local market for meat.

Fish pond construction and production

Earthen pond of 100 m^2 surface area with 1.5 m depth with 3% sloppy was constructed for the farmers (Fig.2). The pond was stocked with 500 Oreochromis niloticus fingerlings with a stocking density of five specimens/m^2. The total length of the stocked fingerlings was 5 cm while the total weight was from 3 to 4 gram . The fish are grown in the pond under poultry house with the necessary managements (environmental monitoring as well as health inspection) for six months. The litter coming out from the poultry house dropped into the pond, diluted with water, and used as feed for the fish. The fish also used natural feed like phytoplankton and zooplankton from the pond. Finally, those fish that reached table size were harvested and used for home consumption and supplied to market as income generation for the farmers.

Horticulture production

Horticulture production activities were carried out a week after the fish and poultry were stocked due to the enhancement of nutrients in the pond for the production of horticulture. The horticultural crops were Gurage cabbage and (Brassica oleracea) and Adama Red Onion (Allium cepa) (Fig.3).

Procedurally the land was cleared, plowed, and then prepared for planting the horticultural crops at different phases. The total area of irrigated land was 600 m^2. The horticulture was grown by water coming out of the fishpond without adding any additional fertilizer. Management of the horticulture was done according to the recommended for each plant. Finally, the horticulture was harvested for the local market and home consumption. The remaining by-product of the plant was used as a feed for fattening animals.

Forage production and animal fattening

Desho grass (Pennisetum pedicellatum) and Elephant grass (Pennisetum purpureum) were planted around the fish pond (on the dike) for animal fattening (Fig.4). The forages were also selected based on adaption and yield performance of the area. Other managerial activities of the forages were conducted throughout the activity period for better production.

The feeds were provided adlib to the bulls from the forages that were planted on and around the dike and by-products of the horticultural crops.

Financial analysis

Simple financial analysis was employed to analyze the costs involved and the benefit gained from the integrated production used for the demonstration. In the component of the integrated farming system, those costs incurred in the construction of poultry house and fish pond, land, feeding, and watering troughs, as well as fishing gear, were fixed costs while costs incurred for the purchase of animals, feeds, labor payments, and other inputs were variable. Since small-scale farmers employ only family labor for production activities, cost of labor did not form an important variable cost. Transport costs were other variable costs, which can be quite high if the producer lives far away from the input suppliers and the market. However, this was not the case in this activity, because its proximity to the market which was Bishoftu town. While the feed is the major variable cost in pond culture alone, this was not the case in the integrated farming system as there was no supplementary feeding except for poultry.

Data analysis

Fish growth performance was expressed in terms of daily growth rate using length-weight data taken monthly during the experimental period. Data on fish, egg, horticulture, forage production, and animal fattening were analyzed using excel and presented using tables in the result part. Net benefits formula was used for financial analysis.

RESULTS AND DISCUSSIONS

Farmers and other stakeholders Training

The multidisciplinary research team (Aquaculture, fishery extension, and socio-economic) were given training for development agents, experts, and farmers on production, management, post-harvest handling, and marketing information of the integrated farming system of different commodities. The participants actively participated by sharing their experience and knowledge.

Table 1. Number of participants in the training

Trainee	Participants		
	Male	Female	Total
Farmers	13	3	16
Experts	5	1	6
Total	**18**	**4**	**22**

After FREG were formed, training was given in two components. The first component focused the importance of FREG group organization and theoretical aspects of the integration and the second training was on practical activity. Twenty-two (18 M and 4 F) participants attended the training, of which sixteen (13 M and 3 F) were farmers and six (5 M and 1 F) were exports (Table 1). From the trainees, 72.7% were farmers of which 18.8% were female (Table 1) and the balance were males. Different extension materials were prepared and distributed to the participants. During the training, different questions, opinions, and suggestions were entertained. Most farmers showed high interest in technology, because of better income generation as compare to individually practiced commodity production. Generally, all farmers were very interested for having the technology in future production. Therefore, all concerned bodies shared responsibilities for the future intervention.

At the practical training on the integrated farming system, the farmers have got knowledge of fish pond and other related components of the integrated system. The FREG members and other local farmers have learned the indoor poultry management practices for better egg production. They also learned forage production on the top of the dike for fattening using water coming from fish pond that has been enriched with poultry litter as the pond was constructed under poultry house. The water was later released to plots for horticulture production, substituting inorganic fertilizer.

Egg production

A total of 30 pullets of 90 days old were purchased from the local market and stocked which started laying eggs at the age of 20 weeks. An average egg production per hen per day was 24 eggs (79.6%). The study showed that egg-laying is not economically feasible after the chickens reach 15 months of age (Fig.7) because the production decreased due to the physiological change of chickens.

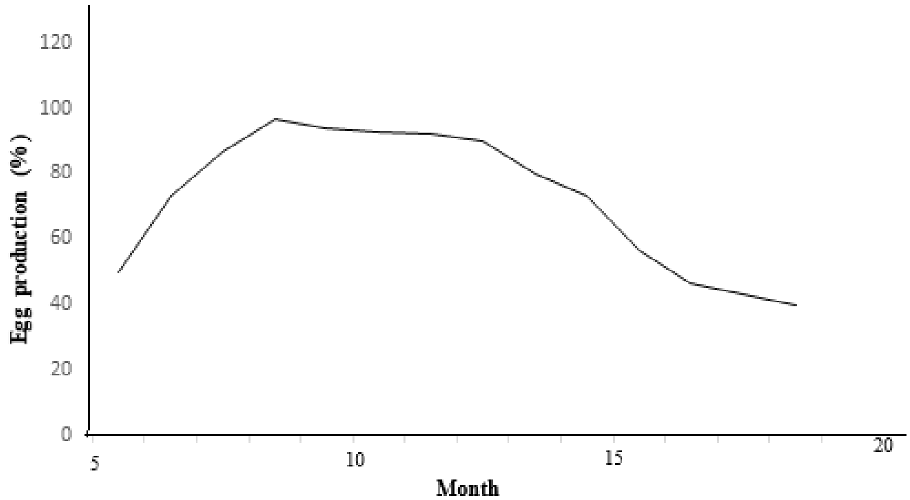

Figure 7. Trends of egg production and age of chicken

The chemical composition of the poultry litter was nutrient-rich and was used as feed for fish production in aquaculture particularly in an integrated farming system with agriculture and aquaculture. The amount of poultry litter which was dropped to the fish pond contains more nitrogen and phosphorous which are also used for the production of horticulture as layers produce more excreta (Lemma, 2013). The egg production was similar compared to earlier report (Lemma, 2019).

Fish production

In this study, fish production depended on the recycling waste in the integration without providing any supplementary feed. Initially, 500 fingerlings of O.niloticus with a total initial weight that ranged from 3 to 4 grams were stoked.The fish attained a final weight ranging from 121 to 341 grams, with an average of 235 grams within six months (Table 2 and Figure 8). The mean daily growth rate was 0.76 gram which is comparable with other reports (Lemma, 2019; Daba et al., 2017a; Megerssa et.al., 2016).

Table 2. Summary of fish growth performance

Initial weight range (in gram)	Final weight range (in gram)	Average weight (in gram)	Fish Daily Growth Rate (in gram)
3 – 4	**121-341**	**235**	**0.76**

On the other hand, the growth performance of the fish was faster than the fish culture within a pond that not integrated with different commodities. Poultry has a short digestive tract, 80% of chicken litter represents undigested feedstuffs (Chen, 1989). The litter was also used as fertilizer to promote phytoplankton and zooplankton productivity.

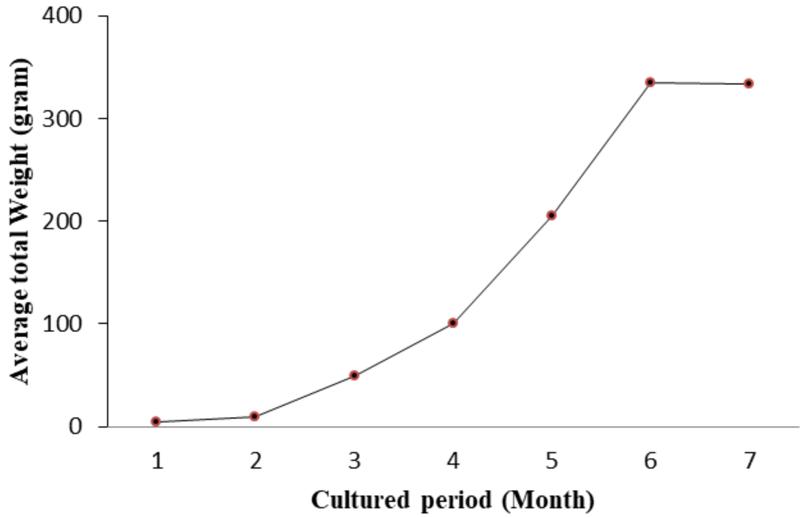

Figure 8. Average growth performance of Oreochromis niloticus

In integrated poultry-fish farming, the protein-rich chicken dropping was made available to the fish either directly or indirectly via the primary producers in the aquatic food web (Oladosu et al., 1990), which in most cases reflects the productive capacity of the ponds. It also contains non-digested feed metabolic excretory products and residues resulting in a microbial synthesis which can be utilized to replace reasonable parts of feedstuff used in conventional fish production cost.

Horticulture production

The yield obtained from B. oleracea and A. cepathat was integrated with fish were separately analyzed and changed to the yield per hectare (Table 3). Production of B. oleracea was 6183 kg per hectare (Table 3), and the production of this study was slightly higher than the previous study by Lemma (2019) who reported 5,500 kg. Even it was much higher than the other studies which reported 4,400 kg ha^{-1} (Megerssa Endabu et al, 2016) and 2,210 kg ha^{-1} (Lemma Abera, 2013). The production of onion in this activity was 28,000 kg ha^{-1} (Table 3), which was slightly lower than Daba et al., 2017b (30,000 ton ha^{-1}) at Dugda district with different different agroecolgy.

Table 3. Yield of horticulture in the study area

Type of Vegetable	Plot area (m^2)	Yield (kg)	Yield (kg ha^{-1})	Sale (Eth. Birr)
Brassica oleracea	600	371	6183	5,009
Allium cepa	600	1680	28,000	25,200

Forage and fattening activity

All forages were grown on the top of the dike with water from the fish pond. The dry matter yield of P. pedicellatum and P.purpureum were 9,934 and 22,233 kg ha^{-1}, respectively (Table 4).

Table 4. Forage yield from the dick of the pond

Type of forage	Plot area (m^2)	Yield/ from allocated area (kg)	Yield (kg ha^{-1})
Pennisetum pedicellatum	152	151	9,934
Pennisetum purpurum	40	88	22,233

In general, in Ethiopia low productivity of livestock is mainly because of poor feed quality (FAO, 2010). To combat the livestock feed shortage, the use of improved forage as a feed source is recommended. P. pedicellatum was harvested 3 months after planting when the grass reached about one meter high and the dry matter yields was around 10 tones per hectare per year (Table 4).

Pennisetum purpurum was used for land rehabilitation around the pond's dike in addition to fodder for fattening in the integration. The grass is an important fodder plant the cut-and-carry system that was also used for fattening in the study area . The grass also takes many nutrients from the soil (Lukuyu et al., 2007). Forage production from the integration and the byproducts of the horticulture was used as feed for fattening and farmers can get huge profit without adding any other cost for supplementary feed (Table 5).

Partial budget analysis

The products from the integrated farms were sold to the local market for home consumptionby the local community. The financial values of consumed products were estimated to obtain the estimated profitability of the farms as a source of income. Production cost and revenue generated from the products were presented in table 5.

The total farm area occupied by the integration system was 910 m^2. The total costs for fish, poultry, horticulture, forage, and fattening were 940; 25,970; 7,917, 275 and 8,000 Birr, respectively. The revenues obtained from the harvested fish, poultry, horticultural crops, and fattening were 11,500; 39,600; 30,209; and 12,000 Birr, respectively (Table 5). Forage produced was used for cattle fattening which minimize feed cost for cattle fattening. In general, the total cost required to establish the farming system was 43,102 Birr, and the revenue generated from the system was 96,833 Birr, and the total profit was 53,731Birr (Table 5).

The farmer didn't get more than 5,000 Birr profit from the traditional farming practice before the technology was introduced (Lemma, 2019). The huge difference in profit was because, in the integrated farming system the waste from one commodity was used as an input to the other.

Table 5. Summary of partial budget analysis of fish - poultry - fattening - horticulture - forage production in the study area

Items	**Production cost (in birr)**	**Revenue (in birr)**	**Amount (in birr)**
Fish production			
Fingerling purchase	250	Fish selling (125 birr/kg x 92Kg)	11,500
Estimated labor cost	160	Profit	10,560
Fishing net depreciation cost	220		
Pond depreciation cost	310		
Total cost in fish component	940		
Poultry (egg) production			
Pullets purchasing	3,750	Revenue from egg production(24*30*12*4)	34,560
Poultry feed purchase	15,100	Estimated value of poultry at the end of the trial(Cull out hen) (29 *160)	4640
Poultry feeders & equipment	820	Estimated value of equipment	400
Estimated labor cost	5,500	Revenue from poultry	39,600
Poultry house depreciation	800	Total profit in poultry	13,630
Total cost in poultry	25,970		
Horticulture production			
1. Estimated cost for land preparation, seed, weeding, harvesting, etc for Brassica oleracea	1,485	Selling of Cabbage	5,009
		Profit from Cabbage	3,524
2. Estimated cost for land preparation, seed, weeding, harvesting, etc for Allium cepa	6,432	Selling of onion	25,200
		Profit from onion	18,768
Over whole cost from horticulture	7,917	The whole profit from all horticulture production	22,292
Forage production			
Pennisetum pedicellatum	180		2,900
Pennisetum purpureum	95		1,500
Total cost	275		4,400
		Feed cost for cattle fattening is minimized by (4,125)	
Cattle Fattening			
Bull purchase	6,500	Selling of bull	12,000
Feed cost	0		
Estimated labor cost	1,500	Profit from beef	4,000
Total cost	8,000		
Total cost of the whole integrated farming system			
	Amount in birr	Revenue generated	Amount (in birr)
For the whole integration	43,102	From the whole integration	96,833
		Total profit in the system	53,731

CONCLUSIONS AND RECOMMENDATIONS

Mean egg production was 79.6 percent per day, and egg-laying is not economically feasible after the chickens reach 15 months of age. The final weight of the fish ranged from 121 to 341 grams, with an average of 235 grams within six months. The average yields obtained from B. oleracea and A. cepawere 6,183 and 28,000 kg ha-1, respectively. The dry matters of P. pedicellatum and P. purpureum, which were planted on the top of the dike, were 9,934 and 22,233 kg ha^{-1}, respectively. Forage production from the integration and the byproducts of the horticulture were used as feed for fattening and the farmer had huge profit without adding any other cost for supplementary feed. Hence,it was concluded that the integration of different commodity (Fish, poultry, fattening, horticulture, and forage) and the waste from one component that was used as input for the next part and the farming system could be an economically viable avenue for the smallholder farmers for better livelihood. As a recommendation, the study confirm that the technology is profitable and it needs to be scaled up as one of aquaculture strategy that can be adopted by smallholder farmers of the country to increase farm returns from per unit area of land.

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Pre-Extension Demonstration of Improved Fishery Technologies in Sorga and Fincha Reservoirs of East and Horo Guduru Wollega Zone, Oromia Region, Ethiopia.

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ABSTRACT

Fish is used as a source of the human diet, source of income, and employment opportunity for people living near lakes and reservoirs in Ethiopia. This activity was conducted to demonstrate improved fishery technologies for fishery cooperative organized at Sorga Reservoir (East Wollega Zone) and Fincha Reservoir (Horo Guduru Wollega Zone). The objectives of the study were to demonstrate fishery technologies for fishers, to exploit and utilize stocked fish resources properly from existing reservoirs that benefit the local communities, and to improve fishermen, fishery experts, and development agent capacity (Knowledge, Skill, and attitude) through training on fish production, processing techniques, and utilization. Three Farmer Research & Extension Groups (FREGs) were formed which consists of 15-30 farmers' members considering gender participation at Sorga and Fincha reservoirs. Training on the importance of improved fishery technologies, fish gear preparation, fishing wooden boat construction, and fishmeal preparation have been given to FREG members comprising 70 farmers, 3 DAs, and 6 experts at both reservoirs. The major fish species available at Sorga reservoir were Nile Tilapia (Oreochromis niloticus), Tilapia Zilli, and common carp (Cyprinus carpio) and their average length were 21.1, 22.6, and 29.9cm respectively. In the case of Fincha reservoir well-adapted common fish species were Nile Tilapia (Oreochromis niloticus), African Catfish, Common carp (Cyprinus carpio), and Tilapia zillii and their average length were22.7, 55.9, 33.4 and 21.4 cm respectively. However, fish farmers commonly used Nile Tilapia for both family consumption and sales. One wooden boat, one gillnet gear, gear needle, and twine were provided to FREG at Sorga reservoir whereas gillnets, gear needle, hooks, and longline and twine were distributed to all FREG members at Fincha reservoir. Therefore, those improved fishery technologies increase fish production and have high demand by fish farmers and it needs to be further scaled-up.

Key Words: Demonstration; FREG; gear; wooden boat

INTRODUCTION

In 2010, global capture fisheries and aquaculture from both marine and inland waters produced 148 million tons of fish, which was valued at $217.5 billion (FAO, 2012). The value of the global fish trade exceeds the value of international trade in all other animal proteins combined. Developing countries account for over 60% of global fish catch (FAO, 2009). Developing countries play a major role in the global trade of fish and fish products; 50% of all fishery exports in value terms and more than 60% in quantity terms are supplied by developing countries (World Bank, 2011). The context in which this production takes place is one in which an estimated 1.4 billion people are in poverty, 868 million people are estimated to be chronically hungry and an estimated one-third of children in the developing world under five years of age are stunted (Conway, 2012). At the same time, demand for fish products is likely to rise as a result of rising populations that are expected to reach 9.3 billion by 2050.

Furthermore, developing countries now display a positive trade balance due to their increasing involvement in global fisheries trade.

Ethiopia is called the water tower of Africa due to its combination of mountainous areas with a comparatively large share of water resources in Africa. It has many lakes and rivers with a substantial quantity of fish stocks. There are 10 major lakes with a total area of 7,400 km^2 and a combined length of 7,185 km of major rivers (Brook, 2012). Almost all the fish consumed in Ethiopia are collected from the wild using artisanal methods. The current total fish production potential of the country is estimated to be more than 90,000 tons annually for the main water bodies, of which only around 38,400 were exploited very recently (FAO, 2014). The major fish supply to the major cities and towns in Ethiopia are captured from the Rift Valley lakes (40%) and Lake Tana (50.2%) in the north (Tesfaye, 1998), and the remaining percentage going to riverine fisheries.

Ethiopia is actively exploiting its water resources by building dams, reservoirs, irrigation and diversion canals, and hydropower stations. The benefits of the dams are not only limited to hydropower. Many dams are multi-purpose dams that are also designed to provide water for irrigation, drinking water, fish farming, and flood control. The region of Oromia is endowed with numerous water bodies including lakes, reservoirs, and rivers. Though fisheries managers' interest is increasingly focusing on the protection, conservation, and surveillance of natural inland waters and large man-made reservoirs, but a little scientific interest has been given to small reservoirs. Sorga reservoirs were constructed in 1994 for irrigation, livestock watering, and domestic uses (NUAO, 2019).

Fincha reservoir different fish species like Nile Tilapia (Oreochromis niloticus), Common carp (Cyprinus carpio), and grass carp (Ctenopharyngodonidellus) were introduced in the 1980`s. The former two species and Tilapia zillii were reported to be well established in the reservoir in 1998 (Fasil and Gashaw, 2012). In the study area underutilization and Poor culture of eating fish in the community (C. carpio), poor fish handling and processing technics for fish, an appropriate fishing gears, and Lake of sustainable use of the resource were the main constraint that identified so far.

Before demonstrated fishery technologies at Sorga reservoir farmers was not benefited from the fishery resource even if some farmers were organized. They do not have the necessary and recommended material used for fishery production. Due to the lack of fishery technologies the fishermen especially at Fincha reservoirs during a surplus production, the price of fish was determined based on the pleasure of the buyer rather than the market. At both site, farmers have a huge demand for modern fishery technology with necessary equipment. So, to exploit and utilize stocked fish proper fishing technology like fishing gears, processing tables and set net with awareness is critical for each reservoir with improved processing mechanisms. Fishery technologies were designed to demonstrate to solve the lack of fishery technologies. As the sector increasingly recognized as an alternative means of addressing the problem of food security and poverty for smallholder farmers this study aims to improve fish production and utilization to increase the income of target beneficiaries through technological demonstration and training in Fincha and Sorga reservoirs of Horo Guduru and East Wollega Zone respectively.

MATERIAL AND METHODS

Description of the Reservoirs

Fincha Reservoir

Fincha reservoir is one of the reservoirs in Ethiopia used for hydroelectric power generation. The reservoir is found in the Western part of the country in Horro Guduru Wollega Zone, 286 km far from the capital city, Addis Ababa. The reservoir, situated at 9°33’N/37°24’E is surrounded by four administrative Districts, namely Jimma Genet in South-West, Horro in West, Guduru in East, and Southeast, and Abay Choman in North and Northeast. It has an area of about 350 km2 at an elevation 2000 meter above sea level. The reservoir has a mean depth of 7 m, a maximum depth of 17 m with a temperature of 230C, dis-solved oxygen 9.4 mg/l, pH 6.4, conductivity 78.3 µs/cm, and Secchi Disk of 130 cm. The reservoir has an outflow called river Fincha that generates the Electric power and used for irrigation (Fincha sugar Factory) then joins with river Abay (Tilahun, 2014).

Sorga Reservoir

Sorga reservoir is found in East Wollega Zone, and Sorga in Nekemte town, Ethiopia. Sorga reservoir is used as a site for fish production, recreational areas, and crop irrigation. The total area of the Sorga Reservoir (14 ha). Sorga reservoir, situated at 9°4'12"N/ 36°30'47"E.

Site and farmers’ selection

Sorga and Fincha reservoirs were selected purposively to conduct this demonstration activity. The target population of this technology demonstration was farmers from Sorga Reservoir and Fincha Reservoir. Farmers were selected purposively based on proximity to the reservoirs.

FRGs/FREGs

Nowadays, the group approach (as institutional intervention) is more efficient than dealing with individuals especially in our context where the majority of farmers are smallholders and clear socio-economic differences are existing. It enhances the development, popularization, dissemination, and adoption of improved fishery technologies meant for our farmers. Thus, the selection of FRGs/FREGs members was based on farmers’ willingness to be held as a member, good history of compatibility with groups, and genuineness and transparency to share innovations to other farmers. Consequently, three FRG/FREG having 15-30 members with the composition of resource-rich, medium, and poor category of farmers including men, women, and youth farmers were established at selected reservoirs. Gender and youth balance in each FRG/FREG unit was strictly considered (at least 40%). After the establishment of the FRGs/FREGs, a theoretical training session was arranged to farmers, DAs, and experts at Nekemte town, Horro, and Jimma Geneti district.

Table 1. Number of FREGs member

No	Reservoir	District	Number of selected farmers		
			Male	Female	Total
1	Sorga	Nekemte town	11	5	16
2	Fincha	Horro	15	6	21
		Jimma Geneti	16	6	22
	Total		**42**	**17**	**59**

Source: Own data source, 2019.

A multidisciplinary team of researchers from BFOALRC delivered the training on the following topics: participatory fishery research and promotion through FRGs/FREGs, improved fishery technologies, gear preparation, and fishmeal processing, cooking, nutritive importance of fish, and post-harvest managements of fish. For each organized FREG at each selected site both theoretical and practical training was given on the preparation of gear technology (gear making), fishing, yield management, processing, preservation techniques, and sustainable use of the resource, in addition, to demonstrating fishery technologies. Then brainstorming training was conducted on the sustainable use of the current resource as well as to identify the existed local knowledge practiced by the community. One (1) local boats, one (1) Gill nets, 30 needles, and one pack of twine were provided for Sorga FREGs and forty (40) hooks/longline, forty (40) needle, two-pack of twine were prepared and given for each FREGs organized on Fincha Reservoir for on demonstration. Stakeholders in the district were to be made aware and discussion on sustainable resources utilization systems.

Methods of data collection and data to be collected

To obtain relevant information, the study collected qualitative and quantitative data through filed observation, FGD, and measurement. Quantitative data effectiveness of technologies demonstrated at the selected site, a total number of farmers participated in demonstration, and many farmers and experts participated in training and yield advantage of the technologies were collected using a checklist. In addition, qualitative data such as farmers' and experts' feedback on the technology demonstrated, knowledge and skill change of farmers and experts on demonstrated fishery technologies. Regarding the fishing activities the secondary data was taken from the Agricultural office and another secondary source.

Method of Data Analysis

The collected data was analyzed using SPSS and descriptive statistics such as mean, frequencies distribution, and percentages.

RESULTS AND DISCUSSIONS

Both theoretical and practical training were the main approaches that have been used to create awareness about the technology being demonstrated among farmers to capacitate the farmers, DAs, and experts’ knowledge and skill. A multi-disciplinary team from Batu Fish and Other Aquatic Life Research Center that composed of socio-economist, agricultural research extensions, limnology, and food science have participated to facilitate extension effort.

Training

The project key stakeholder farmers, development agents, and expert capacity built through two round theoretical and practical training conducted at the respected site. Training was given mainly focusing on the importance of demonstrated fishery technologies, fish production, processing, cooking, and utilization. Practical training were given how to make fish gear (gillnet and beach seine) and usage of fish gear. It also gave due attention to linkage among stakeholders especially the agriculture and natural resource development office, research center, and farmers. A total of participants of which 22 (27.5%) female and 58 (72.5%) males have participated in the training at selected reservoirs. As indicated in Table 1, a total of 56 farmers, 3 development agents, and 7 fishery experts were participating in the training.

Table 1: Training participants on fishery technologies demonstrated

No	Districts/Site	Experts			DAs			Farmers		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
1	Horro	3	1	4	1		1	13	6	19
2	Nakemte town	1		1	1		1	20	9	29
3	Jima Geneti	2		2	`1		1`	`16	6	22
	Total	**6**	**1**	**7**	**3**		**3**	**40**	**16**	**56**

Source: Own Survey Results, 2019-20.

Fish production and fish species in selected reservoirs

Fish as a source of human food has a long history in Ethiopia. People consume a large amount of fish in fasting days, in big cities, around production areas and towns, especially in Zeway, Arbaminch, Bahir Dar, and Addis Ababa. Outside these areas, however, the domestic fish market is small. The major fish species available at Sorga Reservoir were Nile Tilapia (Oreochromis niloticus), Tilapia Zilli (Tilapia Zillion), and common carp (Cyprinus carpio) (Table, 2). In the case of Fincha reservoir Nile Tilapia (Oreochromis niloticus), Common carp (Cyprinus carpio), African catfish (clarissa gariepinus), and Tilapia Zillii (Tilapia Zillion) were common fish species well adapted. Mean length (L) and body weight (W) of Nile Tilapia, Tilapia Zilli and common carpwere 23.1 cm & 215.2g, 22.6cm & 193g, and 29.9cm & 325g respectively in Sorga Reservoir. In Fincha ReservoirMean length (L) and body weight (W) of Nile Tilapia, African catfish, Tilapia Zilli and common carp were 22.7 cm & 205.1g, 55.9cm & 1950g, 21.4 cm & 179.8g, and 33.4cm & 432.3g respectively. However, fish farmers commonly used Nile Tilapia for both family consumption and sales.

Table 1: Fish species and the average length

No	Reservoirs	Fish species	Mean Length(TL)(cm)	Mean Weight (g)
1	Sorga	Nile Tilapia	23.1	215.2
		Tilapia Zilli	22.6	193
		Common Carp	29.9	325.0
2	Fincha	Nile Tilapia	22.7	205.1
		African Catfish	55.9	1950
		Tilapia Zilli	21.4	179.8
		Common carp	**33.4**	**432.3**

Source: Own survey Result, 2019-20.

Farmers' perception of fishery technologies

After theoretical and practical training, FRG members were given a gear (gillnet and beach seine) and wooden boats in the case of Sorga Reservoir. After technologies were provided for farmers, they evaluate the efficiency of the technologies. Accordingly, farmers choose beach seine gear with 10 cm mesh seize over gillnet gear for Sorga reservoir. The participants in the technology demonstration process preferred wooden boats over the traditional (Yebela) for fish production in the case of Sorga Reservoir. Moreover, participants familiar with the way of preparing and maintaining fishing gears and wooden boats. Both gillnets and beach seine gears were appropriate for catch Nile Tilapia, Zilli tilapia, and common carp which were common fish species harvested from the Sorga reservoir.

Farmers in the area preferred Nile Tilapia over other fish species because consumers preferred it. Farmers indicated that low price fish/ low demand for fish consumption was the main problem they raised for fish production in the study area. According to Nekemte Livestock and Fishery office information, buyers pay 4(four) to 5(five) ETB per one-kilogram (1kg) of gutted fish. But, after filleted and transported to Addis Ababa they sell 70-80 ETB per one-kilogram of filleted fish. This shows that the traders were more benefited rather than the exited farmers that were organized in the reservoir.

In the case of Fincha reservoir Fish for All (FFA) Ethiopia, local NGO is participated in providing fish farming inputs fishing boats, fishing gears (nets), a refrigerator that is essential inputs at the production stage. Gill nets of different mesh sizes (80 mm and 100 mm mesh size) and beach seine (50 m long) were used to harvest the Nile Tilapia and Common Carp fish whereas hooks/longline for harvest Africa Catfish at Fincha reservoir. Batu Fish and Other Aquatic Life Research Center provided longline-and-hooks gear and gillnets (way of preparation). Farmers preferred longline/hooks to catch African catfish whereas participants preferred gillnets/beach seine for catch Nile Tilapia/common carp. Now times farmers preferred Nile Tilapia, which has high demand commercially.

CONCLUSIONS AND RECOMMENDATIONS

This demonstration activity was conducted in two purposively selected reservoirs namely Sorga and Fincha reservoirs. To undertake a demonstration of this technology one FREGs at Sorga Reservoir and two FREGs at Fincha Reservoir were established. Fishery technologies demonstrated were Gillnet, beach sine, hooks/longline, wooden boat, gear preparation, fish processing, and fish meal preparation. Fishing communities benefited from improved fishery technologies, which enables them to produce better quality fish products and/or supply to markets. Training of local fisheries and experts on fish harvesting, fish handling and preservation, processing, and packaging innovations, including new equipment and technology, and improved preservation and distribution skills, is very crucial to strengthen their capacity in fish production and marketing by reducing fish spoilage. As fish production is a new practice in the area, local administrative bodies, regional and federal governments, and concerned institutions to extend the fishery technology into potential areas, should give attention. Generally, since fishery technology has positive feedback from farmers and high demand for fish consumption in the area, Livestock and Fishery Offices at Districts and Zonal level in collaboration with another stakeholder should work on the wider scaling up of this improved fishery technologies and expand fish production in available water resource to meet fish demand.

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Pre-extension Demonstration of Nile tilapia fingerlings Multiplication at Wayu Tuqa

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ABSTRACT

This study was initiated to demonstrate and popularize Oreochromis niloticus multiplication technologies in Wayu Tuqa (East wolega zone) during the 2019/20 production season. A selected strain of Oreochomis niloticus, A Tilapia with good growth performance was demonstrated for fingerling production. The pond size was 10m x 10m replicated on FTC fields. The result of descriptive statistics shows that a mean yield of 1200 fingerling hapa^{-1} was recorded. Since aquaculture is at its infant stage in the area, Oreochromis niolicus of Chamo strain can be evaluated for its growth performance and stress resistance in the area. Large production of fingerlings in a hapa in the area can easily avail fingerling in the area, which increases the income as well as the livelihood of the Aquaculture farming in the area. Therefore, organizations should further scale up/out the fish multiplication technology in the study districts and other similar areas to reach a greater number of farmers.

Key Words: Aquaculture, Fingerling multiplication, Oreochromis niloticus

INTRODUCTION

The Nile tilapia, Oreochromis niloticus L. (Pisces: Cichlidae) is one of the most important fish species in the inland fisheries, particularly in rift valley lakes (Vijverberg et al. 2012). The species is also the most important in the commercial fisheries of Ethiopia. Tilapia is one of the ideal candidates for aquaculture because of their tolerance to wide pH fluctuations, high ammonia and nitrite levels, and low dissolved oxygen levels (Ardjosoediro and Ramnarine 2002). In addition, tilapia is fast-growing and omnivorous, with an ability to utilize a wide range of feed ingredients such as detritus, algae, macrophytes, and bacteria (Liu et al. 2013, Bhujel 2014). Tilapia culture is one of the fastest-growing forms of aquaculture worldwide, with more than 3 497 390 tonnes produced in 2010 (Fitzsimmons 2013).

Despite the startup of aquaculture in some parts of the country, the absence of good quality seed has constrained the sustainability of aquaculture (Tugie et al. 2017). Sustainable production and supply of fish seed are essential for farm-level aquaculture production. Lack of widespread hatcheries has led to either for the transportation of selected fingerlings for a longer distance or the utilization of wild-collected fingerlings for aquaculture. The development of appropriate technologies and management approaches for resource-poor households requires their participation, which can, in turn, improve their capacity for self-experimentation. This paper presents the resultsofanon-farmtrialwithfarminghouseholdsWayu Tuqa (East Wollega zone) to assess the adoption and performance of Hapa basedseedproduction.

MATERIALS AND METHODS

The site and FREG selection

The study was conducted in Wayu Tuka districts of East Wollega, the zone of Oromia Region during the 2019/2020 production season. To apply the technologies farmer training center (FTC) was selected. The selection of the district was based on accessibility for field monitoring and visit and potentiality for distribution of fingerlings to local, fish producing farmers.

One FREG was established with three hosting farmers with the rest being participant farmers. Development Agents and district experts collaborated in site and farmer selection. The FREG member farmers were selected based on willingness; accessibility for the supervision of activities and willingness to share innovations with other farmers. Besides; the experimenting farmers were selected based on the availability of sufficient water and land to accommodate the trials.

Activity design and field management

The ponds were constructed at the FTC, Land clearing was conducted and two new earthen ponds each surface area of $100m^2$ with 1.50m depth were constructed at the FTC (Fig 1.). The pond bottom was compacted, and filled with diverted nearby river water.

In Each pond, a 2.0 ×1.0 × 1.0 m spawning and nursing hapas; were installed with polesforsuspendingthehapas. Oreochromis niloticus broodfish of Chamo strains wereraised in brood ponds for a year, they were sex separated in different ponds at the FTC. Thebroodfishhadbeenfedalocallyavailablerationoffinewheat branandnug cake asadrymashtwicedailyat5%body weightd $^{-1}$.Brood fish were stocked at 3 female and 1 male ratio. The broods were removed after one month, the fish fries were left to grow in their respective hapas.

Data Analysis

The efficiency of the production of nursed fry was compared in terms of hapa (fry m^{-2}), pond (fry m^{-2} pond $^{-1}$). Pairwise T-test was used to test differences in Nile tilapia seed production in the study areas.

RESULT AND DISCUSSION

Training

Practical training on Hapa based tilapia seed production was held for the FREG involved in the trial. The contents of training focused on the reproductive biology of Nile tilapia, identification of male and female broodfish, preparation of ponds and hapas, stocking and management of broodfish, swim-up fry collection, nursing, and marketing fry.

Fish Seed Production

The survival rate of Nile tilapia ranged between 96 to 98% and fish maintained healthy and active during the experimental period. Tilapia seed production in hapas in ponds was successful at Wayu Tuka FTC. There was a variation in mean swim-up fry production per harvest among individual Hapas. Mean swim-up fry production in hapas (fry harvest^{-1} hapa) was 1200 ± 78 compared to 379± 39 in an open pond. The differences in the mean swim-up fry production between the two methods were highly statistically significant ($p > 0.05$). fish farming in hapas can result in a higher number of fingerling (Hussain 2004, Bhujel 2014)..

Distribution of produced fingerlings

Nile tilapia fingerlings were in high demand from grow-out farmers. 77% of the nursed fry produced were distributed for stocking at the FREG farmers participating in integrated fish horticulture farming.

CONCLUSION AND RECOMMENDATION

The demonstration activity was conducted in five AGP II districts using FREG approach in two consecutive years, 2019-2020. Fry production in hapa and open pond were used for demonstration. The results indicated that fry production in hapa produced a higher number of fingerlings at the demonstration sites. The participant farmers and other stakeholders got better knowledge and skill of using the technologies. Based on the number of fingerlings distributed, hapa based fish production was selected as the best technology. Therefore, hapa based fish production was recommended to be promoted to other places with similar agro-ecologies.

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Pre-Extension Demonstration of Improved Fodder oat Varieties in Selected Districts of Western Oromia, Ethiopia

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ABSTRACT

The pre-extension demonstration of fodder oat technology with its full agronomic practices was done with the objective to demonstrate and popularize the newly released oat variety and thereby create awareness for farmers and agricultural extension agents. Two improved fodder oat varieties (Bate and Bonsa) were demonstrated on purposely selected AGP II districts namely; Boneya Boshe, Wayu Tuqa, Guto Gida, Diga and Horro districts of East and Horro Guduru Wollega zones, respectively. One peasant association (PA) was selected purposely from each districts based on forage production potential and compatibility with AGP II criteria. The experiment was demonstrated on a simple plot with size of 10 x 10 m. Forage dry matter and grain yield data, and farmer perceptions and preference were collected and analyzed by simple descriptive statistics and pair-wise ranking technique. The varieties showed remarkable variation in their dry matter and grain yield potential across the testing areas. The average dry matter yield performance of Bate (4.67 t/ha) variety obtained from the farmers filed were relatively higher than Bonsa (4.19 t/ha) variety used as a standard check. Similarly, the average grain yield performance recorded for Bate (31.24 qt ha^{-1}) variety was also higher as compared to Bonsa (25.02 qt ha^{-1}) variety. Based on the procedure of variety evaluation and selection criteria, farmers set their own criteria to evaluate, rank and select the best variety in accordance with real situation existing. Thus, against each of the criteria and weight attached, Bate variety was selected and ranked first for its high dry matter and grain yield, tolerance to disease and lodging, and leafiness as compared to Bonsa variety. Therefore; it is important to scale up this variety in a larger scale to improve the availability of quality feed and boost production and productivity of livestock in the area.

Keywords: Bate, demonstration, Farmers' preference, fodder oat, herbage dry matter

INTRODUCTION

Livestock in Ethiopia derive most of their feed from natural pasture and crop residues. CSA (2017) report on livestock feed usage and experience by small holders indicates, grazing is the major type of feed resource (54.59%) followed by crop residues (31.6%), hay (6.81%), by-products (1.53%) and improved feed (0.31%). Grazing (natural pasture) and crop residue which contributes the higher proportions of livestock feed resources are characterized by high fiber, low protein, minerals and vitamins (Adugna et al., 2000). Such low quality feeds are associated with a low voluntary intake, thus resulting in insufficient nutrient supply, low productivity and even weight loss (Hindrichsen *et al.*, 2004). Thus, for more efficient and productive livestock industry, cultivation and utilization of nutritious, high yielding, and low cost feed technologies that are easy and available within the limit of the resources poor farmers has paramount importance. With this view, introduction, evaluation and dissemination of different improved forage species have been carried so far in different parts of Ethiopia including Western Oromia.

One of such potential forage species for integration in to the existing livestock feeding system is annual fodder oat (*Avena sativa*). Fodder oat is the most widely used annual forage crop worldwide, serving as an important sources of nutrition for ruminant livestock (Andrzejewska et al., 2018). It is well adapted fodder crops mainly in altitude range from 1700-3000 m.a.s.l. with 500-800 mm mean annual rainfall (Mengistu, 2008). It is an erect annual fodder crop up to 1.5m tall. Oat is well adapted to a wide range of soils and relatively tolerant to moisture stress, water logging and frost. It can be a good source of animal feed in the dry season if harvested at the right stage of growth, cured and stored as hay. It is also a quick growing, palatable, succulent and nutritious fodder crops (Aklilu and Alemayehu 2007).

So far, introduction, evaluation and selection of fodder oat genotypes was carried at Bako agricultural research center, and thus one variety named as Bate was released. The recently released oat variety (Bate) is good herbage yielder as compared to both previously released and locally adapted variety. However, in order to popularize the variety in the study area, demonstration of this variety with its production package has not been done yet at on farm level. Since demonstrating new technology on farmers training center (FTC) and farmers' field are the main tools to familiarize the farming communities with the new feed technology and thereby select the best variety/ies with farmer participation which in turn will facilitate the adoption process, there is a strong need of undertaking further popularization of this promising forage crop. Therefore, based on this background the current study was undertaken with the objective to demonstrate and popularize improved fodder oat variety at farmers level through participatory approaches and thereby improve the availability of livestock feed in the study area.

MATERIALS AND METHODS

Site and farmer selection

This demonstration activity was carried in purposely selected districts of East and Horro Guduru Wollega zones. Boneya Boshe, Wayu Tuqa, Diga and Guto Gida districts were selected from east Wollega zones, while Horro district was selected from Horro Guduru zone. Selections of these districts were done based on potentiality for forage production, accessibility for proper field supervision and compatibility with AGP II criteria. One potential PA was selected from each district following the criteria used while selecting districts.

In each PA, one farmers research group (FRG) comprising 12 farmers were established considering 40% gender and youth balance. Then, 4 farmers were selected from each FRG as experimental farmers while the rest were considered as participants. Selection of farmers and establishment of FRG was carried in collaboration with development agents and districts expertise. The FRG members were selected based on the willingness to be held as member in FRG, accessibility for supervision, compatibility with group dynamics and willingness to share innovations to other farmers. Moreover, farmer's selection were also done based on the availability and accessibility of land to accommodate the demonstration task, vicinity to roads so as to create the chance of the demonstration work to be visited by other farmers.

Technology implementation and demonstration procedures

Two improved fodder oat varieties (Bate) including the standard check (Bonsa) were demonstrated on well prepared land with plot size of 10m*10m. All agronomic practices were properly applied according to the recommendation in the center for the varieties. Seeds of both varieties were sown at a uniform seeding rate of 70 kg/ha across locations and periods, and thus seeds were drilled in row with a spacing of 30 cm. Diammonium phosphate (DAP) and urea fertilizer was applied to all plots during plantation at a rate of 100 kg/ha where, split application was used for urea. The varieties were then be evaluated based on the farmer`s selection criteria. During the evaluation session, farmers were assisted to jot down their own evaluation criteria, which were then ordered using the pair wise ranking techniques. Then, each variety was evaluated against the criteria ordered based on the weight attached to each parameters. Finally, result of evaluation was displayed to the evaluators, and discussion was held on the way ahead.

Training and Field visit

As part of the intervention activities, training on full agronomic practices as well as utilization system was provided to farmers, development agents and expertise. Finally, in order to evaluate the performance and final output of the varieties and share the lesson learned with the different stakeholders` field visit was arranged in the farmers` field where demonstration work was undertaken. In the field visit, farmers, development agents, head of agricultural and rural development office, researchers from Bako agricultural research center and district expertise were being invited.

Method of data collection

The data on grain yield and herbage dry matter yield of the varieties were collected from all plots of beneficiary farmers. Farmers' perception data of the varieties were collected using focus group discussion held during the evaluation periods. The perception data were grouped as biomass and grain yield, tolerance to lodging and disease, plant height, maturity period, leafiness and uniformity. The farmers were responding their perception level on the relative advantage of each characteristics of the improved variety (Bate) compared to the variety used as a standard check (Bonsa)

Method of data analysis

Forage dry matter and grain yield data collected from all farmers field were analyzed by simple descriptive statistics such as mean. Data on farmer perceptions and preference were collected and being subjected to pair-wise ranking technique.

RESULTS AND DISCUSSION

Provision of training

Training is very important tool for awareness creation and to bring improvement filling the gap, skill and attitude. Thus, participatory training was given to participant farmers, experts and development agents (DA) by Animal feed and extension researchers drawn from Bako agriculture research center. The theme of the training was mainly focused on the availability of improved fodder oat feed technology for the mid and highland agroecology of western

Oromia and its production, management and utilization systems of the technology. In order to create awareness about the availability and importance of improved fodder oat technology and thereby share the experience among farmers field visit was also held at each demonstration site. Generally, a total of 197 trainers including target farmers, experts and DAs` were involved on the training.

Table 1. List of participants (farmers, experts and DAs`) involved on the training

	Farmers		Experts		DAs`		
Study locations	M	F	M	F	M	F	Total
Boneya Boshe	21	12	2	1	5	2	43
Wayu Tuqa	19	13	2	1	5	1	41
Guto Gida	24	12	2	1	5	1	45
Diga	18	11	3	-	5	2	39
Horro	23	12	2	2	4	2	45
Total							197

M: male; F: female; DA: development agent

Herbage dry matter (DM) and grain yield performance of the varieties

The herbage DM (Figure 1) and grain yield (Figure 2) performance of the two oat technologies evaluated under different locations demonstrated that, the varieties are performing differently across locations. The result showed that, the herbage DM yield of Bate variety was higher at Horro site followed by Wayu Tuqa > Boneya Boshe > Guto Gida > Diga with a mean yield of 4.67 t/ha, while that of Bonsa variety was recorded higher at Horro site followed by Wayu Tuqa > Guto Gida > Boneya Boshe > Diga with a mean yield of 4.19 t/ha. This variability among locations might have stemmed from difference in the status of soil fertility and site specific varying weather conditions.

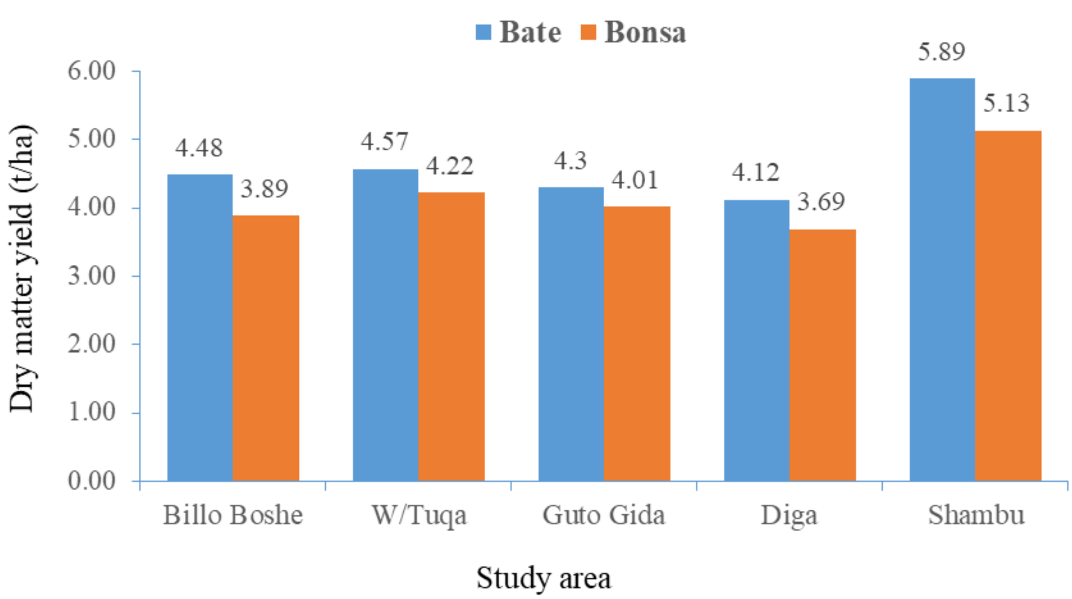

Figure 1. Dry matter yield performance of fodder oat varieties under farmer field condition

With regard to grain yield (Figure 2), the overall mean grain yield performance of Bate variety was 31.24 qt ha^{-1}which was higher at Horro sites, lower at Diga but intermediate at

Boneya Boshe site. Similarly, the average grain yield recorded for Bonsa variety was 25.02 qt ha^{-1} across locations which was higher at Horro site, lower at Diga but intermediate at Guto Gida site.

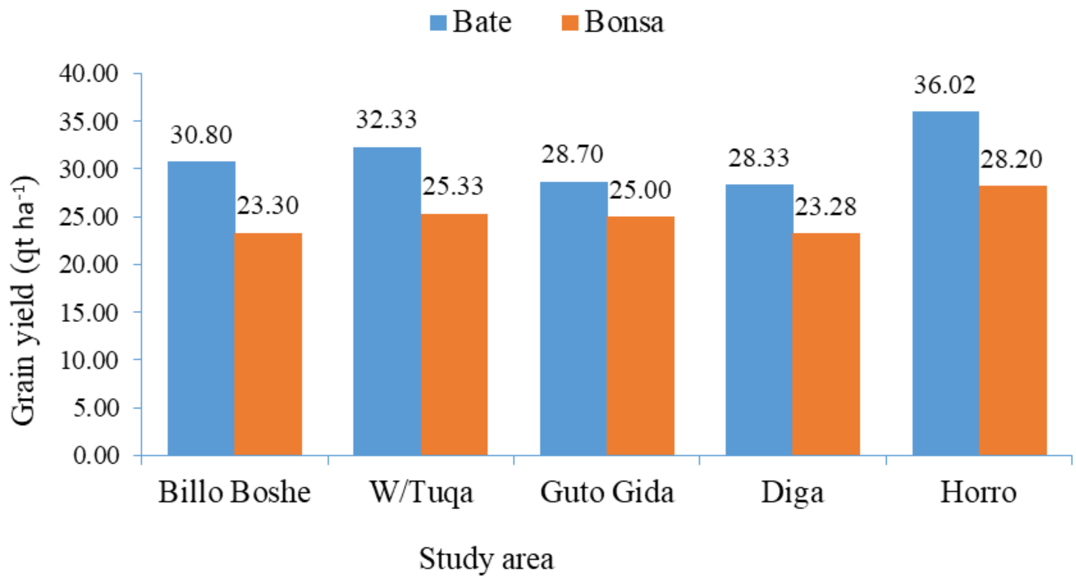

Figure 2. Grain yield performance of fodder oat varieties under farmer field condition

Farmers' varietal preference

Farmers' evaluation was made when the crop reach the recommended (40-50% flowering stage) stage for forage harvesting. Following the procedure for variety evaluation and selection criteria, farmers' evaluated, ranked and selected the best bet varieties from the demonstrated fodder oat varieties against each of the criteria and weight attached. According to the result in Table 1, Bate variety was selected and ranked at first by farmers from Horro, Wayu Tuqa, Diga and Boneya Boshe districts followed by Bonsa variety. However, farmers at Guto Gida selected and ranked Bonsa at first than Bate variety. Based on the overall mean score, Bate variety was preferred and selected by farmers' across the study area, and thus this variety will be proposed for further scaling up. Below (table 1) summarizes farmers score rank of the varieties across the districts.

Table 1: Score ranking of fodder oat varieties by farmers across the districts.

Study locations	Bate			Bonsa		
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank
Horro	37	4.62	1st	34	4.25	2nd
Guto Gida	31	3.87	2nd	36	4.5	1st
Wayu Tuqa	38	4.75	1st	32	4	2nd
Diga	36	4.5	1st	31	3.87	2nd
Boneya Boshe	36	4.6	1st	31	3.8	2nd
Overall rank	-	-	1st	-	-	2nd

Farmers selection criteria: 1= Growth Habit, 2=Maturity Time, 3=Biomass, 4= Plant Height, 5=Leafiness, 6=Uniformity, 7=Disease Tolerance and 8=Lodging Tolerant

From the evaluation result, the reasons for selecting as the best variety and suited utmost by farmers' at large between the demonstrated varieties against the weight attached to each of the trait was summarized and presented in Table 2 below.

Table 2. Varietal ranking based on farmers' selection criteria

No	Varieties	Rank	Reasons
1	Bate	1st	High biomass yield, disease tolerant, lodging tolerant, very good plant height/ stand, high in leafiness, very good in uniformity
2	Bonsa	2nd	Low biomass yield, disease tolerant, lodging tolerant, medium plant height/ stand, medium in leafiness, very good in uniformity

CONCLUSIONS AND RECOMMENDATION

Two improved fodder oat varieties including check were demonstrated in five districts of East and Horro Guduru Wollega zones during the year 2019. Biomass yield, disease and lodging tolerant, plant height/stand, leafiness and uniformity were identified and used as selection criteria across all the locations to select the best performing varieties. The overall mean herbage dry matter yield of Bate variety was 4.67 t/ha which is relatively higher than Bonsa variety which gave 4.19 t/ha. Similarly, the average grain yield performance of Bate (31.24 qt ha^{-1}) variety was also higher than that of Bonsa variety (25.02 qt ha^{-1}). Generally, participant farmers' participated on participatory evaluation and selection of the varieties reasonably evaluated, ranked and selected Bate as first best preferred and suitable variety with the real existing situation on the ground, and thus this variety will be proposed for further scaling up.

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Pre-extension Demonstration of Improved Pigeon pea (Cajanus cajan) Varieties in Selected Districts of East Wollega Zone, Oromia, Ethiopia

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ABSTRACT

Pre extension demonstration of improved pigeon pea varieties was conducted in 2018 and 2019 rainy seasons at Boneya Boshe, Wayu Tuka, Diga and Guto Gida districts of East Wollega zone, Oromia, with the objective of demonstrating and evaluating the performance of recently released pigeon pea varieties along with their management practices under farmer's conditions and creating awareness on the production of the developed varieties. A representative peasant association (PA) was selected purposively from each district based on forage production potential and accessibility for field monitoring and visit. In each PA, one farmers' research and extension group (FREG) comprising 18 farmers was established to evaluate and select the varieties. Training was given to farmers, DAs and experts. Two improved pigeon pea varieties (Degagsa and belebas) were demonstrated along with standard check 'Tsigab'. The varieties were sown on four farmers' fields using farmers as a replication on a plot size of 10 m x 10 m (100 m^2) per variety. Yield data per plot was recorded and analyzed using descriptive statistics, while farmers' preference to the varieties was identified using focused group discussion and summarized using pair wise and simple ranking methods. The demonstration result revealed that statistically significant yield difference was observed among the varieties across testing sites. Degagsa variety gave superior mean herbage dry matter yield of 7.63 t/ha per harvest with yield advantage of 10.1 % & 23.06 % over Belebas and Tsigab varieties (6.93 t/ha) & 6.2 t/a), respectively. Whereas, Belebas variety performed better mean grain yield (20.26 qt/ha) than Degagsa (18.68 qt/ha) and Tsigab (12.24 qt/ha) having yield advantage of 8.46 % & 65.52 % over Degagsa and Tsigab varieties, in that order. Participant farmers were reasonably evaluated, ranked and selected best preferred and suitable varieties in accordance with real existing situation. Thus, Degagsa was ranked and selected firstly for its high biomass yield, disease tolerance, good plant height, leafiness, survival rate and uniformity. Besides, secondly selected variety 'Belebas' share similarities with Degagsa in many criteria's and have special merit acquired; high seed yielder. Therefore; both varieties were recommended for further scaling up in all demonstration sites and similar agro ecologies.

Keywords: Cajanus cajan, Degagsa, demonstration, Farmers' preference, herbage dry matter

INTRODUCTION

The crop-livestock mixed farming systems in Ethiopian is one the most common production systems practiced in mid and high altitude of the country. Most lands previously expected for livestock production are under continuous stress due to increased crop cultivation and reduced pasture lands. As a result, animals are kept on limited land that further leads to land degradation, and declined size and productivity of grazing lands (Funte *et al*., 2010; Gemeda, 2010). The decreased feed production resulted in low production and productivity of animals that further affected the benefits they provide at household or national level. Hence, production and adaptation of multipurpose fodder trees through integration with food crops were suggested as potential feed resource for livestock (Solomon, 2001).

Uses of improved forage and tree legumes like Pigeon pea as supplementary options can improve the production and productivities of livestock in Ethiopia (Ajebu *et al.*, 2008). Pigeon pea is well adapted to the climate and uniquely combines such optimal nutritional profiles, high tolerance to environmental stresses, high biomass productivity and most nutrient and moisture contributions to the soil. Its foliage is an excellent fodder with high nutritional value. It contains 20-22% crude protein, 1.2% fat, 65% carbohydrate and 3.8% ash. In addition, they are found to possess different minerals and vitamins and are good source of carbohydrates for all mono-gastric animals (Khandelwal *et al.*, 2010). Thus far, pigeon pea genotype selection activities have been conducted at Bako Agricultural Research Center and similar agro-ecologies of western Oromia. Hence, two varieties of pigeon pea were released. However, demonstration and popularization of these varieties were not conducted at on farmer level. Therefore, the objective of the current study was to evaluate and demonstrate the performance of the varieties along with their management practices under farmer's conditions and creating awareness on the production of the developed varieties at farmers' level through participatory approaches.

MATERIALS AND METHODS

Description of the study area

Pre extension demonstration of improved pigeon pea varieties was conducted in 2018 and 2019 rainy seasons at Boneya Boshe, Wayu Tuka, Diga and Guto Gida (Uke) districts of East Wollega zone, Oromia. These study areas were dominated by midland with altitude that ranges between 1500 and 1800 m.a.s.l. The area receives an annual rainfall of about 1200-1800 mm, 90 % of which falls between June and September. Farming system of the districts is characterized by mixed crop-livestock farming. The major crops grown in the districts are maize, sorghum, hot pepper, finger milet, sugar cane, sesame, soybean, common bean, field pea, banana, mango, papaya etc. Important livestock species abundantly reared in the districts include cattle, shoat, equines and chickens.

Sites and farmers selection

The demonstration activity was conducted in purposively selected districts and selection of the districts was based on livestock production potential, accessibility for field supervision and compatibility with the AGP-II project criteria. A representative peasant association (PA) was selected purposively from each district for the implementation of the activity in collaboration with woreda experts and development agents. In each PA, one farmers' research and extension group (FREG) unit encompassing 16-18 farmers was established (considering gender and youth balance, 30-40 %) to evaluate and select the varieties. In each FREG unit four hosting farmers were selected with the rest being participant farmers. Farmers' selection was done based on interests of farmers in forage production, ownership of suitable land, ability to manage experimental plots and willingness to share their knowledge and experience to others.

Training of Farmers experts and DAs

After establishing of the farmers research group (FREG) theoretical and practical training were given to farmers, Development agent and district experts. The training was given by researchers on production, management and utilization of improved varieties as well as issues like economic and nutritive importance, suitable ecologies and weather condition for the developed varieties.

Field design and management

Two improved Pigeon pea **v**arieties; Degagsa and Belebas along with standard check (Tsigab) were planted on 10 m *10 m plot of land for each. The demonstration plots were replicated on 16 farmers' field. During plantation NPS Fertilizer was applied at a rate of 100 kg/ha and all other agronomic practices were applied equally to the demonstration plots as per the recommendation and every experimental plots were supervised jointly by the researchers, extension workers and farmers.

Participatory Variety evaluation

Farmers' participatory evaluation and experience sharing program was conducted across the study sites. Both technical groups and farmers evaluated the varieties based on their own preferences and preset criteria. At the end of the evaluation process, results of the evaluation were displayed to the evaluators for final approval. The demonstrated varieties were ranked against the selection criteria by participating farmers through discussion across districts.

Data Collection and Analysis

Both quantitative and qualitative data were collected. The collected data were: Yield data, total number of farmers and other stakeholders' participated in training and field visits and farmers' perception on the attribute of the technology. The collected qualitative data was analyzed and described using descriptive statistics such as mean, frequencies, tables and percentages. Also quantitative data collected were subjected to SPSS software.

RESULTS AND DISCUSSION

Training of farmers and other stakeholders

Theoretical and practical trainings were given to FREGs and other neighbor farmers on improved forage production and utilization to improve their knowledge and skills on the newly introduced varieties. Accordingly, a total of 250 participants (191 farmers, and 45 Das and supervisors and 14 experts) were trained (Table 1). Out of the total trainees, 74 % were male and the rest 26 % were female.

Table 1: Training given to farmers and extension workers across the demonstration districts during 2018/2019

Districts	Participants						Total		Total
	Farmers		DAs & supervisors		Experts				
	Male	Female	Male	Female	Male	Female	Male	Female	
Boneya Boshe	36	9	9	2	4	0	49	11	**60**
Wayu Tuka	32	12	9	2	2	1	43	15	**58**
Guto Gida	33	14	8	3	3	1	44	18	**62**
Diga	38	17	9	3	3	0	50	20	**70**
Total									
Total	139	52	35	10	12	2	186	64	**250**

Yield performance of the demonstrated pigeon pea varieties

The result of pigeon pea varieties demonstration revealed that, significant yield differences were observed among the varieties across the study districts (Fig 1). The newly released pigeon pea varieties performed better than the standard check (Tsigab) at all demonstration sites. Accordingly, Degagsa variety gave higher mean herbage dry matter yield (7.63 t/ha) per harvest than Belebas and Tsigab varieties which gave (6.93 t/ha & 6.2 t/ha), respectively. Degagsa variety had 10.1 % & 23.06

% yield advantage over Belebas and Tsigab varieties, respectively. Whereas, Belebas variety performed better mean herbage DM yield than the standard check (Tsigab variety) having yield advantages of 11.69 % (Table 2).

In the current study, the mean grain yield obtained from the demonstrated varieties was varied among the varieties (Fig 2). The mean grain yield of Belebas variety was higher (20.26 qt/ha) than both Degagsa (18.68 qt/ha) and Tsigab (12.24 qt/ha) varieties. On the other hand Degagsa variety gave superior yield than the standard check (Tsigab). As described in table 2, the grain yield advantages gained for Degagsa and Belebas over Tsigab variety were 52.59 % and 65.54 %, respectively. This indicated that the newly released varieties help to gain extra benefit in percentage that the farmers' obtained from the variety already in production.

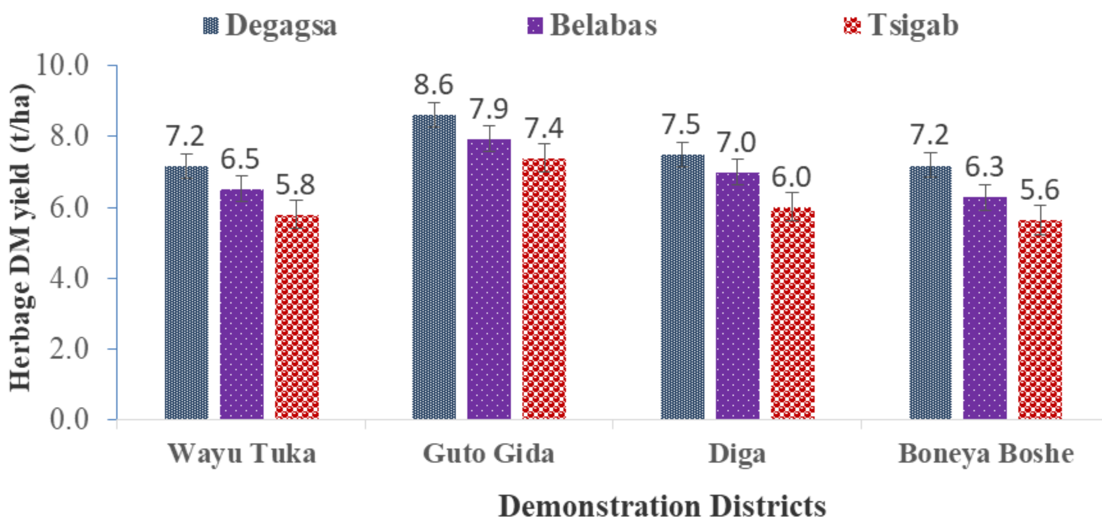

Fig 1.Mean of herbage DM yield ± SE (t/ ha) of pigeon pea varieties across study districts

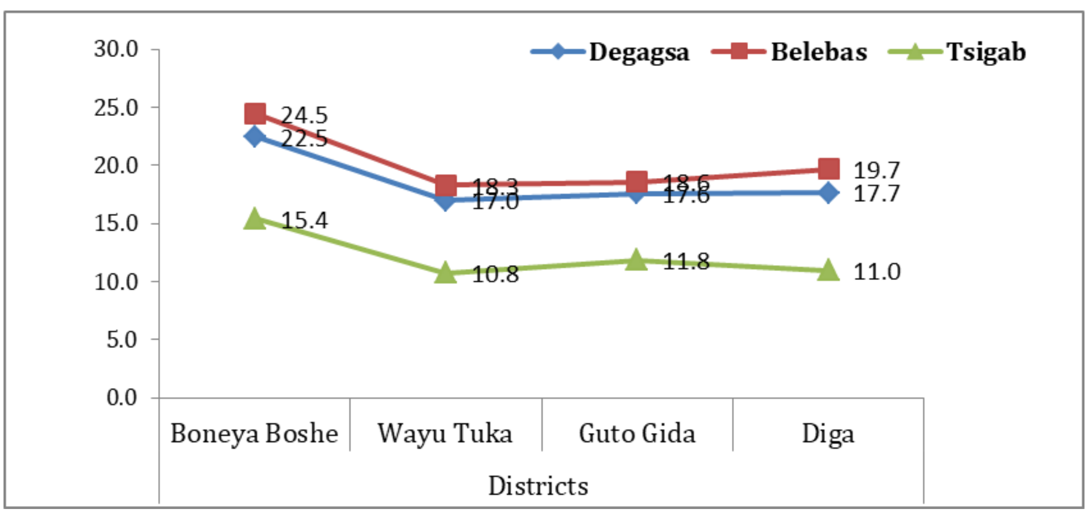

Figure 2: Mean of seed yield (qt/ha) of pigeon pea varieties across study districts

Table 2: Mean herbage DM and grain yield advantages of pigeon pea varieties over standard check

Demonstrated Varieties	Mean herbage yield qt/ha	Mean grain yield qt/ha	Yield advantages over the standard check %	
			For Herbage DM yield	For Grain yield
Degagsa	7.63	18.68	23.06	52.59
Belebas	6.93	20.26	11.69	65.54
Tsigab	6.20	12.24	-	-

Participatory Variety evaluation and selection

Farmers' variety evaluation was made across the study districts at appropriate forage harvesting stages for pigeon pea varieties. Following the procedure for variety evaluation and selection criteria, both technical groups and farmers were jointly evaluated, ranked and selected the best bet pigeon pea varieties against each of the criteria ordered based on the weight attached to each parameters. Participant farmers scored each technology by each trait that was considered important by them and ranking of technologies were done on a scale of 1-5; 1being very poor and 5 being the highest score representing superiority. Herbage yield, plant height, disease tolerant, leaf greenness, leafiness, early maturing, survival rate, uniformity, medium pod per plant, good seed emergency and grain yield were considered as the most selection criteria for each pigeon pea variety.

According to farmers' evaluation Degagsa variety had got the highest total score followed by Belebas variety while the least score were recorded by Tsigab variety (Table 3). Therefore; Dagagsa was ranked and selected first by all the traits then followed by Belebas and finally the least ranked and selected in entire of the traits across all the districts was Tsigab variety. Most of the participant farmers appreciated the performances of Degagsa variety especially with regards to its herbage yield, disease tolerance, good plant height, leafiness, survival rate and uniformity. Besides, secondly selected variety 'Belebas' share similarities with Degagsa in many criteria's and has one special merit acquired; 'high seed yielder'. Below (table 3) summarizes farmers score rank of the varieties across the districts.

Table 3: Score ranking of Pigeon Pea varieties by farmers across the districts.

Variety	Guto Gida			Diga			Wayu Tuqa			Bonaya Boshe			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Tsigab	31	3.10	3rd	25	2.50	3rd	29	2.90	3rd	23	2.30	3rd	3rd
Belebas	40	4.00	2nd	44	4.40	1st	39	3.90	2nd	40	4.00	2nd	2nd
Degagsa	49	4.90	1st	41	4.10	2nd	47	4.70	1st	45	4.50	1st	1st

Farmers selection criteria: 1= Growth Habit, 2=Maturity Time, 3=Biomass, 4= Plant Height, 5= Leaf Greenness, 6=Leafiness, 7=Pod per Plant, 8=Survival rate, 9=Uniformity and 10=Disease Tolerance

According to (table 3) above mean score ranking of pigeon pea varieties across the districts was done; hence, the highest score was recorded for Degagsa variety; 4.55, then followed by Belebas variety; 4.07, and the least mean score and ranking was recorded for Tsigab variety (2.7). Therefore, selecting and ranking of the varieties were done for the reasons indicated in table 4 below.

Table 4. Rank of varieties demonstrated based on farmers preferences

No	Varieties	Rank	Reasons
1	Degagsa	**1st**	High biomass yield, disease tolerant, good plant height, leaf greenness, leafiness, good survival rate, good seed emergency, uniformity, medium pod per plant and medium maturing
2	Belebas	**2nd**	Medium biomass yield, disease tolerant, good plant height/stand, leaf greenness, leafiness, good survival rate, good seed emergency, uniformity, very good pod per plant, best grain yielder and medium maturing
3	Tsigab	**3rd**	Low in biomass yield, low grain yield, susceptible to insect-pest, low survival rate, lack uniformity, poor plant height/stand, low leafiness, but early maturing

CONCLUSIONS AND RECOMMENDATION

Pre extension demonstration and evaluation of pigeon pea varieties was carried out in four districts during 2018 and 2019 cropping seasons. Two improved varieties, Degagsa and Belebas were demonstrated along with Tsigab variety which is the standard check. Herbage yield, plant height, disease tolerant, leafiness, maturing stage, survival rate, uniformity, pod per plant and grain yield were considered as the most selection criteria for each pigeon pea variety. The demonstration result revealed that statistically significant yield difference was observed among the varieties across testing sites. Accordingly, Degagsa variety gave superior mean herbage dry matter yield of 7.63 t/ha per harvest than Belebas variety (6.93 t/ha) and Tsigab variety (6.2 t/a). On the other hand, Belebas variety performed better mean grain yield (20.26 qt/ha) than Degagsa variety (18.68 qt/ha) and Tsigab variety (12.24 qt/ha). In general, the total and mean score result showed that Degagsa variety and Belebas variety were the most preferred varieties and ranked as first and second, respectively, by participants at all districts. Based on these facts, both varieties were recommended for further scaling up in the study areas and other places with similar agro-ecologies.

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Cluster-based pre-scaling up of improved Rhodes grass (Chloris gayana) technologies in some districts of East and Horro Guduru Wollega and West Shawa Zones, Oromia, Ethiopia

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ABSTRACT

Rhodes grass is an important tropical grass widespread in tropical and subtropical countries and it is a productive and high quality forage for animal feed with drought-resistant as compared with other tropical grasses. This activity was conducted at five districts namely: Boneya Boshe, Wayu Tuka Gida Ayyana, Guduru and Bako Tibe and organized to 8 clusters. A total of 40(28 male & 12 female) voluntary farmers having 10 ha of land were selected. Accordingly, Rhodes grass (massaba) variety was multiplied on 10 ha in 8 clusters. Thus, 120 kg of massaba variety seed was provided to selected farmers based on their clustered farms. Farmers were implementing farm activities on selected experimental sites of each cluster in collaboration with researchers and extension agents after both theoretical and practical training was conducted. Field day has been organized by AGP-2 and Bako agricultural research center with coordinating role was given for cluster team members. Farmer's during field tour and interviews reveals that improved Rhodes grass showed good adoptability and high biomass yield performance across the study districts. Result indicted that Rhodes grass variety had given high yields for both herbage biomass and seed yield. The average seed yield performance for the variety was ranges from 220 kg/ha to 280 kg/ha in one harvesting time across the study districts. Besides, 19.11 t/ha mean herbage DM yield were produced after seed harvest which rages form 17.84 to 20.29 t/ha per harvest, so that it was used as double advantage for farmers. Therefore, scaling-out works of this variety would be carried in similar areas by districts extension agents through cluster approach.

Keywords: Cluster, massaba, pre-scaling up, Rhodes grass

INTRODUCTION

Despite huge livestock population in the country, productivity of animals in Ethiopia is lower than the regional and continental average. Among the factors contributing to low productivity, availability of poor quality feed resources remains to be the major bottleneck to livestock production. Native pastures are the major ruminant livestock feed resources of the pastoral and mixed crop-livestock production (Lemma and Abubeker, 1995). But the qualitative and quantitative inadequacy of these pastures for profitable animal production. Hence, the introduction of forage grasses like *Rhodes grass* into the farming system has been suggested as one of the strategies for ensuring the sustainability of livestock production.

Rhodes grass (*Chloris gayana*) is an important tropical grass widespread in tropical and subtropical countries. It is useful forage for pasture and hay, drought-resistant and very productive, of high quality when young. Rhodes grass can withstand long dry periods (over 6 months) and up to 15 days of flooding (Cook *et al*., 2005; FAO, 2014). Rhodes grass is suited to both rain fed and irrigated pastures. Therefore, incorporation of such grasses into the farming community through extensive seed multiplication can improve feed availability and thereby enhance the production and productivity of livestock sector. Therefore, the pre-scaling up activity was proposed to promote the Rhodes grass variety along with its recommended agronomic practices, to enhance production and productivity of Rhodes grass, to create awareness and demand on Rhodes grass production and to improve farmers' knowledge and skill of application of the technology for future wider scaling up through cluster approaches.

MATERIALS AND METHODS

Site and farmers selection

The pre-scaling up activity was conducted in five purposely selected districts namely Boneya Boshe, Wayu Tuka, Gida Ayyana from East Wollega zone, Bako Tibe district from West Shawa zone and Guduru district from Horro Guduru Wallega zone, as target areas which were selected based on their livestock production potential. One potential peasant association (PA) was selected purposively from each district based on their representativeness and accessibility for farmers to visit and for monitoring and evaluation. In each PA, two clusters were established that have been consisting 1.25 ha per each were established in each PAs making up the number of clusters to eight (8) in total. Each cluster comprises five (5) farmers who have contributed 0.25 ha of land and a total plot size of 10 ha was scaled up. Therefore, a total of 40 voluntary farmers having 10 ha of land were selected (considering gender and youth balance, 30-40 %). Participant farmers were selected based on willingness, gender composition and capacity and capability to properly execute the planned pre scaling up activity.

Field establishment and Management

Improved Rhodes grass variety 'Massaba' was planted on selected farmers' fields on 10 ha of land. The pre-scaling up plots was replicated on 40 farmers' fields which were organized to 8 clusters across the study districts. Thus, 120 kg of massaba variety seed were provided to selected farmers based on their clustered farms. NPS and urea fertilizer were applied to all plots during plantation at a rate of 100 kg/ha for each and split application was used for urea. All farmers in a cluster were applied the recommended Rhodes grass production packages and fields were managed by participant farmers with close supervision of researchers and DAs.

Training of farmers and extension workers

Both theoretical and practical training were given to participant farmers, subject matter specialists (SMS), development agents (DAs) on cluster and value chain approaches of Rhodes grass packages (production and management practices). The training was prepared with clear objectives, outputs, method of training, trainers and schedule. Farmer practical training was mainly carried out on farmers' field and FTCs in collaboration with researchers and extension workers.

Data collection and analysis

Both quantitative and qualitative data were collected. Yield performance (biomass and seed), Number of trainings and field tour organized, Number of farmers and stakeholders participated in training and field visits, change in level of knowledge and skill of farmers and farmers' perception were data collected. Descriptive statistics, knowledge test, qualitative narrations are employed to analyze the collected data.

Method of data collection:
Both qualitative and quantitative methods of data collection such as field observation, household interview, focused group discussion (FGD), knowledge test items and attitude/perception scales will be employed to collect all range of data required for the study.

RESULTS AND DISCUSSION

Training of target group (Farmers, DAs and Experts)
After formation of the cluster both theoretical and practical training was organized at all study sites (clusters). It was given on the topics of agronomic practices, utilization system, stakeholders' linkage and extension approach and market and information linkage. Accordingly, out of 118 training participants 82(60 male and 22 female) farmers, 22(16 male and 6 female) development agents and 14 (12 male and 2 female) experts were participated (Table 1).

Table 1: Training given to farmers and extension workers across the study districts

Districts	Participants						Total		Total
	Farmers		DAs & supervisors		Experts				
	Male	Female	Male	Female	Male	Female	Male	Female	
Boneya Boshe	8	4	2	1	2	0	12	5	**17**
Wayu Tuka	7	3	2	1	2	1	11	5	**16**
Gida Ayana	15	6	4	2	3	0	22	8	**30**
Guduru	14	4	4	1	3	0	21	5	**26**
Bako Tibe	16	5	4	1	2	1	27	7	**34**
Total	60	22	16	6	12	2	88	30	**118**

Field Tour and visits
Field tour and experience sharing events which encompasses different professionals from different places were organized to create awareness, collect feedback and facilitate knowledge & experience sharing among farmers and other stakeholders. Regular joint monitoring and evaluation and provision of technical advice were conducted at different crop stages. Mini farmers' field days were organized at each cluster site in order to involve key stakeholders and enhance better linkage among relevant actors. Accordingly, participant farmers and other stakeholders were appreciated Rhodes grass variety for its high herbage yield performance, adaptability to the environment and good crop stand at all study sites.

Yield performances
The herbage DM yield (Figure 1) performance of Rhodes grass was varied from place to paces. Mean herbage DM yield (t/ha) of the variety was ranged from 17.86 to 20.29 t/ha across the study districts. The result showed that, the herbage DM yield of Rhodes grass variety was higher at Wayu Tuka (20.29 t/ha) district followed by Guduru district (19.93 t/ha) while lower result was recorded at Bako Tibe with a mean herbage DM yield of 17.84 t/ha. The differences may indicate that due to soil fertility status of the experimental sites and attention given to the crop management by owner farmers.

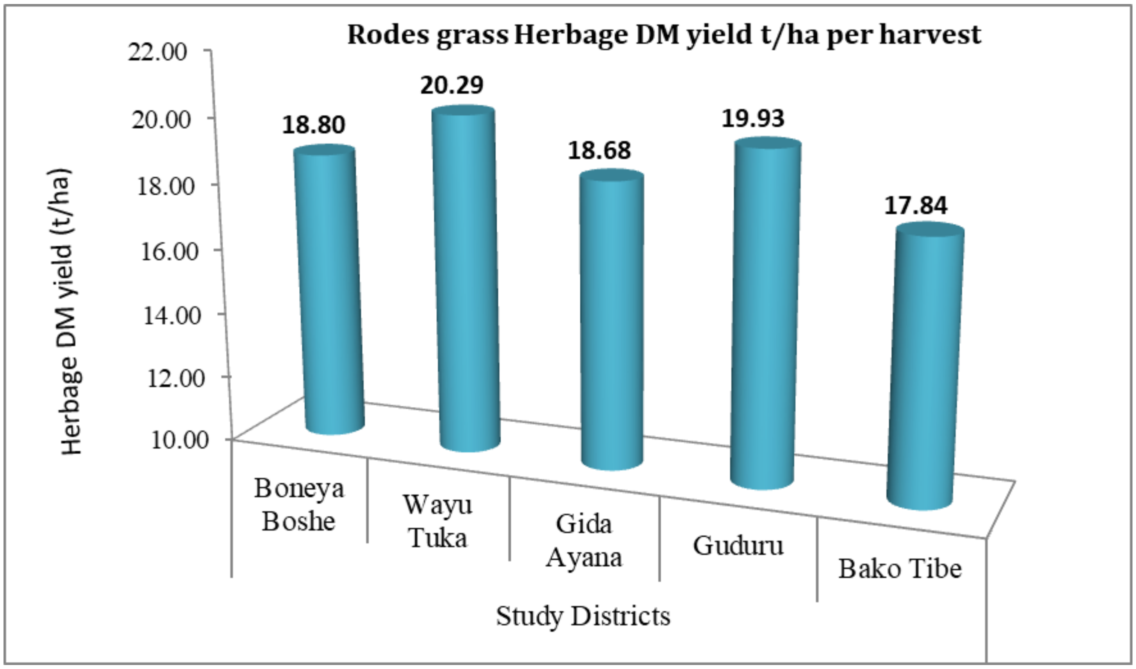

Figure 1: Mean of herbage DM yield (qt/ha) of Rhodes grass variety across study districts

Likewise, the seed yield performance of Rhodes grass was varied across the tasting districts (sites). The variety had higher mean seed yield of 280 kg/ha per harvest a Wayu Tuka district followed by Guduru and Gida Ayana districts which recorded the same results of 240 kg/ha. Whereas lower results was obtained at Boneya Boshe and Bako Tibe districts with mean seed yield of 220 kg/ha and 230 kg/ha per harvest, respectively.

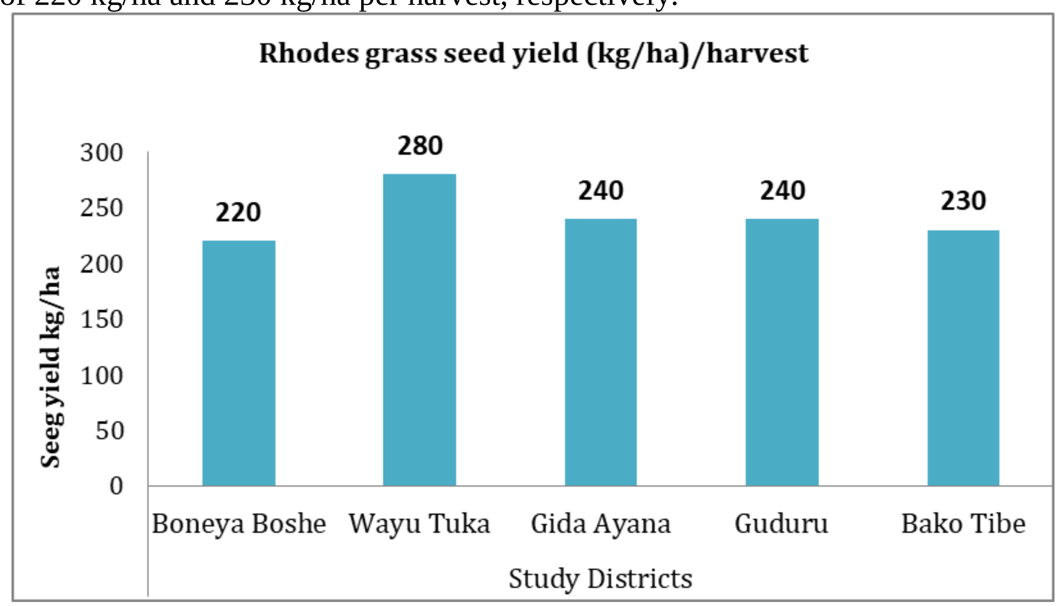

Figure 2: Mean of seed yield (qt/ha) of Rhodes grass variety across study districts

CONCLUSIONS AND RECOMMENDATION

The cluster-based pre-scaling up of improved Rhodes grass activity was conducted at five districts in 2019 using one variety of Rhodes grass (massaba). The aim of the study was to produce large and quality seed of Rhodes grass and scale up at farmers level through cluster approaches for further utilization in the farming communities. The results indicated that the variety gave promising mean herbage DM yields ranging from 17.84 to 20.29 t/ha per harvest across the study districts. Similarly, reasonable average seed yield performance for the 'massaba' variety was recorded in which ranges from 220 kg/ha to 280 kg/ha in one harvesting time across the study areas. Different yield results were recorded in both herbage DM and seed yields across the study districts. This yield differences may indicate that due to condition of soil fertility of the experimental sites and management practices by owner farmers within the clusters and agro ecological difference across the study districts. In terms of farmer's perception during field tour, participant farmers and other stakeholders were valued Rhodes grass variety for its adaptability and high biomass yield performance at all study sites. Therefore, based on the results improved Rhodes grass 'massaba' variety is recommended for pre-scaling up at the study districts and in similar areas.

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Pre-extension Demonstration of Elephant Grass in selected Districts of Bale Zone

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ABSTRACT

Pre-extension demonstration of improved Elephant Grass accessions was conducted in Ginnir and Agarfa districts of Bale Zone. The main objective of the study was to demonstrate and evaluate adapted accessions of Elephant Grass. The demonstration was under taken on single plot of 5mx5m area for each accession with row planting of recommended spacing of 0.7m/0.3m between rows and plants respectively and fertilizer rate of 100/50kg/ha NPS/UREA. Mini-field day involving different stakeholders was organized at each respective site. Fresh Biomass Yield data per plot was recorded and analysed using descriptive statistics, while farmers' preference to the demonstrated accessions was identified using focused group discussion and summarized using pair wise ranking methods. The demonstration result revealed that ILRI 18601 accession performed better than the other accessions (18600 & 18787) with an average fresh biomass yield of 92ton/ha, 78ton/ha and 75.5ton/ha respectively. ILRI 18601 accession had 17.95% and 22.67% fresh biomass yield advantage over ILRI 18600 and ILRI 18787 respectively. Furthermore, this accession was selected by farmers. Thus, ILRI 18601 accession was recommended for further scaling up.

Key words: Demonstration, Farmers' preference, Elephant Grass, Selection criteria

INTRODUCTION

Livestock contributes to people's livelihoods through numerous channels: income, food, employment, transport, draft power, manure, savings and insurance, social status etc. (FAO, 2018). A major problem facing livestock producers in tropical countries is how to provide a proper nutrition for their animals, especially during the dry season when pasture and cereal residues are limiting in quantity and nutritional quality. Underfeeding reduces animal growth and milk yield and diminishing farmer's income, Animals become weak, more susceptible to disease and their fertility declines (Rusdy M 2016).

The major constraint to cattle production in Ethiopia is nutrition. Cattle are predominantly fed on natural pastures and crop residues. However, due to rising human population, traditional grazing lands are widely being converted to croplands, forcing cattle to graze on marginal and overgrazed lands with poor quality forage (Kitaba and Tamir, 2007). Elephant Grass is one of the grasses used as forage. Napier or elephant grass (PennisetumpurpureumSchum.) shows a great potential to alleviate the problem because it is drought resistant and has high dry matter yield potential. Elephant grass is fast growing and has a high annual productivity that depends on climatic and soil conditions. The range of protein content of elephant grass varies from 4.4 to 20.4% with the mean around 12% (Rusdy M 2016). Napier grass (Pennisetumpurpureum(L.) Schumach), also known as elephant grass, originated from sub-Saharan tropical Africa (Clayton et al., 2013). Napier or elephant grass (Pennisetumpurpureum) is a perennial grass grown widely in East Africa as a fodder crop. It is being promoted in Ethiopia for use by cut and carry (zero grazing) smallholder livestock keepers (Adey, 2009). Adaptation trial of Elephant grass accessions were evaluated in Bale lowland by SARC in 2016-2018. Finally, ILRI 16801, ILRI 16800 and ILRI 16787 of Napier grass accessions were performed better and recommended for the area. Therefore, it is important to undertake the demonstration of these accessions.

METHODOLOGY

Description of the study area

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

Site and farmers selection

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

Materials used and Field design

Improved accessions, ILRI 18601, ILRI 16800and ILRI18787 were demonstrated. Simple plot demonstration was used on area of $25m^2$ (5m x 5m) for each accession. Full packages were applied in which, row planting with 0.7m/0.3m cm b/n rows and plants respectively and fertilizer rate of 100/50kg of NPS/UREA per hectare was applied. Twice hand weeding was done.

Data collection

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

Data analysis

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

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 accessions in order of their preference, how to carefully assess each accession by considering each criteria and using rating scale, how to organize collected data, how to make group discussion and reach on consensus, and finally report through their respective group leaders.

Table 1: Participants of Demonstration

	Farmers					
Districts	**Men**	**Women**	**Youth**	**Total**	Others	Total
Ginnir	16	1	10	27	5	32
Agarfa	14	4	6	24	5	29
Total	30	5	16	51	10	62

RESULT AND DISCUSSION

Yield performance of Demonstrated Accessions

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

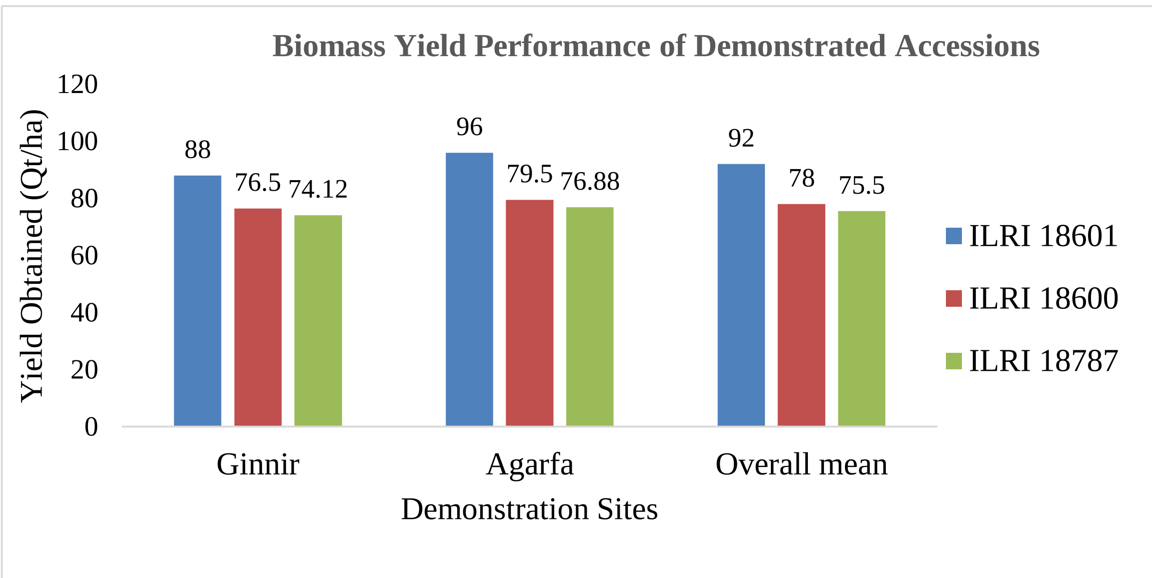

Fig 1: Yield performance of the demonstrated accessions

The demonstration result revealed that,accession ILRI 18601 performed better accession ILRI 18600 and accession ILRI 18787 all over the demonstration sites. It gave higher biomass yield at all locations. The mean yield of ILRI18601 accession was 88ton/ha and96ton/ha, at Ginnir and Agarfa respectively with all over mean yield of 92ton/ha. The mean yield of ILRI 18600 accession was 76.5ton/ha and 79.5ton/ha at Ginnir and Agarfa respectively with all over mean yield of 78ton/ha. Similarly, The mean yield of ILRI 18787 accession was 74.12ton/ha and 76.88ton/ha, at Ginnir and Agarfa respectively with all over mean yield of 75.5ton/ha (Chart 1). The yield advantage of ILRI18601 over ILRI 18600 and ILRI 18787 is 17.95% and 21.85% respectively.

Comparison of yield advantage of accessions

Yield Advantage of **ILRI 16801over**ILRI 16800:(((92-78)/78)x100% =**17.95%.**

Yield Advantage of **ILRI 16800 over** ILRI 18787: ((92-75.5)/75.5) x100% = **21.85%.**

Pair wise ranking was used to identify farmers' preference of accession traits. Accordingly, biomass yield,tillering capacity andrapid growth were the top three priority concern given by farmers (table 2).

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

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

A=Higher biomass yield, B=Rapid growth, C=adaptable to soil, D=adaptable to environment, E=higher tillering capacity, F=higher plant height

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

Table 3: Rank of the accessions based on farmers' selection criteria

No	Accession	Rank	Reason
1	IRLI 18601	1st	Higher biomass, Rapid growth, adaptable to soil, adaptable to environment, higher tillering capacity, higher plant height
2	IRLI 18600	2nd	Medium biomass, moderate growth, moderately adaptable to soil, moderately adaptable to environment, moderate tillering capacity, moderate plant height
3	IRLI18787	3rd	less biomass, less growth, less adaptable to soil, less adaptable to environment, less tillering capacity, shorter plant height

CONCLUSIONS AND RECOMMENDATIONS

Pre extension demonstration and evaluation of improved elephant grassaccessions was carried out on eight (8) representative trial farmers' fields. Improved accessions viz. ILRI 18601, ILRI 18600and ILRI 18787were demonstrated and evaluated. Accordingly, ILRI18601 gave higher biomass yield than ILRI 18600 and ILRI 18787 accessions. Moreover, ILRI 18601 was selected by participant farmers in all districts due to it is has higher biomass yield, rapid growth, adaptable to soil, adaptable to environment, higher tillering capacity and higher plant height. Based on these facts, ILRI18601 accession was recommended for further scaling up.

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Pre-extension demonstration of Elephant/Napier grass (Pennisetum purpureum) for Animal Feed Resources in Dire Dawa and Harari Region rural areas

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ABSTRACT

Pre-extension demonstration and evaluation of elephant grass varieties with the objectives of promoting and popularize improved elephant grass technologies and to create awareness through giving training and enhance stakeholders participation. A total of forty (40) trial farmers were selected from four potential elephant grass growing kebeles of Dire Dawa administration council and Harari region. Four FRG having 60 farmers were established. Two improved elephant grass varieties (IRLI14983 and other locally available) were replicated on the plot of 20mx20m. Training on which a total of 63 participants took part were organized at Sofi Harari Region. Elephant grass varieties were evaluated based on their early maturity, Biomass yield. The yield performance of IRLI14983 ranged from 6.7 to 12.9 t/ha with a mean of 9.8 t/ha, local variety gave the 4.3 and 9.1 ton/ha biomass yield respectively. The biomass yield varied significantly ($P<0.01$) among the demonstrated varieties and Generally, Elephant grass varieties respond differently across the Demonstrated environments due to differential responses of the climatic and biotic factors. Recorded at Dodota (10.62 t/ha) followed by Wahil (9.61 t/ha).Hence IRLI14983 recommended for scaling up

Key words: Biomass Yield, Demonstration, Elephant grass Varieties

INTRODUCTION

Sustainable livestock production is highly dependent on the availability of quality feed and forage resources. Napier grass, also known as elephant or Uganda grass, is one of the most important tropical forage crops. It is widely used in cut and carries feeding systems (Lukuyu *et al*, 2012) and is of growing importance in other agricultural systems. Napier grass possesses many desirable characteristics, including high yield per unit area, tolerance to intermittent drought and high water use efficiency making it forage of choice. It has the ability to withstand repeated cutting and will rapidly regenerate, producing palatable leafy shoots (Kabirizi *et al.*, 2015). Agriculture is back bone of Ethiopian economy and accounts for 46% of Gross Domestic product and, livestock sector contributes 30% to35% and more than 85% of cash income. The subsector also accounts for 19% export earnings (Jimma *et al.*, 2016).

Despite this fact feed shortage and poor quality of available feeds are the major constraints to increase livestock productivity in Sub Saharan Africa particularly Ethiopia (Orodho, 2011). Sowing a new pasture or improving an existing natural pasture requires a reliable source of seed or vegetative material or species recommended and adopted for the area (Worku, 2009).

Inadequate nutrition and feeding are major constraints to livestock production in sub-Saharan Africa (SSA). Feeds (usually based on fodder and grass) are either unavailable in sufficient quantities due to fluctuating weather conditions or are available but in a poor quality that they do not provide adequate nutrition (Ishii *et al,* 2013). These constraints result in low milk and meat yields, high mortality of young stock, longer inter calving intervals and low animal weights (IRLI, 2009).

Use of improved forages would reduce pressure on natural pasture, improve soil fertility and erosion of marginal lands, improve carbon sequestration to mitigate climate change, support system substantially and enhance natural assets and system reliance **(**IRLI, 2009), for instances some of improved forage species can be used for these above services are desho grass, elephant grasses, sesebainiasesban, Rhodes, oats, cow pea and others **(**Jimma et al., 2016**).** Therefore, to overcome this livestock production loss using alternative feed resources like Napier/Elephant grass is indispensable. Having this in consideration this research activity was developed to improve feed security of livestock in Dire Dawa and Harar rural areas through Napier/Elephant grass demonstration on farmers land/degraded land and Farmers Training Center.

MATERIALS AND METHODS

This research activity was undertaken in selected districts of Dire Dawa and Harari region.

Site and farmers' selection

The Kebeles as research sites were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting, accordingly, Kile and Dodota from Harari and Wahil, and Bishan Bahe from Dire Dawa were selected. In addition, farmers were selected based on their interest, innovation he/she has, land provision for this demonstration, interest in cost-sharing, willingness to share experiences for other farmers, and studying their profile.

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

District	Pas	No. of trial farmers	FTCs	Area covered
Dire Dawa	Wahil	10	1	20mx 20m for each plots
	Bishan Bahe	10	-	
Harari	Dodota	10	-	
	Kile	10	-	
Total		40	1	

Research design and implementation

Elephant/Napier grass cuttings (two varieties IRLI14983 and local check were selected for this demonstration purpose, because IRLI14983 variety was being adaptable in these environment when its adaptation trial on research station was conducted. Then, cuttings of Elephant grass were prepared in form of at least 5cm-8cm (in number 300-400 cuttings per kebeles in total of 12000-16000 cuttings) were planted on the contour in respect to 80cm between cuttings and 100cm between rows according to availability of contour structure or watershed areas in addition on Farmers Training Centers.

Data Collection

Both quantitative data sheet were collected by data sheet and qualitative through personal field observation, individual interview, Focus Group Discussion by using checklist.

Data analysis

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

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

Multidisciplinary research teams: crop, extension and socio-economic researchers and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge, journalists for the sake of publicity of the work done, Development Agents, Experts and farmers were participated on the training entitled Elephant/Napier grass production and management.

Table 2: Participants on the elephant/Napier grass training at Research Sites

No.	Participants	Male	Female	Total
1	Farmers	39	10	49
2	Das	4	1	5
3	District experts	4	2	6
4	Journalists	3	0	3
	Total	50	13	63

Source: Own computation 2018/19

Among the participant stakeholders, 77.7% were farmers whereas 20.4% were female farmers' participant. Different extension materials were utilized and distributed for the participants these were 35 leaflets and 20 manuals on the technology that are organized in Afaan Oromoo (local language) and English were distributed.

Agronomic and yield performance

The following table describes the yield performances of the demonstrated Elephant/Napier grass varieties across the study site. The yield performance of the improved varieties (IRLI14983 and local) were 10.62, 8.20, 8.87, 9.61 and 7.27, 5.60, 6.13, 6.19 ton/ha at Dodota, Sofi,Bishan Bahe Wahil respectively.

Table 3.Yield performance of improved elephant grass varieties across districts on Farmers land

PA	**Varieties**	**N**	Std. Deviation	**Mean (ton/ha)**	**Maximum**	**Minimum**
Dodota	IRLI14983	10	1.887	10.62	12.90	7.70
	Local	10	1.174	7.27	9.10	5.50
Sofi	IRLI14983	10	1.529	8.20	11.10	6.50
	Local	10	.915	5.60	7.00	4.30
Bishan Bahe	IRLI14983	10	1.172	8.87	10.90	7.00
	Local	10	1.454	6.13	8.20	4.00
Wahil	IRLI14983	10	1.379	9.61	11.20	6.70
	Local	10	1.113	6.19	8.00	4.70
Total			2.143	7.81	12.90	4.00

Table 4 Independent t-test

	Test for equal variances		t-test for equality of means				
	F	Sig.	T	df	Sig.(2-tailed)	Mean difference	Std. Error Differences
Equal variances assumed	4.58	.035	8.92	78	.000	3.03	.339

Statistically significant difference 1% probability level

Yield Advantage

The result indicated that IRLI14983 variety has better yield (58.12 ton/ha) when compared with local check (55.07ton/ha).Accordingly, the yield advantage of the IRLI14983 variety over the local check was 48.17% under farmer condition.
Yield advantage of the demonstrated varieties was calculated using the following formula.

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

Table 5: Summary of yield performance in study areas

Varieties	Average yield ton/ha	Yield difference ton/ha	Yield advantage over the local check (%)
IRLI14983	9.32	3.03	48.17
Local check	6.29		

Source: Own computation 2018/19

Farmers' Opinion/Perception

Farmers set criteria after having know-how about the variety and by using those criteria they gave ranks for the varieties with reasonable remarks during variety demonstration that were: biomass, survival, adaptability, palatability by livestock, and drought tolerant. As a result, most of the farmers selected IRLI14983 variety to reuse on their farm for the future as depicted in following table 6.

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

Varieties	Farmers rank	Reasons	Remarks
IRLI14983	1st	Good biomass, good survival ,adaptable, good palatability and drought tolerant	Biomass was measured by Balance in ton, counting the tinted and matured cuttings(survival measurement), gave to livestock(palatability measurement) and produced with existing rainfall
Local	2nd	Good biomass, good survival ,adaptable, good palatability drought tolerant	

Table 7: Pair-wise ranking matrix result to rank variety traits.

Code no.	Traits	Biomass	Survival	Adaptability	Palatability	Drought tolerant	Frequency	Rank
1	Biomass		1	1	1	1	4	1st
2	Survival			2	2	2	3	2nd
3	Adaptability				3	3	2	3rd
4	Palatability					4	1	4th
5	Drought tolerant						0	5th

The highest average yield of the IRLI14983 Elephant/Napier grass were recorded at Dodota 10.62 ton/ha and Wahil 9.61 ton/ha as compare to local varieties across the sites. This indicates that this variety is very adaptable and suit with the existing environmental conditions in these sites. And there was yield difference of the varieties across the research sites due to rainfall, soil type and other climatic conditions. In addition there was yield advantage of IRLI14983 variety over local check that is 48.17% as depicted in table 5 since there was yield of 3.03 ton/ha in comparison and statistically significance different at $p<0.01$.

Moreover, farmers evaluated these two varieties (IRLI14983 and local) at different stages based at farm level based on their own criteria: good biomass, good survival, adaptable, good palatability and drought tolerant, accordingly, ranked IRLI14983 variety on first rank as compare to local as shown on table 6, and even evaluated these criteria by pair-wise ranking, as result, ranked biomass first with the rest as on table 7. Based on these above result and discussion the following conclusion recommendation was derived.

CONCLUSION AND RECOMMENDATION

The yield performances of the demonstrated elephant grass varieties across the study sites were 9.32to/ha for (IRLI14983) and 6.29 ton/ha for local variety with 3.03ton/ha yield difference in which IRLI14983 has more yield advantage 48.17% over local variety. As a result, farmers selected IRLI14983 variety on first rank due to its good biomass, good survival, and adaptable, good palatability and drought tolerant because in these areas there is an opportunity of underground water availability, suitable soil, and other suit climate conditions they can produce this Elephant/Napier grass IRLI14983 variety in these agro-ecology.

Therefore, from this research finding it is recommended to promote further IRLI14983 Elephant/Napier grass variety in similar agro-ecology is very important by government, Nongovernment and other stakeholders through their program to small holder farmers for enhancement of food security for human and feed forages for livestock .

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On-farm Evaluation and demonstration of small hive beetle (Aethina tumida) trapping technology

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ABSTRACT

On farm Evaluation and demonstration of small hive beetle (Aethina tumida) trapping technology was conducted in 2018/2019in West Shoa zone,Bako Tibe district to evaluate the effectiveness of the trap, minimize the absconded of honey bees and produce quality honey.one representative PA was selected based on honey production potential and accessibility field monitoring and visit. Beneficiary farmers were selected based on the criteria and objective of the program (Agricultural Growth Program II,) and the willingness of farmers to participate in the demonstration. The FREG members include 20 beekeepers (5female and 15 men.) Training was given for beekeepers,Woreda experts and DAs.20 Langstroth hives (10 treatment and 10 control) were established at one apiary site. Pieces of corrugated cardboard (45 cm × 45 cm), with one surface peeled to expose the ridges were placed on the bottom board of each bee hive with the ridged side down for treatment group hive. Small hive beetle adult and larvae were trapped counted, removed and burned. Honey bee colonies from the treatment group were not absconded whereas control group honey bee colonies were more absconded. The honey yields obtained from treatment group 16Kg/hive/season and 7Kg/hive/season from control group. The number of small hive beetle adult and larvae counted from the card board and other parts of the hive body were decreased through data collection season. The FREG members appreciated the technology; therefore, further scaling up of this technology should be conducted in different areas of beekeeping.

Key words: cardboard, Langstroth, Small hive beetle

BACKGROUND AND JUSTIFICATIONS

Small hive beetle 'SHB', *Aethina tumida* (Murray) is known as a major pest and scavenger of honeybees (Neumann and Ellis, 2008; Neumann and Elzen, 2004; Hepburn and Radloff, 1998). During the last 25 years, SHBs were introduced into many countries worldwide, leading to economic, societal, and ecological consequences for apiculture (Sch€afer et al., 2019). The beetle is likely to continue spreading in the future (Cornelissen, Neumann, & Schweiger, 2019) in different countries. It is becoming a serious threat to the long-term sustainability and economic prosperity of beekeeping.

The SHB is indigenous to Africa, where it was previously considered as a minor pest for bee colonies of African honeybees (*Apis mellifera*) (Lundie, 1940). Nests of social bees not only provide comparatively rich food resources for SHBs but also protection from a range of environmental hazards (Michener 1974; Hepburn and Radloff 1998), e.g. almost half of the SHB population (44 %) was recorded outside hives during hot months, but during cooler times, SHB populations were predominantly within hives (Annand 2011b). However, in such nests, SHBs are facing defenses from the host workers thereby resulting in a trade-off scenario between highly rewarding food and the danger of injury.

Currently, the beetle is widespread in different states of the world, including Europe (Cuthbertson et al., 2013; Doug, 2003; Elzen et al., 2002; Elzen et al., 2001). In Ethiopia, small hive beetle was lately detected in southern and south eastern parts of the country in 2000 (Desalegn & Amssalu, 2001). Eight years later the pest was detected with highest distribution and prevalence rates in most beekeeping potential areas of the country (Amssaluet al., 2012).

Adult and larval beetles can be a significant problem in the honey house (Lundie, 1940; Hood, 2000).Both the larvae and adults of SHB live in honey bee colonies, where they feed on pollen, brood, and honey, but the larvae inflict the most damage (Elzen et al., 1999). Adults invade honey bee colonies, where they lay eggs in crevices and on the combs. For pupation, the larvae crawl out of the hive and burrow into the surrounding soil where the moisture level is suitable for pupation (Zawislak, 2010). Upon eclosion from the ground, adult beetles search for honey bee colonies, probably identifying the host colony by a suite of olfactory cues (Zawislak, J. 2010; Elzen et al. 1999). The SHB has been shown to cause significant damage to honey bee colonies that are weak or under great stress, but also effects strong bee colonies to the point of absconding (Ellis 2004). Studies have shown that beetles fly before or just after dusk and attracted to odor from various hive products (honey, pollen) and particular pheromone from adult bees (isoamyl acetate) (Schmolke 1974; Elzen et al. 2000). They are strong fliers from hive to hive, and between apiaries in search of suitable places to get food and to reproduce. In severe infestations, the bees are generally forced to leave their hive and depressingly affect the beekeeping production (Morse and Calderone, 2000; Elzen et al., 1999). Moreover, defecation in the hives and on the comb honey can cause honey fermentation that decrease the honey quality (Elzen et al., 1999).

An investigation on the effects of small hive beetle on honeybees and the effectiveness of different control methods were conducted at Bako apiary site from the years of 2010 to 2012. Of the control treatments, trapping of adult beetles using cardboards over the bottom boards revealed about 78 % control efficiency and reduces honeybee colony absconding (Alemayehu *et al.*, 2017).

Therefore, on-farm evaluation and demonstration of this technique was help to develop a pragmatic prevention and/or control measure at the farmer's situation with the objectives of:to evaluate and demonstrate the effectiveness of small hive beetle trapping at farmers level, to increase honey production and quality by preventing /controlling small hive beetle infestation, awareness creation on small hive beetle trapping technology and to minimize the loss caused due to small hive beetle infestation.

MATERIAL AND METHODS

Site and Farmers selection

The study was conducted in Bako Tibe district of West shoa zone. One appropriate PA was purposively selected in Bako- Tibe district based on criteria and objectives of AGP-II project. The activity was carried with farmers' Research Extension Groups (FREG). FREGs with 20 beekeepers (15 male and 5 female) were established to facilitate farmers" participation in demonstration and training on trapping technology. Pre-training was taken for the FREG members on the implementation of trapping materials and regular monitoring of the pest.

Farmer’s training

After identifying farmers, practical and theoretical trainings were provided to the district experts, development agents and farmers. Theoretical training was given for group members on small hive beetle trapping and its utilization before colony transferring. Training was one of the most important FREG approach used. The training enabled them to develop skill on the general management practices of trapping technology, when and how small hive beetle larvae and adult control from honey bee colonies using card board.

FREGs groups	No. of beekeepers		Woreda experts		Total Participant
	Male	**Female**	**Male**	**Female**	
Bako- Tibe	15	5	6	0	26

Table1: Number of participants before colony establishment

Experimental set up

Ten Langstroth type hives were modified with open underneath on the bottom board and covered with mesh wires (treatment groups). Another 10 Langstroth type hives without modification were used as (control groups). An effort was made to reduce the number of small hive beetle adult and larvae present in colonies. All Langstroth boxes were new and previously unused at the beginning of the study. A total of 20 honeybee colonies (10 in to treatment and 10 in to control groups) were transferred. Both treatment and control colonies were fed 1:1 sugar/water every dearth period/season. Then for all the treatment groups, pieces of corrugated cardboard (45 cm × 45 cm), with one surface peeled to expose the ridges were placed on the bottom board of each bee hive with the ridged side down. Underneath of the frames on the bottom board were covered with mesh wires which allow SHB to enter and hide in the corrugations, but exclude honey bees to fit the bottom board. Corrugated card board insert were removed after a few hours and replaced every 21 days to examine small hive population measure. Then, broken, open the card board peeled back and the number of adult and larvae of small hive beetles live were counted removed.

Data collection

Colony infestation by small hive beetles, acceptance of technology, and number of beetles captured in each trap, honeybee colony absconding rate and honey yield were recorded.

Data analysis

Quantitative data was summarized using simple descriptive statistics (average and Percentage) while the qualitative data collected using group discussion and qualitative data collected using group discussion,field observation and oral histories was analyzed using narrative explanation.

RESULT

Technology Evaluation and Demonstration

On farm evaluation demonstration of the on the bottom board trap trial was implemented on FTC (farmers training center). The evaluation and demonstration of the trial was followed by process of demonstration approach by involving FREGs, development agents and experts. Knowledge on trap helped to small hive beetle adult and larvae minimize using the effective management of bee colonies. At every observation/inspection/ time there were SHB larvae and adult found in colonies. During field studies data collection representative sample of SHB collected by trap. When the beetles attempt to hide from light and move to the card board they come into enter in card board trap after a few hour the card board removed and small hive beetle were counted.

Table 2: Numbers of *A. tumida* adult and larvae captured by bottom board trap during trapping periods in February up to May.

Apiary site	Replicates	Total larvae	Total adult	Average	
				Larvae	Adult
Tibe-Bako	10	16	681	3.2	97.2

FREG Capacity Development

All hives and other beekeeping equipments were distributed by the fund of AGP-II for farmers group (materials incentives and technical training). The material fund included introduction of Langstroth hives, honey extractors, smokers, hive tools, hand gloves, veils and etc. Group members were trained in all aspects of small hive trap using on card board. Small hive beetle trap was seen at experimental site in mass during the training time and demonstrated to all participants. Practical training was given for FREGs members at the apiary site on SHB trap technology, this includes mainly based on the importance of technology (hive stand making card board peeled and inserting, by using the light the SHB move from the colonies and hide in the peeled card board). Training is the most important part of this activity and training was delivered to the, 20 beekeepers target farmers (15 males and 5 females. With regard to the cardboard technology, it was found that all members of the formed beekeeping groups fully agreed the tarp irrespective of their gender.

According to the participant beekeepers SHB control /minimize is a better method for honey production and honey bee colony absconding rate minimize. All participant farmers were very much engaged and attracted to use this trap to small hive beetle control from their honey bee colonies.

Colony infestation by SHB

When hives were opened adult beetles quickly drop away from the light, so look for adult beetles moving inside the hive, running across the combs and bottom boards to find hiding places as they do not like to be exposed to light. The number of SHB adult in different months, 724, February, 327, March 133, April and 35 May and SHB larvae in 23 February, 3March, 8 April, and 6 May. The use of trap to capture small hive beetle larvae and adult in honey bee colonies is an effective way to reduce infestation levels. The number of SHB collected by card board trap decreasing from initial data collected time to final time because when the SHB removed honey bee colonies come strong and also strong bees actively remove larvae SHB from the hive. From the treatment group only one honey bee colony was absconded whereas 6 honey bee colonies were absconded from the control group.

We evaluated the effectiveness of small hive trapping using card board to control and limit the infestation of SHBs adults in Bako Tibe honey bee colonies. We see that the card board trap was most effective trap without any disturbing the colonies. However, in colonies with no traps (control), the numbers of honey bee colonies abscond.

Honey Yield

During the 2012 honey harvesting season, honey was harvested both from the treatment and control groups. The amount of honey harvested from the treatment and control hive was measured with farmers at study site in harvesting season. Honey yield obtained from treatment group 16kg/hive/season and 7.3KG/hive/season was harvested. The yield difference between the control and treatment brought from the implementation of small hive beetle trapping practices. Strong colonies produce high yield honey where as weak colonies produce low /or not produced honey.

CONCLUSION AND RECOMMENDATION

Scavenger of honey bee colonies small hive beetles were affects weak colonies than strong colonies. The study showed that hives with the trap have better honey yield, colony performance (strong) and highly favored by the FREG than control groups. The small hive beetles led to absconding of many colonies and reduce the production of the hives because the hive becomes empty. The Performance of colonies was weak in hives without trap and about 60% of the colonies were absconded in different seasons. Hence Small hive beetle larvae and adults effect on honey yield and colony performance.

This study provides evaluation of SHB trap underneath on the bottom board in Bako Tibe site. Based on the finding of the study it is highly recommended that the concerned governmental and non-governmental organization should give emphasis to promote this trap technology at small scale farmers.

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NATURAL RESOURCE MANAGEMENT

Pre-Scaling up of In Situ Moisture Conservation Techniques on Maize (Zea mays L.) yield in Dugda District

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ABSTRACT

The activity was conducted during 2019 cropping season in Dugda District of Tepho Choroke Kebele.The objective was to scale up the selected in situ moisture conservation structures with maize crop (Tied ridge and furrow closed at both ends), improved farmers' knowledge and skills on application of improved technology through training and analyzed cost benefit of the structures. Five FREG groups were established in Tepho Choroke kebele of Dugda District. The total number FREG members were hold 30 male and 10 female farmers. A total of 126 farmers, 2 DAs, 4 SMS and 16 others were participated on the training respectively. The mean yield obtained from tied ridge and furrow closed at both ends were 99.41 and 86.74 kg ha^{-1}, respectively and sold 850 Birr Qt^{-1} at the current price. The net benefit obtained from tied ridge and furrow closed at both ends were 56,230 and 45,194-Birr ha^{-1}**,** respectively. This implied that, the profit obtained from tied ridge was much better than furrow closed at both ends. This structure is much better in increasing yield and crop residue of maize. In addition, the total estimated profit obtained from furrow closed at both end are much better than the usual farmers practice. This also implied that in situ moisture conservation structure (tied ridge and furrow closed at both ends) are more economical and better if it is more scaled up in the study area and similar agro ecologies. Extension worker and Woreda Agricultural Bureau should have given attention to popularized and scaling up this technology to overcome problem of moisture deficit and food insecurity and improve agricultural production in the study area and similar agro ecologies.

Key words: FREG, Furrow closed at end, Moisture deficit, Net benefit, Tied ridge

INTRODUCTION

Ethiopian semi-arid and arid areas are experiencing low crop yield due to a combination of biophysical problems (Gicheru, 2002; Gitau, 2004). Low agricultural productivity in semi-arid region is not only due to land degradation, but also due to moisture deficit (Gebreegziabher et al., 2009). Moisture stress is a prolonged period of short precipitation resulting to water deficiencies and lack of soil moisture to support crop production (Solh and van Ginkel, 2014). Since rainfall is seasonal and erratic in dry lands of Ethiopia, there is moisture stress limiting the productivity of rain fed agriculture in the moisture stress areas (Haregeweyn et al., 2005). A study by Mekuria and Waddington (2004) noted the moisture stress being the major limitation to crops yield in cereal based cropping systems in Eastern and Southern Africa.

In East Shewa of Ethiopia, high moisture deficit is the primary problem that is highly constrains the productivity of farmers of the District (priority problems raised by farmers). In moisture scant environments like Central Rift valley in generally, particularly in Dugda District crop would face shortage of moisture available in the soil throughout the growing season. In Dugda district, there is an uneven distribution, late start and early finish of rainfall. In addition, the distribution of rainfall is not sufficient to sustain crop growth and development in the study area. The moisture deficit in the study area leads to low crop production and productivity. The major problem in this study area is unavailability of in situ moisture conservation techniques (Fikirneh Negash, Fiseha Tadesse, Megersa Handabo, Shimelis Gizachew, Tilahun Firomsa, and Abreham Feyissa, 2016).

Maize is the potential and staple food crop in Dugda district of Tepho Chore Kebele. In general, food deficit in the whole country, particularly in the moisture stress areas is increasing mainly due to drought (Kidane and Abuhay, 2000). The average annual rainfall recorded in most of meteorological stations in the Central Rift Valley (CRV) is well above 700 mm yr^{-1} (Jansen et al (2009). In theory, this amount would be sufficient to grow crops, yet large areas do not achieve food self-sufficiency. The underlying reason for low crop yields might be that a high proportion of the rainfall is not available to the crop, because of excessive surface runoff and unproductive soil evaporation and erratic rainfall during the cropping season.

Accordingly, crop frequently suffers from moisture stress at some stage during its growth period with the ultimate result of reduced yield from their farmland because of shortage or uneven distribution of rainfall and absence conserving surface runoff within the catchment. This calls to design and scaling up in-situ moisture conservation techniques that have better role in sustaining crop production. Therefore, planting crops using in situ moisture conservation reduces problems of soil moisture stress by reducing runoff through increased infiltration and storage of water in the soil profile, the onset and occurrence of severe water stress is delayed thereby buffering the crop against damage caused by water deficits during dry periods (Nyamadzawoetal.,2013).

In these regard, using tied ridge and furrow closed at both end are some of the methods that contribute to mitigate soil moisture deficit and enhance maize productivity in semi arid and arid areas. Currently there is no sufficient research works on scaling up in situ moisture conservation techniques on improving maize yield in Dugda District. Hence, the use of in situ moisture conservation structure is critically important to increase crop yield and improve food security. The two selected in situ moisture conservation structures were gave a significant yield improved over the surrounding the famers' practice in the study area. Therefore, the objectives of the experiment were to scale up the selected two in situ moisture conservation structures (Tied ridge and furrow closed at both ends), improved farmers' knowledge and skills on application of improved technology through training and analyzed cost benefit of the structures for further farmers used in the study area and similar agro ecology.

MATERIALS AND METHODS

Description of study area

The field experiment was conducted at Dugda District, which is found in East Shewa zone of Oromia National Regional State. The Capital town of the district is Meki, which is located at a distance of 140 and 88 km from Addis Ababa and Adama respectively. Geographically, it situated in the central rift valley between 8º02‘59" N latitude and 38º43'59" E longitude respectively. Its elevation is 1600 masl. According to the climatic data collected in 2019 from Adami Tulu Agricultural Researcher Center, the total annual rainfall of the area is 795.4 mm and minimum and maximum temperature is 13.6 ºC and 29.2 ºC respectively.

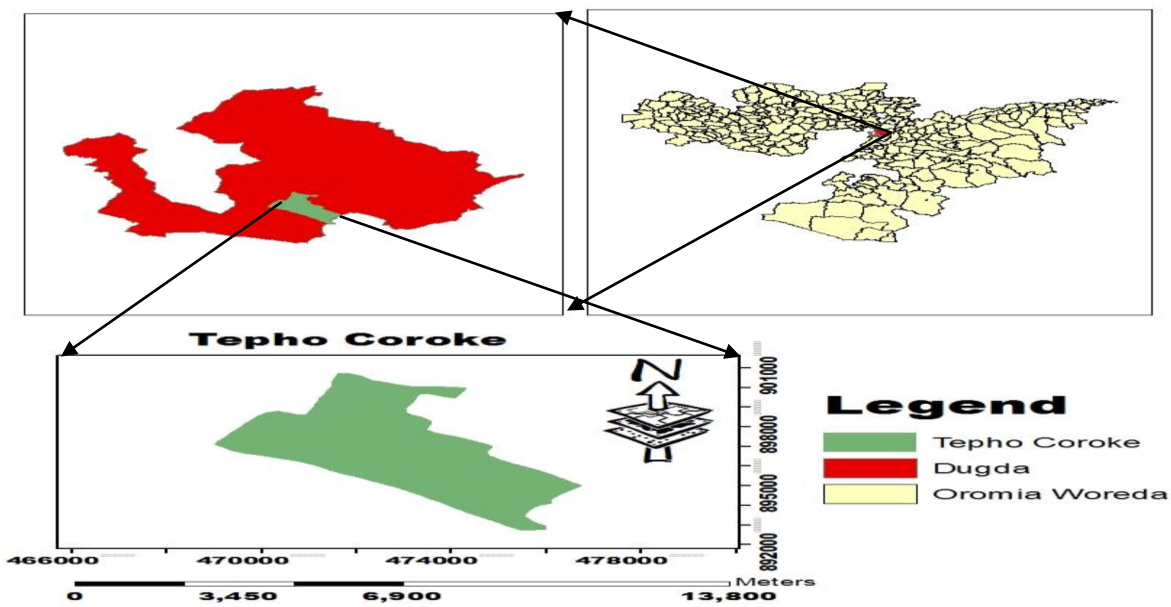

Figure 1: Map of study area

Site and Farmer selection and In-situ moisture conservation

The experiment was conducted at Tepho Chore kebele of Dugda district on five farmers farmland, to pre scaling up of the selected (Tied ridge and Furrow closed at both ends) in situ moisture conservation structures. Tepho Choroke kebele and farmers were selected purposively collaboration with district Agricultural experts and Development Agents (DAs). A total of five farmers were selected and formed in cluster. The farm size selected for each farmer was 100m*100m (10,000m^2). Totally, five hectares (5ha) of land were selected to conduct the experiment. Land preparation was done before construction of in-situ moisture conservation structures on field. Two in situ moisture conservation structures (ridge furrow closed at end and tied ridge) were prepared by labor and used for demonstration in the study area. Cost benefit analyzed at the end of experiment. The roles and responsibilities between ATARC and farmers were signed before conducting of the experiment.

Planting materials, fertilizer used and management

The BH-540 maize variety was used as testing crop. The recommended seed rate, such that 25kg/ha of BH-540 maize variety was used. The recommended fertilizer rate applied for the maize crop. Half of the rate of UREA and the full rate of the DAP fertilizers were applied at the time of sowing respectively. The second half of the UREA fertilizer was applied 30-40 days after planting. All necessary field managements starting from the land preparation, planting, structure preparation, fertilizer application, weeding, chemical spray and harvesting was undertaken collaboration with Adami Tulu Agricultural Research Center.

Economic evaluation

The total costs required for the experiments were recorded. In addition, total revenues obtained from the experiments were recorded. The calculations were done by converting the parameters per hectare. The recorded grain yield and crop residues were converted to current market price. Then, the profit obtained from the experiment was calculated by subtracting total cost from total revenue. This showed in Eq.1:

$$\text{Profit} = \text{TR} - \text{TC} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{eq.1}$$

Where, TR=Total Revenue and TC= Total Cost (Total fixed costs + Total Variable costs)

Data analysis

The grain and economic data were collected using data collection sheet. Simple financial analysis was employed to analyze the costs required for the experiment and the net benefit gained from the production of each in situ moisture conservation structures. All costs required for the experiments and revenue obtained from experiments were recorded and subjected to analysis. The organized data was entered into Microsoft excel and simple descriptive analysis was undertaken and results were presented using tables.

RESULTS AND DISCUSSIONS

Farmers Selection and FREG establishment

From the Dugda district, Tepho Choroke kebele was selected for conducting an experiment. The selected farmers were organized under Farmers Research Extension Group (FREG).The FREG members were selected purposively with Agricultural expert and Development agent (DA) with the criteria of those of who had commitment to implement the technology, interest and transferred knowledge obtained from training and field to adjacent farmers. The total numbers of FREG members were hold 30 male and 10 female farmers participated in the project and formed in five FREG group. The total of established FREG members had 75% of male and 25 % female farmers (Table 1). From each FREG members, as hosting farmer, one directly benefited farmer was selected based on his willingness, commitment and interest.

Table 1: FREG establishment and number of FREG

District	Kebele	FREG Established	Number of FREG		
			Men	Women	Total
Dugda	Tepho Choroke	5	30	10	40
	Total	**5**	**30**	**10**	**40**

Capacity development

Training

Training was organized before imposing any experiment on farmers' field. Totally 95 male and 31 female farmers, 1 female and male DAs, 4 male and no female SMS and 15 male and 1 female others were participated on the training respectively (Table 2 and Figure 2). The title of training is on the concepts of rainwater harvesting, it's importance on increasing yield in moisture deficit area and its effect on yield reduction if it is not prepared. Training was organized and given to stakeholder on the objectives and target of the activities to meet specific gaps on the experiment in the implementation of the activities. All FREG members were participated on training to obtain theoretical concept. Farmers, DAs and experts were attended and became aware on the in situ moisture conservation technologies.

Table 2: Number of farmers, DAs, SMS and others participated on the training

District	Kebele	Farmers			DAs			SMS			Others		
		Men	Women	Total	Men	Women	Total	Men	women	Total	Men	women	Total
Dugda	Tepho Choroke	95	35	130	1	1	2	4	0	4	15	1	16

Grain yield obtained from selected in situ moisture conservation structure

Table 3: Mean yield of maize obtained from tied ridge and furrow closed at both ends per hectare

Selected treatments	**Yield ($Qtha^{-1}$)**
Tied Ridge	99.41
Furrow closed at both ends	86.74

The mean yield obtained from tied ridge and furrow closed at both ends were 99.41 and 86.74 $Qtha^{-1}$ respectively (Table 3). The mean yield from tied ridge was better than furrow closed at both ends in the study area. The higher grain yield of maize recorded from planting on the tied ridge might be attributed to the higher water harvesting and retain more moisture when compared to the furrow closed at both ends in the study area. In addition, in tied ridge, moisture might be somewhat uniformly conserved and distributed within furrow when compared to the furrow closed at both ends. However, mean yield obtained from furrow closed at both ends were better than without conservation structures (flat bed) and this implied that, it conserve more moisture when you compare with neighboring farmer yield (used neighboring yield as check plot). The farmers also confirmed that this yield was better than what they have been obtained so far. The seeds, which were supplied with adequate moisture, did mature well to have heavier seed weight. This result agreed with Georgis and Takele 2000 reported, who stated that tied ridges have been found to be very efficient in storing the rainwater, which has resulted insubstantial grain yield increase in some of the major dry land crops such as sorghum, maize, wheat, and mung beans in Ethiopia.

In addition, it attributed to the greater infiltration and storage of water in soil; which gives plants ample time to take up the stored water. This is apparently due to the moisture conserving benefits of this technology being critical in drier areas (kassie et al., 2007). In addition, in-situ water harvesting can improved crop yield and have resulted in positive effects on moisture conservation and agricultural productivity (Alamu and Kidane, 2014) and it aligned with this result. This finding agrees with many researchers Heluf, (2003), Gebreyesus (2004), and Taye and Yifru (2010) had reported the importance of tied ridge is increasing crop yield by increasing the time for the water to penetrate into the soil.
Generally, the experiment results indicated that maize yield was affected by selected in situ moisture conservation practices. Consequently, the significant maize yield increment resulted from tied ridge and furrow closed at both end of structures. Tied ridge and furrow closed at both ends is an effective measure in storing moisture.

Yield Advantage

$$\text{Yield advantage }(\%) = \frac{\text{yield obtained from Tied ridge} - \text{yield obtained from FCE}}{\text{yield obtained from furrow closed at both End(FCE)}} \text{x100 Eq. 2}$$

$$\text{Yield advantage }(\%) = \frac{99.41 - 86.74}{86.74} \text{x100} = 14.61$$

Yield advantage obtained from tied ridge was 14.61% than furrow closed at both ends. This implies that tied ridge conserved more rainwater and same what uniformly distributed in the structure than furrow closed at both ends. However, the furrow closed at both ends also much better than flatbed (control). This result agreed with that of Araya and Stroosnijder (2010) and Walker et al. (2005), who stated that single interventions through water conservation could improve crop yield by up to 50% in arid and semi- arid regions of sub-Saharan Africa. In addition, Husen, D. and Shalemew, Z. (2020), who stated that the grain yield advantage of 45.5% and 30.68% were obtained from, tied ridge and furrow closed at both end respectively over the farmers' practice in Dudga district of Ethiopia. Similarly, Barron and Okwach (2005) showed that the rainwater harvesting technique increased yield by about 70% in semi-arid Kenya. Hence, practicing in situ rainwater harvesting structures is imperative and significance difference in grain yield.

Financial Analysis

Table 4: Estimated summary cost required for the tied ridge and furrow closed at both ends/ha

Description	Tied Ridge/ha	Furrow Closed at both ends/ha
	Sub-total (birr)	Sub-total(birr)
Total Fixed Costs(TFC)= Land purchase cost	4,000	4,000
Total Variable Costs(TVC)=Labor, necessary payment and transport cost	25,500	24,667
Agricultural Input (seed, fertilizer and chemical)	4,170	4,170
Land preparation cost	3,800	3,800
Total Costs(TC)	37,470	36,637

The total estimated summary costs required for the tied ridge and furrow closed at both end was 37,470 and 36,637 ETH. Birr ha^{-1}, respectively. The tied ridge and furrow closed at both ends structures were labor intensive, thus it required more cost.

Revenue obtained for the experiment

Table 5: Estimated summary Revenue obtained from the tied ridge and furrow closed at both end/ha

Descriptions	Tied Ridge/ha	Furrow Closed at both ends/ha
	Total(birr)	Total(birr)
Yield	84,500	73,731
Crop residual	9,200	8,100
Total Revenue(TR)	**93,700**	**81,831**

From tied ridge, 99.41 Qt ha^{-1} of maize obtained and sold 850-Birr Qt^{-1} at the current. In addition, from furrow closed at end, 86.74 Qt ha^{-1} of maize obtained and sold 850-Birr Qt^{-1} at the current. The total estimated profit obtained from the tied ridge and furrow closed at both was 93,700 and 81,831 ETH. Birr ha^{-1}respectively (Table 5). The tied ridge was provided a better crop residual than furrow closed at both ends, and the revenue of yield and crop residual obtained from tied ridge was better than furrow closed at both ends. This implies that the tied ridge was providing greater revenue than furrow closed at both ends.

Net Befits

Net Benefit obtained from the experiment is calculated by using eq. 1

Net Benefit obtained from tied ridge per hectare =Total revenue/ha- total cost/ha

Net Benefit obtained from tied ridge per hectare =93,700-37,470-birr ha^{-1} =**56,230** Birr ha^{-1}

Net Benefit obtained from furrow closed at both ends per hectare =Total revenue- Total cost

Net Benefit obtained from furrow closed at both ends per hectare =81,831-36,637 Birr ha^{-1} =**45,194** Birr ha^{-1}

The total profit obtained from tied ridge and furrow closed at both ends were 56,230 and 45,194-Birr ha^{-1}respectively. This implies that, the profit obtained from tied ridge was much better than furrow closed at both ends. This structure is much better in increasing yield and crop residues of maize. In addition, total estimated profit obtained from furrow closed at both ends was better. In generally, the two structures were better in the study in providing better profit and more economical.

Challenges encountered and possible solutions given

Maize was attached by Stalk Borer (spodoptera frugiperda), but it was easily controlled by spraying chemical. However, in-situ moisture conservation was not implemented in whole area of farmland; because of lack of equal awareness between famers, lack of budget or delay of budget, area is large and structure preparation is labor intensive. On the other hand, samples of insitu moisture conservation structures were prepared on the farmer field; and some what created the awarness in order to compare the performances of crop on selected in situ moisture conservation structures with neighbouring flat bed (without conservation) parctice by themselves. The fielddaay was not prepared because shortage of budget and the structures were not prepared on the whole farm land.

Exit Strategies

Agricultural Extension worker and district agricultural bureau should have given great attention to popularized and scaling up in situ moisture conservation technologies. In addition, the theoretical and practical training should be provided to farmers on in-moisture conservation and other should be learn from them and the close follow up and monitoring should be done as to be reach to other farmers

CONCLUSIONS AND RECOMMENDATIONS

The low crop productivity in the country particularly in the study area is due to low soil moisture, erratic and poorly distributed rainfall. This calls to design effective and efficient in-situ moisture conservation strategies, which have better role in sustaining crop production. The effect of selected in-situ moisture conservation structures (tied ridge and furrow closed at both ends) were better in terms of maize production. The tied ridge structure gave more mean grain yield of maize than furrow closed at both ends. The furrow closed at both end also better in terms of mean grain yield. Tied ridge and furrow closed at both ends showed a promising result on maize grain yield.

Therefore, tied ridge and furrow closed at both ends were more economical and it is best for mitigation of low moisture stress. As future recommendations, it needs to scale up this technology more in moisture deficit area and disseminate the results of the present to end user and more focus on awareness creation.

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Cluster-Based Pre Scaling up of Soil Test Based Teff Response Phosphorus Recommendation and Requirement map in Lume district, East Shewa, Oromia, Ethiopia.

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ABSTRACT

Soil fertility improvement technology demonstration through a large scale is the main entry for wider popularization and acceptance of technology by the smallholders. Large scale demonstration of soil test based fertilizer recommendation and Phosphorus requirement map for teff was done at Lume district in 2019 cropping season with the objectives to popularize the technology and to create awareness among Teff producers in the district. Depending on the willingness of the farmers, three clusters were organized in two different Kebeles in the district, where a total of 40 farmers (36 male & 4 female) participated & each cluster has 13-14 members. A total area of 18.08 ha of land was planted. Awareness creation training was given for farmers in collaboration with district expertise & DAs on the subject matter. Based on phosphorus fertilizer requirement map and soil test phosphorus recommendation, 150 kg NPS ha^{-1} & 46 kg N ha^{-1} were recommended and Boset teff variety was sown at the rate of 30 kg ha^{-1}. Field days were organized three times (at Kebele, District and Regional level) during Field days stakeholders from different research centers; Oromia Agricultural Bureau, Oromia Agricultural Research Institute, district, and Zone experts have participated. Grain Yield data were collected from each clustered field. Descriptive statistics indicated that total grain yield of 36700 kg was harvested from 18.08 ha of land, giving the average productivity of 2028 kg ha^{-1}. Therefore, this technology should be further popularized and the collaboration of all stalk holders is very important for the wider expansion of the technology in the district & similar agro-ecologies.

Keywords: Phosphorus requirement Map, pre-scaling up, Soil test based fertilizer application, Teff

BACKGROUND AND JUSTIFICATION

Teff (Eragrostis tef), is a cereal grain included in the grass family of Poaceae, diversified and endemic to Ethiopia supports more than 70-75% of Ethiopia's population as a staple and co-staple food (Davison and Laca, 2010). Teff contains high and unique nutritional values, grains are comparably rich in iron, calcium, and fiber (FAO, 2015). The most common utilization of teff in Ethiopia is the fermented flatbread called Injera (Zhu, 2018). According to Seyfu Ketema,1997 teff is grown in Ethiopia at middle elevations between 1,800 and 2,100 meters above sea level and in regions that have adequate rainfall. Teff is considered a low risk crop as it can withstand adverse weather conditions (Fufa et al., 2011).

Currently, Ethiopia is the largest teff producing country, and the only country to have adopted teff as a staple crop. According to (Minten et al., 2013) teff is the most important crop in Ethiopia in terms of area and value of production, Teff production in Ethiopia largely relies on traditional practices that means uses blanket recommendation of (100 Kg/ha DAP and 100 Kg/ha Urea).

Soil test interpretation is the relationship between the amount of a nutrient extracted by a given soil test and the number of plant nutrients that should be added to achieve optimum yield for each crop (Corey, 1987). Moreover, the current research shows that clustering in the agricultural sector presents many benefits, such as creating and enabling environment for inter-firm cooperation, facilitating the diffusion and popularization of technology (FAO, 2010).

Batu Soil research center has recommended Pc (phosphorus critical level) and Pf (phosphorus requirement factor) and validated phosphorus requirement map for teff crop and demonstrated on some Kebele at Lume District through FREGs. However, due to none demonstration of this technology on all Kebeles, further pre-scaling up of this technology through cluster approach was very important. Therefore, the present study was initiated to scale up soil test based fertilizer recommendation, Phosphorus requirement map and create a wider demand on soil test based fertilizer recommendation and map in the district.

MATERIALS AND METHODS

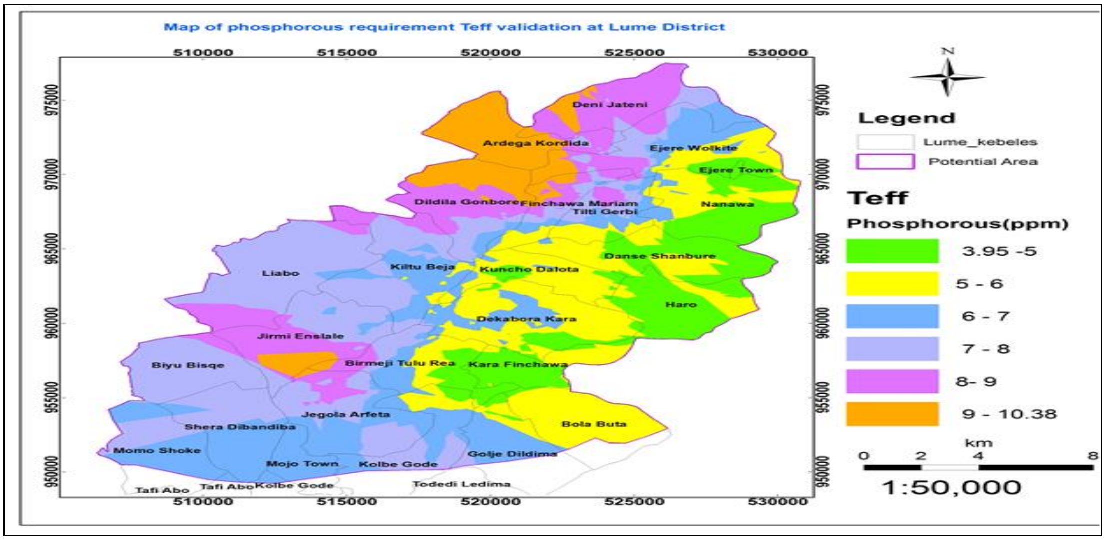
Description of the study area

The large scale demonstration was conducted at Lume district, East Shewa Zone of Oromia regional state in the 2019 cropping season. Geographically located between 8^0 24’300” to 8^0 49’30” North and 39^0 01'00" to 39^0 17'00" East. The Elevation ranges from 1590 to 2512 meters above sea level.

Demonstration Materials

Boset teff variety with the rate of 30Kg ha^{-1} was used as planting material while NPS (19%N: 38%P_2O_5:7%S) and Urea (46%N) were used as a source of phosphorus and nitrogen fertilizers.

Phosphorus Fertilizer Requirement Map of teff was used as one demonstrating material and source documents for fertilizer provision for each clustered farm (Tilahun et al., 2019). However, NPS fertilizer was applied with the rate of 150Kg ha^{-1} whereas Urea was applied with a rate of 46N Kg ha^{-1}.



Source: Reta et al., 2018.

Soil Sampling and Analysis: Representative Composite soil samples were collected with a depth of 0-20cm from each farmer's field by using soil Auger. The collected soil samples were put in a polyethylene plastic bag, transported and submitted to the Batu soil laboratory for analysis. Accordingly, the soils are left to dry with air for some days and grind with Pestle and mortal, sieved with 2mm diameter and less than 0.5mm sieve. Available soil phosphorus was analyzed by Olsen et al., 1954 method.

Identification of Stakeholders: Team of researchers from Batu soil research center**,** District officials, DA's, and Farmers were identified as stack holders for executing the project**.**

Both District office of Agriculture and Natural Resource together with the Batu Soil Research Center they played a major role in coordinating farmers, site selection, soil sample collection, giving training, Input provision, and organizing Field days. At Kebele level Development agents giving technical advice to the farmers, convince farmers through frequently approaching and telling the advantage of the technology, organizing Kebele and District level Field days.

Site and Farmers Selection

For appropriate site selection and clustering, discussions were made with the district office of agriculture and create a common understanding of the technology to scale up. Accordingly, two (2) teff potential PAs were selected purposively, and sites were verified visually by teams organized with BSRC.

Cluster Formation

Awareness creation training was provided for Expert, DAs’ and Farmers on Cluster formation and importance. Farmers were organized based on their willingness and having the same interest to plant the same crop to the adjacent farmers. Accordingly, 3 clusters were organized within two PA's having 13-14 Farmers by contributing 0.45ha of lands.

Input Provision

Inputs were provided for each farmer organized under each cluster. Accordingly, Boset teff variety was sawn at the rate of 30kg/ha. While, fertilizers, 150 kg NPS $ha^{-1}$and 46 kg N ha^{-1} were recommended based on the fertilizer requirement map. Agronomic management(weeding and disease control) was followed according to the farmer practices.

Data Collected: Grain yield data and opinion tests were collected from the total harvest of the crop and Farmers participated from the cluster respectively.

Statistical Analysis

Statistical instruments including mean, frequency, and percentage were used to summarize grain yield data, number of stakeholders participated in training and field days respectively. For data entry, descriptive Microsoft Excel was employed.

RESULTS AND DISCUSSION

Training

Training is one of the means through which agricultural technologies, knowledge, and skills are conveyed to the small-scale farmers (Tolessa et al., 2017). Soil test based crop response fertilizer quantity/rate recommendation based on phosphorus requirement map it needs frequent and organized training to develop skills and knowledge of the stack holders. Awareness creation training was given on soil fertility management and phosphorus requirement map of teff. As a result, a total of 6 SMSs (4M &2F), 6 DAs (4M&2F), and 50 farmers (47 Male and 3Female) were trained (Table 1). During awareness creation, training material and methods such as Photographs on phosphorus requirement map, slide show, and flip chart, extension methods were used.

Table 1: Training participants during stakeholder analysis and clustering, at Lume District, 2019.

Type of Trainees	No participants		
	2019		
	Male	Female	Overall Total
SMSs	4	2	6
DAs	4	2	6
Farmers	47	3	50
Total	55	7	62

Beneficiaries Involved and Input Distributed

Depending on the Interest and willingness of the Farmers, three Clusters were organized in two different Kebeles (Tede Dildima and Tullu Re's) in the district, where a total of 40 Farmers (36 Male and 4 Female) participated on three clusters. A total of 18.08ha of land was planted participating 40 beneficiary Farmers. On Average 0.45ha of land which has been each adjacent farmers were pull together and form a Cluster (Table2). Overall Inputs NPS (2711.25Kg), Urea (1782.75Kg), and seed (542.20Kg) were distributed for direct beneficiaries in the cluster.

Table 2: Beneficiaries and Input provided on Teff Cluster at Tede Dildima and Tullu re'e Peasant association, Lume District, 2019.

Kebeles	No Farmers			Area(ha)	Input delivered		
	M	F	Total		NPS Kg	Urea Kg	Seed Kg
Tede Dildima	10	3	13	4.250	637.50	400.250	127.50
Tullu Re'e-1 & 2	26	1	27	13.825	2073.75	1382.50	414.75
Total	36	4	40	18.08	2711.25	1782.75	542.20

Field Day

Field days are one way of technology demonstration method that enabling stakeholders to create awareness on technology promotion. Series of field days were organized at Kebele, district, and regional level. Sixty-four (64) farmers attended the first field day(at the vegetative stage), Eight three (83) farmers where attended the second field day that was the grain filling stage, whereas eight one (81) farmers attended the third field day which was the grain ripen stage of the crop(Table 3). Results presented in table 3 indicated that different stack holders such as Sixty two (62) researcher from different research centers, Sixty-eight (68) SMSs from Zone, District, and regional level agricultural and natural resource office and bureau, whereas ninety-three (93) DAs participated on the field days. During field day participants raised questions, comments, and suggestions regarding the expansion and sustainability of the technology. It was discussed and commented by the respected bodies.

Table 3: Field day participants at a different level on the Teff cluster at Lume, district 2019.

Levels	Participants												
	SMS'		DA's		Farmers		Researcher		Others/TA		Sum		Overall Total
	M	F	M	F	M	F	M	F	M	F	M	F	
Kebele level	3	-	5	-	52	12	3	-	-	-	63	12	75
District level	16	4	50	10	60	23	8	-	4	-	138	37	175
Regional level	40	5	24	4	71	10	50	1	39	6	224	26	250
Total	59	9	79	14	183	45	61	1	43	6	425	75	500

Grain Yield

Grain yield data were collected from each clustered field. Accordingly, the overall total grain yield of 36700Kg was harvested from 18.08 ha of land, giving the average productivity of 2029 Kg ha^{-1} (Table 4). The result as indicated in table 4 implied that 241 Kg ha^{-1} and 281 Kg ha^{-1} yield advantage was obtained over regional and national average yield respectively.

Farmer's opinion toward the yield

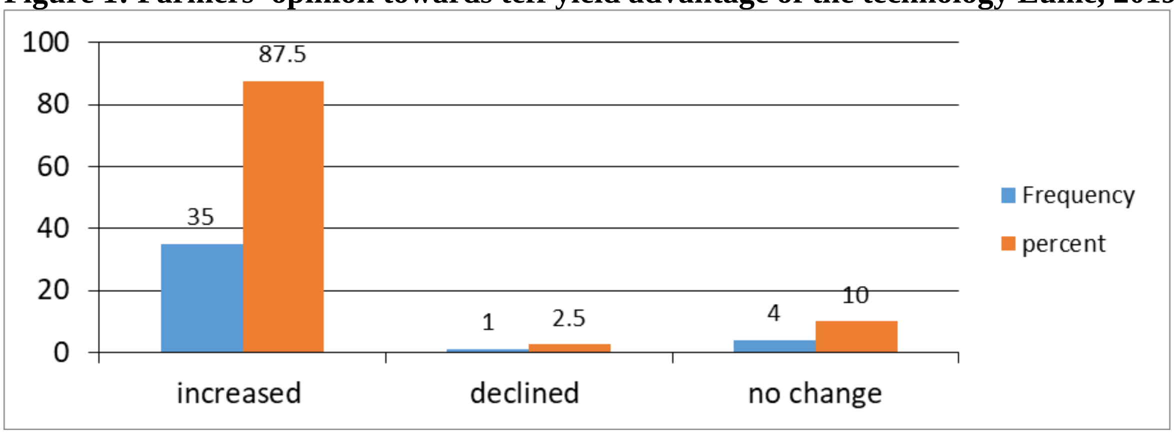
As indicated on figure 1 opinions on yield advantage were collected from direct beneficiaries of the technology. Accordingly, Forty (40) respondents gave their own opinion towards yield increments. Eighty-eight (88%) of the respondents were harvest increased yield over the previous year, while the twelve (12%) of the respondents gave their opinion on declined and no change from the previous which has been due to the problem of unexpected rain during harvesting.

Table 4: Mean Grain yield obtained from Teff Cluster at Lume District, 2019.

#	Kebeles	Total Area of the Cluster(ha)	Average grain yield Kg /ha	Total Grain Yield from the Cluster (Kg)	NAY CSA2018 Kg/ha	RAY CSA2018 Kg/ha	ZAY CSA2018 Kg/ha	WAY Kg/ha
1	Tede Dildima	4.252	1817.26	7727	-	-	-	-
2	Tullu Re'e 1	7.653	2076.05	15888	-	-	-	-
3	Tullu Re'e 2	6.183	2116.29	13085	-	-	-	-
	Average	18.088	2028.96	36700	1748	1788		1800

Key: NAY: National average grain yield; RAY: Regional average grain yield; ZAY: Zone average grain yield; WAY: Woreda average grain yield

Figure 1: Farmers' opinion towards teff yield advantage of the technology Lume, 2019.



Source: Computed from collected data (2019).

Lessons Learned

- Coordination of Stack holders (Research institute, District office of agriculture and NR, Experts, DAs and Peasant association leaders

CONCLUSION AND RECOMMENDATION

Cluster-based pre Scaling up of soil test based teff response phosphorus recommendation and requirement map in Lume district take place in 2019 cropping season. Awareness creation training was given for the stakeholders, soils samples were collected and analyzed, input (fertilizer & Seed) were provided according to the fertilizer requirement map. Finally grain yield data was collected and summarized. However, farmers and stakeholders who participated on the field days appreciate this soil test based crop response phosphorus fertilizer recommendation based on phosphorus requirement map. Therefore, this technology should be further popularized and the collaboration of all stalk holders is very important for the wider expansion of the technology in the district and similar agro-ecologies.

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Cluster- Based Pre Scaling up of Soil Test Based Bread Wheat Response Phosphorus Recommendation and Requirement Map in Lume district, East Shewa, Oromia, Ethiopia

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ABSTRACT

Large scale demonstration of soil test based phosphorus recommendation through phosphorus requirement map is very important for production maximization and soil technology dissemination at Peasant association' level. Demonstration of soil test based crop response phosphorus recommendation and requirement map for bread wheat crop was done at Lume district in 2019 cropping season. The objectives of the demonstration were to popularize soil test based fertilizer recommendation and phosphorus requirement map at a large scale for the stakeholders. Two representative wheat potential producing kebeles were purposively selected. Awareness creation training was given for Farmers, SMS, and Development agents. Farmers were organized in two clusters having adjacent land of 8.13 ha and beneficiary farmers were 26 (21 males and 5 females). Soil samples were collected, soil initial phosphorus values were analyzed, and fertilizer recommendations were determined and verified with the fertilizer requirement map. Inputs (fertilizer and seed) were provided according to the phosphorus requirement map and the seed rate. Field days were organized at kebele, district and regional level, and many stakeholders participated (Farmers, SMS, Researchers, and Regional, Zonal, and District level officials) were on the field day. Grain yield data and opinion test on the large scale demonstration were collected and summarized using descriptive statistic. Average grain yield 4595 kg ha^{-1} was obtained from all clusters. This implied that a yield increase of about 56% over the regional average yield and a 68% yield advantage over the national average yield (NAY). Farmers and stakeholders appreciated the newly conducted cluster approach technology scale-up particularly the soil test based crop response and phosphorus requirement map. Therefore, Phosphorus requirement map based fertilizer recommendation is important to increase bread wheat production in Lume district. This recalls for further popularization of such technologies & close collaboration of stakeholders.

Keywords: Bread wheat, demonstration, p-requirement map

BACKGROUND AND JUSTIFICATION

Wheat is one of the major cereal crops grown in the Ethiopian highlands. At present, wheat is produced solely under rainfed conditions. From the current total wheat production area, 75% is located in Arsi, Bale, and Shewa regions. A small amount is produced in the rest of the north and south regions MoANR (2016). In East Shewa Zone wheat covered an area of 85,630.68 ha with a total production of 2,494,931.59 quintals and mean productivity of 29.14 Qt ha^{-1} during 2015/16 cropping season (CSA, 2016).

Wheat is a staple food in Ethiopian diets. It is used as a pancake ("injera"), bread ("Dabo"), etc. it accounts for about 11% of the national calorie intake (Demeke, 2013). However, the

country is not self-sufficient in wheat. A substantial gap might be primarily due to the non-application of the site and crop-specific soil test based fertilizer application.
According to the International Fertilizer Development Center (2015) who reported that, lack of soil fertility database and absence of area and crop specific fertilizer recommendation has been taking as a key obstacle in realizing the first GTP of doubling agricultural production by the end of the five-year plan period. Also, some researchers (Abiye et al., 2001; Asgelil et al., 2007) reported that unbalanced application of plant nutrients may aggravate the depletion of other important nutrients. Moreover, Mann and Warner (2015) reported that development of crop-specific, national-level productivity maps are extremely beneficial for understanding production as well as evaluating research and policy interventions
Therefore, in order to tackle this problem, Batu Soil Research Center has recommended Pc (phosphorus critical level) and Pf (phosphorus requirement factor) with fertilizer requirement map for Bread Wheat and demonstrated them against blanket way of fertilizer application at kebeles level for their impact on crop yield and farmers perspectives.

Currently, cluster development programs have become increasingly widespread approach in fostering agricultural productivity and growth of agricultural sector in Ethiopia. A cluster based development including agriculture has also been given a top priority in the country's current five years Growth and Transformation Plan (GTP) as the main tool for prompting income and employment growth among micro and small scale enterprise (Ali et al., 2016).
The Agricultural Growth Project (AGP), run by the Ministry of Agriculture and The World Bank, aims to increase agricultural productivity and market access for key crops and livestock products in targeted districts (Policy & Bank, 2011). So, Lume district is one of targeted district of AGP in east Shewa Zone and the technology of soil test fertilizer recommendation with fertilizer requirement map for bread wheat has demonstrated in large scale to scale up and popularize soil test based fertilizer recommendation, Phosphorus requirement map and create a wider demand for soil test based Fertilizer recommendation and map in the district.

MATERIALS AND METHODS

Description of the study area

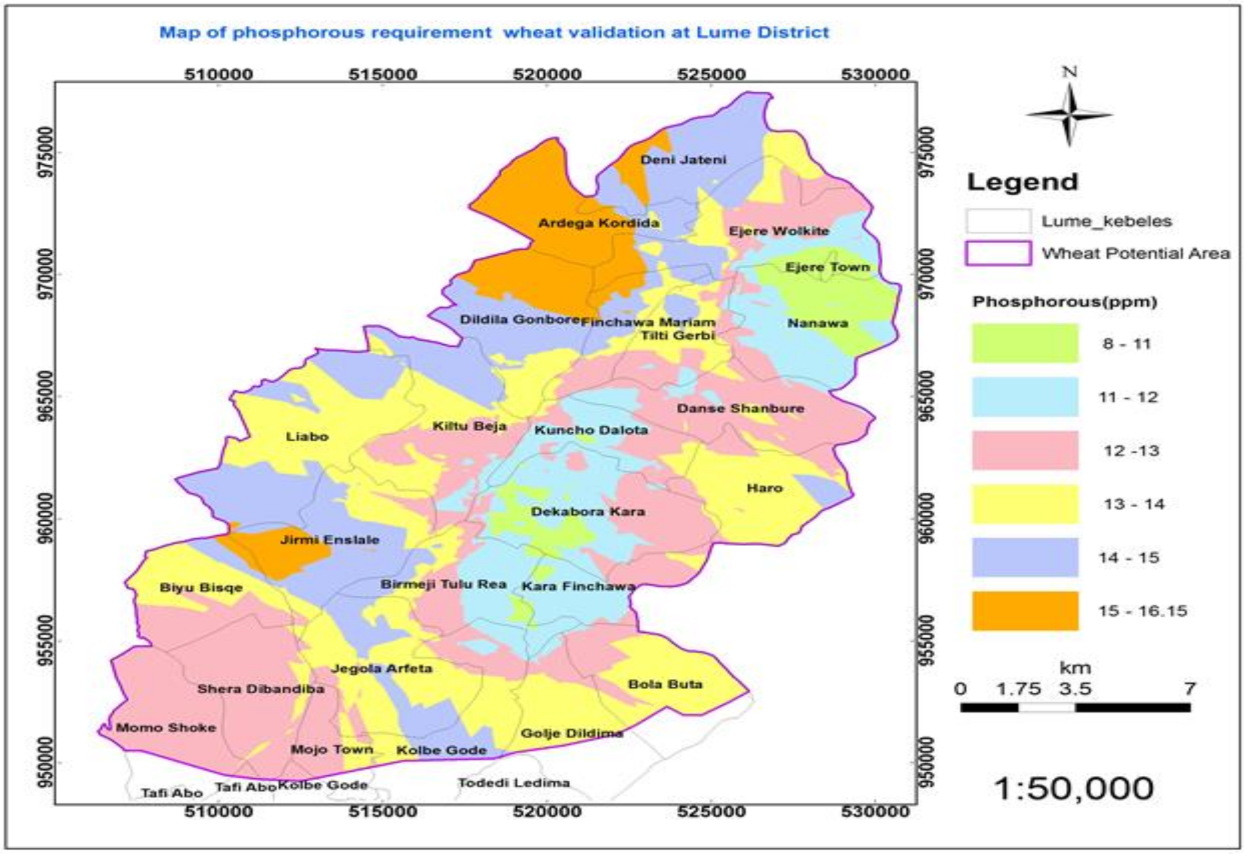
Cluster-based pre-scale-up of soil test based crop response fertilizer recommendation and Phosphorus requirement map was conducted at Lume district. Geographically located between 8^0 24'300" to 8^0 49'30" North and 39^0 01'00" to 39^0 17'00" East. The Elevation ranges from 1590 to 2512 meters above sea level.

Demonstration Materials

Planting Materials

Kekeba bread wheat variety was used with the rate of 150Kg ha^{-1}. Whereas NPS (19%N: 38%P_2O_5:7%S) and Urea were used with the rate of 250 Kg ha^{-1} and 46N Kg ha^{-1} respectively.

Validated phosphorus requirement map of bread Wheat was used as a source document for fertilizer quantity recommendation and demonstration (Tilahun et al., 2020).



Source: Tilahun et al., 2020.

Soil Sampling and Analysis: Soil samples were collected from the 0-20cm depth from each farmland of the cluster and the results were pulled together and used to calculate the average soil available phosphorus. Soil's initial available phosphorus was determined by Olsen et al., 1954, and verified with the phosphorus requirement map **(**Tilahun et al.,2020).

Identification of stack holders: Team of Batu soil research center, Lume District office of agriculture and natural resources, Peasant association level development agents & Farmers were stack holders that coordinate and monitor the cluster.

Batu soil research center, together with District office of Agriculture and Natural resource they have been playing coordinating role on site selection, representative soil sample collection, giving training, Inputs provision, and organizing field days. At kebele level, Development agents played a major role in giving technical advice to the farmers on land preparation, time, and method of sowing and Convince farmers to be a member of the cluster and repeatedly told the advantage of the technology. Also, they were participated in coordinating kebele and District level field days.

Site and Farmer Selection

After discussions were made and create Common understanding with the district office of agriculture and natural resource office on the technology, two (2) representative wheat potential producing Kebeles were purposively selected.

Cluster Formation

Awareness creation training was given for Farmers, SMSs, and Development agents. Cluster farms were formed depending on the willingness of the farmers, accessibility for adjacent farms, and having the same interest to plant the same crop to the adjacent farmers. Accordingly, farmers were organized in two clusters having 13 individual farmers per cluster (Table 1).

Input Provision

The seed of Kekeba Bread wheat variety and Fertilizers (NPS and Urea) were provided for all beneficiaries according to the area of farmland that included in the Cluster.

Data Collected: Soil initial phosphorus, Opinion test, Grain yield data, Number of Training, and Field day participants were collected.

Statistical Analysis

Descriptive statistics were used to identify farmers' opinions towards the large scale demonstration. Statistical instruments including frequency, percentage, and mean were used to summarize collected data (grain yield, training, and field days participants). In the data entry, descriptive computer software Excel was employed.

RESULTS AND DISCUSSION

Training

Awareness creation training was given for six (6) SMSs, Five (5) DA's, and Forty (40) farmers. Overall fifty-one (51) participants participated in the topic of phosphorus requirement map of bread wheat and soil fertility management training which were organized at District and kebele level (Table 1). Training materials like the photograph of requirement maps and flip charts were used.

Table 1: Training participants during stakeholder analysis and clustering

Year	Participants					
	SMSs		**DAs**		**Farmers**	
	M	**F**	**M**	**F**	**M**	**F**
2019	4	2	5	0	34	6

Beneficiaries Involved and Input Distributed

Under two Kebeles (Dekebora Gogile and Kara Finchewa), twenty-one male and five female farmers which have similar interests and willing to plant wheat crops were organized in two Cluster where thirteen (13) individual farmers grouped per cluster. However, each of the Farmer contributing an average of 0.31ha of land (Table 2). Overall inputs, NPS (2031.25Kg), Urea (812.50Kg), and wheat seed (1218.75Kg) were distributed for direct beneficiaries in the cluster.

Table 2: Beneficiaries and input provided on Bread wheat cluster at Dhekebora and Kara Finchewa kebeles, Lume District, 2019.

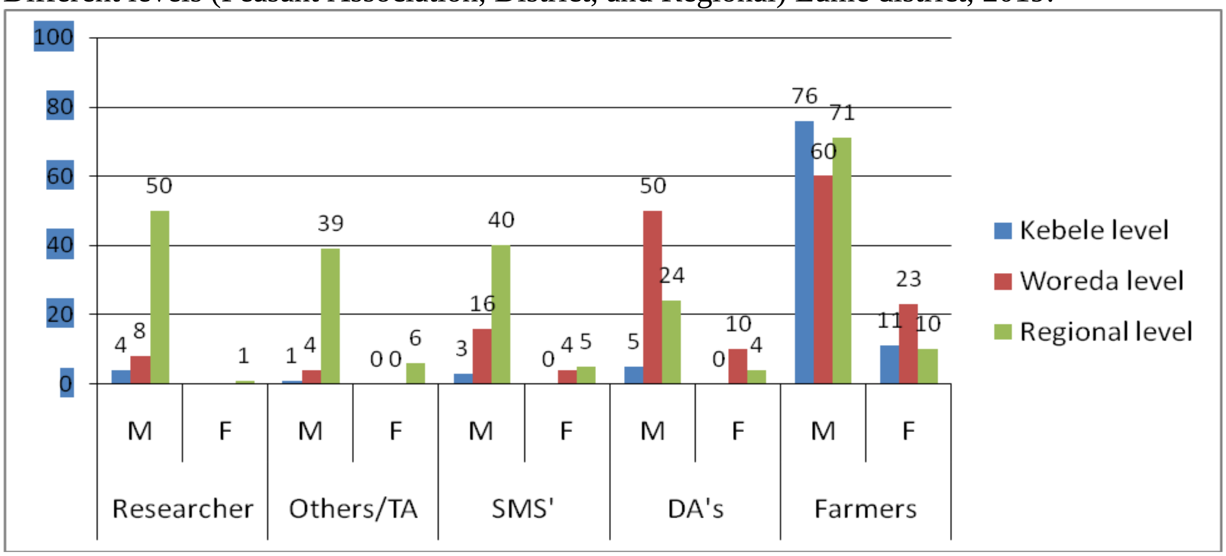
Kebeles	No Farmers			Area(ha)	Input delivered		
	M	**F**	**Total**		**NPS Kg**	**Urea Kg**	**Seed Kg**
Dekebora	11	2	13	4.875	1218.75	487.50	731.25
Kara Finchewa	10	3	13	3.25	812.50	325.00	487.50
Total	**21**	**5**	**26**	**8.13**	**2031.25**	**812.50**	**1218.75**

Technology Demonstration and Communication Technique

Field day

Field day could be enabling farmers easily to insight about the technology. Series of field days were organized at Kebele, District and Regional level with the coordination of development agents and office of Agriculture. As indicated in figure 1 different stakeholders (Farmers, SMSs, DAs, Researchers, Regional, Zonal, and District level officials) were participated on the field days. During field day participants raised questions, comments, and suggestion regarding on the sustainability of technology expansion. It was discussed and commented by the respected bodies.

Fig 1: Stakeholder (Farmers, DAs, SMS's, Researcher, and TA's) participants on Field day at Different levels (Peasant Association, District, and Regional) Lume district, 2019.



Grain Yield

The overall grain yield which 37200 Kg was harvested from 8.13 ha of land. The Average grain yield 4595Kg ha^{-1} was obtained from all clusters. This implied that a yield increase of about 56% over regional average yield and a 68% yield advantage over the national average yield (NAY) (Table 3).

Table 3: Mean Grain yield obtained from Bread wheat Cluster at Lume District, 2019.

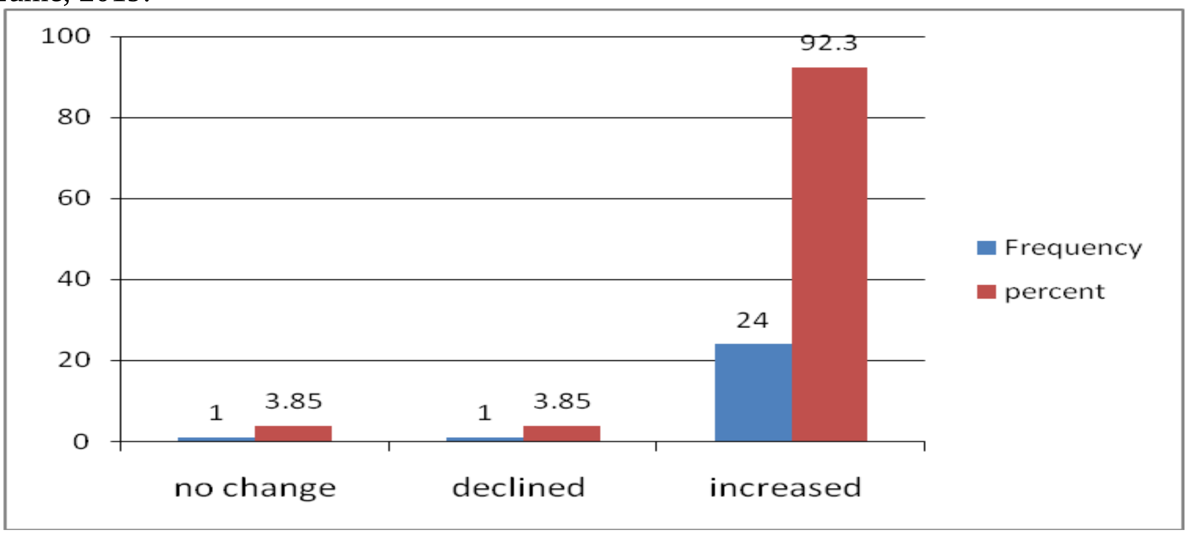
#	Kebeles	Total Area of the Cluster(ha)	Average grain yield Kg /ha	Total Grain Yield from the Cluster (Kg/ha)	NAY (CSA 2018)Kg/ha	RAY (CSA 2018) Kg/ha	ZAY (CSA 2016) Kg/ha	Yield advantage of over RAY Kg/ha
1	Kara Finchewa	3.25	4677	152.00	-	-	-	-
2	Dheke Bora	4.88	4512	219.96	-	-	-	-
	Total	**8.13**	**4595**	**37200**	2736	2971	2914	56%(1671Kg/ha)

Key: NAY: National average grain yield; RAY: Regional average grain yield; ZAY: Zone average grain yield;

Farmers Opinion towards Yield Obtained from the Cluster

Farmers have their own opinion on fertilizer rate recommendations. With their observation cluster approach soil test based fertilizer recommendation better than the Farmer practices on yield advantage, it also create an opportunity for market linkage and mechanization. i.e. for the introduction of combine harvester and thresher in the area. In this large scale demonstration, participant farmers and stakeholders appreciate the newly conducted cluster approach fertilizer rate recommendation based on the soil test based crop response and phosphorus requirement map for bread wheat crop. Accordingly, above 92% of the respondents told as bread wheat yield was increased compared to the previous years (Figure 2).

Figure 2: Farmers' opinion towards the yield increment of bread wheat obtained from Cluster, Lume, 2019.



Source: Own Collected Data 2019.

CONCLUSIONS AND RECOMMENDATIONS

Large scale demonstration of soil test based phosphorus recommendation based on phosphorus requirement map was carried out at Lume district in 2019 cropping season. Awareness' creation training was given for Farmers, SMSs, and DAs. Grain yield data and Farmers' opinions towards yield increments were collected and summarized. Over 92% of farmers were used this technology and they obtained 56% yield advantage over the conventional practice. Accordingly, farmers and stakeholders appreciated the newly conducted cluster approach technology scale-up particularly the soil test based crop response and phosphorus requirement map. Therefore, phosphorus requirement map based fertilizer recommendation is important to increase bread wheat production in Lume district. This recalls for further popularization of such technologies and close collaboration of stakeholders.

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Cluster Based Pre-scaling up of Soil Test Based Fertilizer Recommendation Rate for Maize in Bedele and Chora Districts of Buno Bedele Zone, Oromia Regional State, Ethiopia.

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ABSTRACT

Cluster based pre scaling up of soil test based fertilizer recommendation rate for maize was conducted in Bedele and Chora districts of Buno Bedele zone with the objectives of popularizing soil test based fertilizer recommendation rate for maize, enhancing farmers' knowledge and skill of applying soil test based fertilizer recommendation rate and creating awareness on the importance of site-specific crop response fertilizer recommendation rate through farmer clustered approach in 2019 cropping season. Bedele and Chora districts were selected purposively for maize production potential and conducted calibration studies and then two kebeles were selected from both districts based on road accessibility and land representativeness as clustered, non-clustered farmers and other interested stakeholders contribute in the activities. Accordingly, 52 farmers having 45 male and 7 female were established under two clustered farmers in collaboration with community leaders, development agents and researchers from Bedele Agricultural Research Center. The technology is disseminated to the farmersusingclustered approach, trainings and field days in which more than 335 (273 male and 62 female) participants were took part on the events.The total land size used for cluster based pre scaling up of soil test based fertilizer recommendation rate for maize was 15 ha and the two maize varieties used for the activity were Shone and BH661. Fertilizer rate was determined from site specific soil test result.With compared to national average maize yield which is 3.65 (tonnes per ha) in 2019; the obtained yield were higher in both districts (7.28 tonnes ha^{-1} in Bedele and 5.2 tonnes ha^{-1} in Chora). Thus, further scaling up/out of soil test based fertilizer recommendation rate for maize should be sustained by district extension offices for maize producers across the study areas.

Key Words: Cluster, Pre -scaling up, soil test based fertilizer recommendation rate

INTRODUCTION

Maize (Zea mays L.) is one of the most important cereals broadly adapted worldwide (Christian et al., 2012). Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. Maize is one of the most important cereal crops used in the human diet in large parts of the world and it is an important feed component for livestock. It is also used as industrial raw material for oil & glucose production (MARD, 2014). Maize grain has greater nutritional value as it contains 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3.0% sugar and 1.7% ash. Maize is the single most important crop in terms of both number of farmers engaged in cultivation and crop yield (Shahidur et al., 2010).

Maize is largely produced in Western, Central, Southern and Eastern parts of Ethiopia. In Ethiopia, its total annual production and productivity exceeds all other cereals (23.24% of 267,789,764.02 qt), and second after teff (Eragrostis teff) in area coverage (16.12% of the 10,232,582.23 ha) and mostly grown in the highlands at an altitude ranging from 1,700 to 2,400 masl. In 2017/2018, cropping season 2,128,948.91 hectares of land was covered with maize with an estimated production not less than 83,958,872.44 quintals, which was accounted as 3.94t/ha (CSA, 2017/2018).

However, low soil fertility,Soil Acidity problems and Soil Nutrient leachingare among the major factors limiting maize production and productivity in western Oromia, Ethiopia (Taye, Bekele,2007). Even though, most of the maize producing areas in the world relied upon inorganic fertilizers to improve crop yields and maintain soil fertility; insufficient use of fertilizers resulting in severe nutrient depletion of soils. Achieving high maize yield requires adequate and balanced supply of plant nutrients as declining soil fertility is a prominent constraint for maize production (Okoko and Makworo, 2012).

Thus, soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. It is widely believed that economic optimum fertilizer application can only be achieved by developing appropriate fertilizer recommendation that takes into consideration the nutrient status of individual field. Currently there are no site-specific fertilizer recommendations for different soil-crop climatic conditions.By considering this prevailing problem, Bedele Soil Research Center completed Calibration study with the recommended rate of 92 and 46 kg/ha N-fertilizer for Bedele and Chora districts repectivly and the recommended P-fertilizer rate was determined using $P\ (kg\ ha^{-1}) = (Pc - Po)*P_f$ formula (Chimdessa, 2019 and Dange and Bati, 2018).Hence, the result of conducted calibration studies which is site specific fertilizer recommendation rate for maize should be enlarged across the study areas as to massive farmers use soil test based crop response fertilizer recommendation rate in a sustainable way. Therefore, the objectives of this study were, to popularize soil test based crop response fertilizer recommendation rate for maize, to create awareness on the importance of site-specific crop response fertilizer recommendation rate through farmer clustered approach and to share information, knowledge and experiences among technology producers and other concerned stakeholders.

MATERIALS AND METHOD

Description of the Study Areas

The study was conducted in Bedele and Chora districts of Buno Bedele zone in 2019cropping season.

Bedele District

Bedele is one of the districts in Buno Bedele Zone, Oromia Regional StateSouthwest part of Ethiopia. The district lies between $08^0$14’28.6” to $08^0$37’52.8” N latitude and $036^0$13’22.0” to $036^0$35’09.1” E longitude at the distance of approximately 483 km from Addis Ababa the capital city of the country. The area has an altitude ranging from 1920 to 2012 meters above sea level and mean annual rainfall of 1965.9 mm. The rainy season extends from April to

October and the maximum rain is received in the months of May, June, July, August and September with the mean monthly rainfall exceeding 302.5 mm. The soil of the area is characterized as an old soil called Nitisoils. The economy of the area is based on mixed cropping system and livestock raring agricultural production system among which dominant crops are maize, teff, sorghum, finger millet and haricot bean.

Chora District

Chora is one of the districts in Buno Bedele Zone, Oromia Regional State Southwest part of Ethiopia. The district is bordered on the south by Setema, on the west by Yayo and Dorani, on the north by Dega, and on the east by Bedele. The administrative center of this district is Kumbabe. The district is located 519 km away from the capital city of the country and 36 km away from Bedele Town of Buno Bedele Zone. The district is located at an average elevation 2000 masl and located at $08^0$13’33.7” to $08^0$33’55.0” N latitude and $035^0$59’59.7” to $036^0$15’15.8” E longtude. It is generally characterized by warm climate with a mean annual maximum temperature of 25.5°C and a mean annual minimum temperature of 12.5°C. The driest season lasts between December and January, while the coldest month being December. The annual rainfall ranges from 1440 mm. The soil of the area is characterized as an old soil called Nitisoils. The economy of the area is based on mixed cropping system and livestock raring agricultural production system among which dominant crops are maize, teff, sorghum and wheat and also horticultural crops.

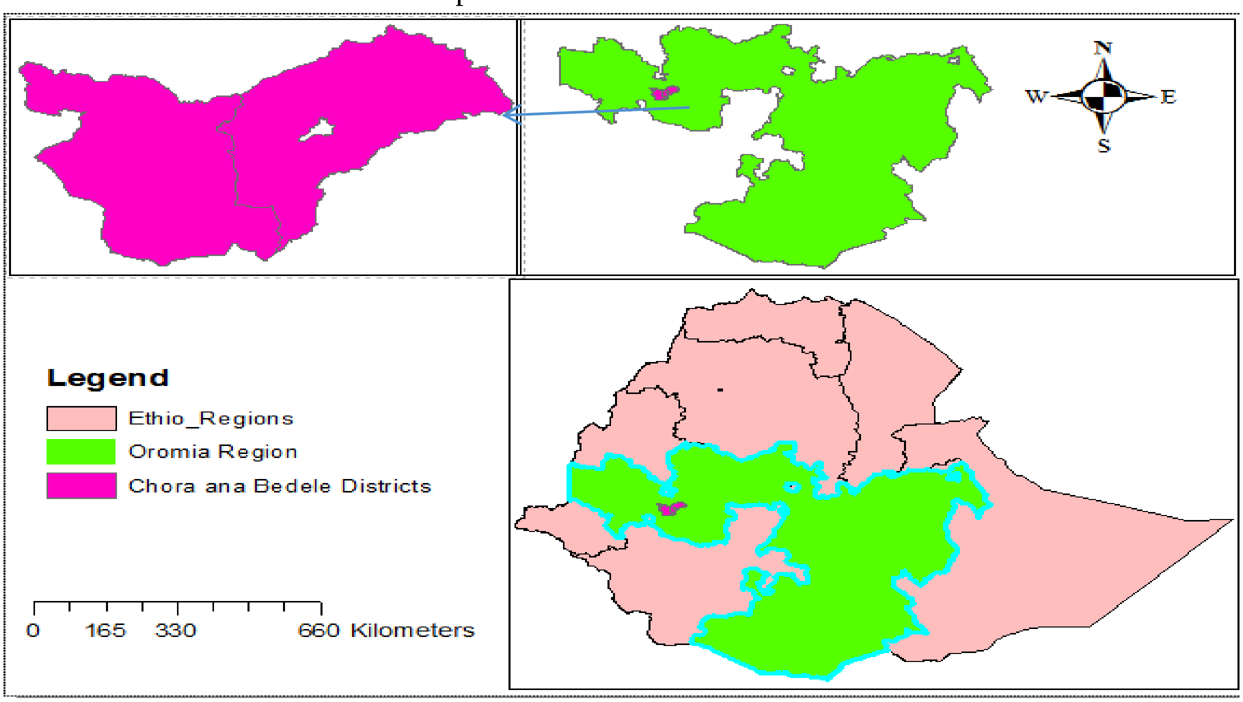

Figure1. Map of Chora and Bedele districts

Site and Farmers Selection

Twodistricts were selected purposively for the implementation of the activitiesbased on maize production potential, conducted calibration study and being AGP II areas. From both districtstwo potential kebeles were selected by considering land slope (soil fertility gradient), farmers adjacent land, road accessibility to bring agricultural inputs (seed, fertilizer and lime) and representativeness of the selected areaas clustered, non-clustered farmers and other interested stakeholders contribute in the activity.Cluster approach was followed to scale up the technology as it strengthens stakeholders linkage, accelerate technology dissemination and increases production and productivity of clustered farmers. Accordingly, Clustered farmers having fifty-two (52) members with the composition of men (45) and women (7) were selected based on willingness to participate in the activity, commitment to share their ideas and the concept of gender disaggregation in collaboration with community leaders, DAs and SMS in both districts.

Materials and Field Design

Based on the interest of clustered farmers improved maize varieties Shone was scaled up on 7 ha whereas BH661 wason 8 ha of land with soil test based p and N fertilizer recommendation rate in Bedele and Chora districts. The land was prepared following the conventional farmers' practices that are ploughed three times before planting, hoeing and weeding by clustered farmers.Based on pH status of the field, 200qt of lime was applied manually in both districts. Using the recommended spacing of 80 and 50 cm between rows and seed respectively both maize varieties were planted with the seed rate of 25 kg ha^{-1} in collaboration with clustered farmers, researchers and district agricultural offices.

Soil Sampling and Analysis

One month before planting, six composite soil samples based on land slope and crop history were collected using auger tool from both clustered farmers' fields at the depth of 0-20cmwas recorded on soil sampling sheet. Composite soil was labeled and backed by a clean plastic bag and brought to the laboratory to analyze available phosphorus and pHof the soil with standard laboratory procedures. Depending on initial phosphorusand pH status the field, p-fertilizer and lime was applied. The previously recommended N-fertilizer (urea) was applied with split application of 1/3 at planting time and 2/3 at tillering stage of the crop.

Technology dissemination method

Training was given to clustered farmers, development agents in the selected kebeles and the district agricultural experts on soil test based N and P-fertilizers recommendation rate for maize and method of implementing the activities to enhance technology dissemination in the study areas. Mass field day that supported with media coverage was organized on the technologies to reach huge number of maize producers and other interested farmers. To enhance the effectiveness of the field day, leaflets that summaries about the technologies were distributed to participants those who can read whereas poster that describe every step of the activities within picture was used for farmers those cannot read.

Data Collected and Method of Analysis

Grain yield data, total number of participants on extension events like training and field day were recorded. The collected data was analyzed using simple descriptive statistics.

RESULT AND DISCUSSIONS

Capacity building of clustered farmers and other stakeholders

Participatory training was given to concerned agricultural stakeholders by the researchers from Soil Fertility Improvement and Agricultural Extension research team of Bedele Agricultural Research Center in the study areas. A total of 37 participants (33 male and 4 female) in Bedele and 33 participants (29 male and 4 female) in Chora districts were participated on the training. Training was given to the participants about the importance of soil test based N and P-fertilizers recommendation rate for maize, acidity and lime requirement and method of implementing the activities (Table 1).

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

participant Categories	Sex	Bedele	Chora	Total
Clustered Farmers	Male	23	22	45
	Female	4	3	7
Development Agents	Male	3	1	4
	Female	-	1	1
Other Stakeholders	Male	7	6	13
	Female	-	-	-
Total		37	33	70

Source: Own Data, 2019

Field Day

At physiological maturity stage of soil test based fertilizer recommendation rate for maize, mass field day that supported with media coverage was organized to reach huge number of maize producers and other interested farmers. Accordingly, a total of 213 (191 male and 22 female) relevant agricultural stakeholders were participated on the events (Table 2).

Table 2: Relevant agricultural stakeholders'participated on field day in both districts.

Participants from	Sex		Total
	Male	Female	
IQQO Directorates and Centers	73	1	74
District and Zonal agricultural offices, OBN media and other sector	36	2	38
Bedele Agricultural Research Center	35	12	47
Clustered Farmers	47	7	54
Total	191	22	213

Source: Own Data, 2019

Yield Performance

With the recommended N-fertilizer rate of 92 kg ha^{-1} and 46 kg ha^{-1} in Bedele and Chora district respectively and site specific soil test based crop response P-fertilizer recommendation rate the average grain yield of maize (shone variety) in Bedele cluster was 72.8 qt ha^{-1}, whereas BH661 in Chora cluster was 52 qt ha^{-1} (Figure 2). The reason for low average grain yield of BH661 in Chora cluster was due to rain interruption (frost) during physiological maturity stage. Even though, the average maize grain yield of soil test based crop response fertilizer recommendation rate was high greater than that of National Average maize grain yield which is 3.65 (tonnes per ha) in 2019 cropping season. Yet the yield still had an extra 99.45% and 42.47 % average yield advantage than the national average maize yield at Bedele and Chora districts respectively (Table 3).

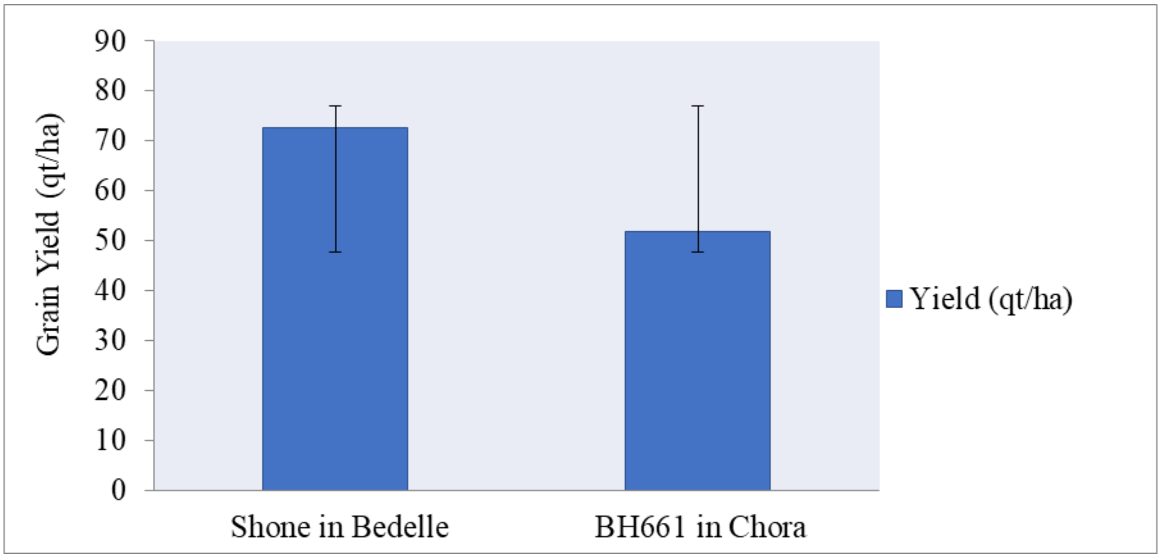

Figure2. Yield Performance of Cluster Based Pre scaling up of Soil Test Based Fertilizer Recommendation Rate for Maize in the study areas in 2019 cropping season.
Source: Own Sketch, 2019

Table 3.Yield advantage of improved maize varieties over Average national maize with Soil Test Based Fertilizer Recommendation Rate for Maize in the study areas.

Location	Maize Varieties	Yield obtained(Qt/ha)	Av. National yield (Qt/ha)	Yield Advantage over national yield (%)
Bedele	Shone	72.8	36.5	99.45
Chora	BH661	52	36.5	42.47

CONCLUSION AND RECOMMENDATION

The dissemination of improved technologies and best practices to the end users are one of the main objectives of Oromia Agricultural Research Institute in general and Bedele Agricultural Research Center in particular to increase income, agricultural production and productivity of targeted farmers and strengthening the capacity of agricultural stakeholders toward the technologies. So, site-specific soil test based crop response fertilizer recommendation rate for maize was scaled up through clustered approach with the support of AGP II project in the study areas. Different extension events like training, demonstration and field day were organized to popularize/disseminate the technology. In spite of rain interruption (frost) during physiological maturity stage; the average grain yield of site-specific soil test based crop response fertilizer recommendation rate for both maize varieties in the study areas were double compared to non-clustered farmers and even national average maize grain yield in 2019 cropping season.Therefore, there should be strong linkage among farmers, woreda and zonal agricultural offices and research center to sustain the dissemination of site-specific soil test based crop response fertilizers recommendation rate for maize to enrich wider areas of similar agro-ecologies.

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Pre-Extension Demonstration of Two Moringa Species in West Shewa and East Wollega Zones, Oromia, Ethiopia

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ABSTRACT

Moringa is a tropical plant belonging to the family Moringaceae. It consists of 13 species, of which five are found in Ethiopia. The present study was aimed to demonstrate the two species on farmers' field and select the best performing farmers preferred species for further popularization. The activity was conducted in Bako Tibe district of west Shawa zone; Guto Gida, Diga, Wayu Tuqa and Boneya Boshe districts of east Wallagga zone. A total of 7 FREG comprising 97 famers (81 male and 16 female) were established. The two moringa species were planted on 36 farmers' field and 2 FTCs on an area of 10m*10m=100m^2 each and 2m spacing between plants. Leaflets and practical training on moringa production, importance and utilization were prepared and given for the farmers, DAs and experts from the districts. A total of 172 farmers were interviewed to evaluate and select the best from the two species depending on their growth performance, their fresh leaf taste and odor, and survival rate. Based on the above criteria, 113 (65.7%) farmers preferred the Moringa oleifera. In general, the two moringa species were performed well in most places, and the FREG member farmers and neighbors are started to use the products of moringa at household level.

Key words: Demonstration, Feedback, FREG, Growth performance, Moringa

INTRODUCTION

Adaptation of two species namely Moringa stenopetala and Moringa oleifera was conducted at Bako some years back and well adopted in the environment (Samuel *et al.*, 2016). *Moringa oleifera* and *Moringa stenopetala* are the two most common species among the 13 species of the Moringa family, Moringaceae. *Moringa oleifera* originates from the Himalaya (northwestern India), while *Moringa stenopetala* is endemic to East Africa, where it occurs in northern Kenya and in Ethiopia. Both species have many characteristics in common. For both species the use as a vegetable and water purifier are similar. They share several medicinal uses and both have high contents of oil in the seeds: between 32 - 42 %. *Moringa oleifera* has a faster development and yields fruits and seeds quickly (Samuel *et al*., 2016). *Moringa stenopetala* is better suited to a drier climate; yields of seeds are higher and they have a higher coagulant content (Bosch , 2004). The two most common English vernacular names for the tree are ' drumstick' (describing the shape of its pods) and 'horseradish' (describing the taste of its roots (Sutherlands *et al*., 1994). Additional names has been given to them such as "Never Die Tree", "The Magic Tree", "The Tree of Paradise" or "Best Friend" based on the multipurpose behavior of the trees. In Ethiopia it is widely cultivated (Schneemann, 2011).

People have different nutritional requirements at different stages in their lives. The leaves from Moringa are exceptionally nutritious for people of all ages and the use of the plant as side dishes or sauces provides daily allowances of important nutrients. The leaves have a high content of Vitamin A and Vitamin C when they are raw. Vitamin A is required for good eyesight and Vitamin C strengthens the gums. The content of minerals like Calcium is very high, which is rare among plants. The Calcium is used for strengthening of bones. 100 grams of moringa leaf powder contains: four times the calcium of milk, four times the vitamin A in carrots, two times the protein in milk, three times and the potassium in bananas and seven times the vitamin C in oranges (Tree Africa, 2006).

Since moringa is very important in food context and medicinal values, we need to demonstrate and scale up/out it in its agroecological ranges. Accordingly, we addressed a total of 5 districts in west Shawa and east Wallagga zones, west Oromia, Ethiopia. The present study was aimed to demonstrate the two species on farmers' field and select the best performing farmers preferred species for further popularization.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Bako Tibe district of west Shawa zone; Guto Gida, Diga, Wayu Tuqa and Boneya Boshe districts of east Wallagga zone (fig. 1). These districts were selected based on their agroecology, accessibility and being AGP-II districts.

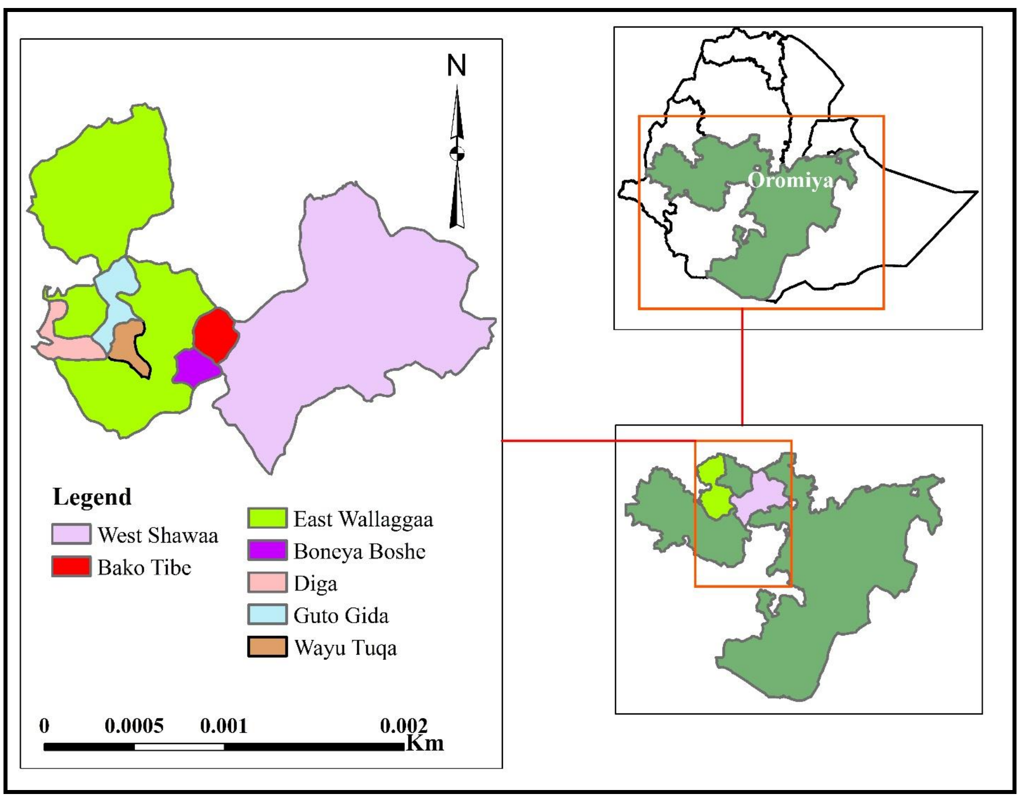

Figure: 1. Site descriptions of Moringa species demonstration sites.

METHODOLOGIES

First year implementation

Areas (districts and/or zones) that have the same agro ecological zone with Bako agricultural research center (BARC), from west Shawa Zone Bako Tibe district and from east Wallagga Zone Guto Gida, Diga, Wayu Tuqa and Boneya Boshe districts were selected for the pre-demonstration activity of the two moringa species. After selection of the districts, we decided to pick purposively based on accessibility and potential, one or two kebeles from each district. After all, we form Farmers' Research Extension Group (FREG) which comprises ten to fifteen members per each kebele. A total of 7 FREG comprising 97 famers (81 male and 16 female) were established. The two moringa species were planted on 36 farmers' field and 2 FTCs on an area of 10m*10m=100m2 each and 2m spacing between plants.

Theoretical and practical training were organized; manual and leaflets were prepared on Moringa's importance and conservation methods for farmers Of FREG members and Development Agents (DAs) of respective kebeles and also for experts of each district.

Second year implementation

Five to ten farmers of FREG members were selected to plant those moringa species (the known *Moringa stenopetala* and the exotic *Moringa oleifera*), and they planted them. Survival count, growth performance, disease occurrence and farmers perception on the two moringa species were recorded.

Third year and fourth year implementations

Training leaflets and manuals on moringa utilization and importance were produced and FREG member farmers were awared about all. Farmers were organized and asked to visit, use, evaluate and put their feedback on the survival count, growth performance, leaf color, odor and seed bearing duration of the two moringa species. Hint of all important components of growth and uses were provided to the FREG member and non-members. Additionally, practical training on moringa planting, management, silvicultural operations, seed collection, seed storage, leaf utilization and other moringa benefits were given for the FRG members including neighbor farmers, DA's and other experts. On the practical training, farmers and other participants have also given chance to evaluate both moringa species and select better one based on the above criteria. The FREG member farmers have been also sharing their experiences to others on moringa planting and management methods.

Data management and statistical analysis.

All the necessary data were collected and analyzed. Farmers' assessment/feedback on the technology (growth performance, affordability, complexity, applicability) were collected through regular interaction with farmers and rapid feedback surveys. Simple descriptive statistics by SPSS and Excel tools and matrix while ranking and qualitative analysis of farmers' assessment/feedback were also subjected to SPSS.

RESULTS AND DISCUSSION

Survival Count and Growth Performance

From the total of 1800 seedlings of *Moringa oleifera* and *Moringa stenopetala* species which were planted on 36 farmers' field and 2FTCs, the last survival rate of *Moringa oleifera* shows 84% and this survival rate is greater by 4% from the 1st survival count for the same species on average of over all locations. This may be due to regenerating potential of dormant seedlings of moringa in the beginning. This survival rate shows for *Moringa stenopetala* 72.6% on average. *Moringa oleifera* has also evaluated by bearing seeds within less than 8 months after planting. We have observed that survival rate, fast growing and good stand performances of both moringa species show better at all sites under farmers whose management activities are controlled by women and children (fig. 2). This results are in-line with (Orwa *et al*., 2009), which defines it as *Moringa oleifera* requires mean annual temperature of 12.6 to 40 ^{o} C and mean annual rainfall of at least 500 mm. Adapted to a wide range of soil types but does well in well drained clay or clay loam without prolonged waterlogging. Prefers a neutral to slightly acidic soil reaction. It is quite drought tolerant but yields much less foliage where it is continuously under water stress. It is not harmed by frost, but can be killed back to ground level by a freeze. It quickly sends out new growth from the trunk when cut, or from the ground when frozen. On the other hand, *Moringa stenopetala* is also mentioned by its intolerance of cold temperatures for the cultivation of the species in Ethiopia because it does not tolerate frost (Orwa *et al*., 2009; Seifu, 2014).

Farmers Perception and Species Selection

A total of 172 farmers were interviewed to evaluate and select the best from the two species depending on their growth performance, their fresh leaf taste and odor, and survival rate. From the total 38 (about 22.1%) farmers were females. Based on the above criteria, 113 (65.7%) farmers preferred the *Moringa oleifera*. The most attractive result here is that from the total females interviewed, about 92% (35 individuals) were preferred the *Moringa oleifera*, due to its leaf biomass and good odor than *Moringa stenopetala* (Table 1; Table 2). The farmers refer *Moringa oleifera* species, taste as local cabbage and simple to grow in a short period of time. They also utilized it and witnessed that they are being cured from headache, gastric, pressure, diabates and wounds of different causes. This preference of the *Moringa oleifera* also agree with the (Orwa *et al*., 2009), study which well states about its contents and uses. Its leaves are good source of protein, vitamins A, B and C and minerals such as calcium and iron, are used as a spinach equivalent. They are an excellent source of the sulphur-containing amino acids methionine and cystine, which are often in short supply. Young plants are eaten as a tender vegetable and the taproots as an alternative for horseradish. Young pods are edible and reportedly have a taste reminiscent of asparagus (Seifu, 2014).

Table 1: Household information and feedback responses

Households		Frequency (%) (N=172)
Sex		Male 134 (77.9%) Female 38 (22.1%)
District		Bako Tibe 32 (18.6%) Boneya Boshe 36 (20.9%) Diga 33 (19.2%) Guto Gida 35 (20.3%) Wayu Tuqa 36 (20.9%)
1	Did you plant moringa species?	Yes 36 (20.9%) No 136 (79.1%)
2	If yes, what kind of moringa species?	Both *Moringa stenopetala* and *M. oleifera* 36 (20.9%)
3	Source of seed/seedling source	Government Organization 172 (100%)
4	Among moringa species, which one is best for you?	*Moringa stenopetala* 59 (34.30%) *M. oleifera* 113 (65.7%)
5	What is/are your selection criteria?	1. Their growth performance 47 (27.3%) 2. Their fresh leaf taste and odor 93 (54.1%) 3. Survival rate 32 (18.6%)

Table 2: ANOVA Table of feedback responses

Questionnaires	**Variation**	**Sum of Squares**	**df**	**Mean square**	**F**	**Sig.**
Did you plant moringa species? 1. Yes 2. No	Between Groups Within Groups Total	5.581 22.884 28.465	31 140 171	0.180 0.163	1.101	0.342
Among moringa species, which one is best for you? 1. *M. stenopetala* 2. *M. oleifera*	Between Groups Within Groups Total	9.174 29.588 38.762	31 140 171	0.296 0.211	1.400	0.097
What is/are your selection criteria? 1. Their growth performance 2. Their fresh leaf taste and odor 3. Survival rate 4. Others (specify)	Between Groups Within Groups **Total**	12.568 65.124 77.692	31 140 171	0.405 0.465	0.872	0.663

Finally, those farmers who achieved higher survival rate and better growth performance for both moringa species by better management according to the previously given training were awarded and recognized for more moringa seed production and experience sharing on utilization.

CONCLUSION AND RECOMMENDATIONS

We have observed that moringa species are extremely fast-growing tree, and within 1-3 months trees reach 2.5 m. In addition to its medicinal values, moringa will help as a supplementary food, and therefore, it is one of the food security tree/shrub species. From the two moringa species demonstrated and evaluated here, *Moringa oleifera* was mostly preferred by farmers considering its growth performance, survival rate, odor, color and taste. The duration for seed bearing was also another criterion for the farmers to prefer the *M. oleifera* species. Moringa species were well performed under practices where hot pepper, bean and vegetables incorporated in. We have also observed it was better survived and performed where women and children control its overall management than men from the house hold members. As far as it is well known that from the three countries in eastern Africa, Ethiopia is the only country that has widely domesticated in its southern landscape as a garden and tree on farm, we need to demonstrate and scale up/out it further in to different parts of the country.

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Pre-Extension Demonstration and Evaluation of improved Desho Grass Varieties in West and Kellem Wollega Zones

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ABSTRACT

Among the recommended mitigation strategies of feed shortage in the country, the utilization of indigenous adaptable multi-purpose fodder species, e.g. Desho grass (Pennisetum pedicellatum) is recommended. To minimize animal feed shortage problem in West and Kellem Wollega zone, pre-extension demonstration of improved Desho grass was carried out with full participation of farmers on fourteen (14) trial farmers' fields using the farmer's field as replication. Six(6) FREGs with a total of 98 member farmers(67 male and 31 female farmers) were organized. Four (4) improved varieties of Desho grass (Kindu kosha 2 DZ #591, Kulumsa DZ#592, Kindu kosha 1DZ#589 and Areka DZ#590) were demonstrated with the objective of demonstrating and evaluating varieties under farmer's management condition in Seyo and Dale Sedi districts of Kellem Wollega zone and Lalo asabi and Guliso districts of West Wollega zone for two consecutive cropping seasons (2018 & 2019 GC). Training was among the tools used to create awareness on the importance of Desho grass production, how to manage, when to use and how to store. Agronomic data like sample fresh weight and dry weight was recorded and biomass yield were analyzed to evaluate the performance of varieties. Accordingly, the relative dry and fresh biomass yield of these varieties were 7.12 t/ha and 49.075 t/ha (Dz-592), 6.5 t/ha and 45 t/ha (Dz-591), 6.70 t/ha and 46.675 t/ha (Dz-589) and 6.89 t/ha and 44.5 t/ha (DZ #590), respectively. Participatory varietal selection and evaluation was done with different stakeholders. Accordingly, farmers were informed to set their own selection criteria to evaluate and select best performing varieties among the demonstrated varieties. The prioritized selection criteria were biomass yield, cattle preference and palatability (nature of stem). Based on the measured trait and farmers preference Kulumsa DZ#592 and Kindu kosha 1 DZ#589 were selected to be popularized by large scale in west and Kellam Wollega zones.

Key words: Desho grass, Demonstration, Farmer's preference, Participation

BACKGROUND AND JUSTIFICATION

In Ethiopian agriculture, livestock production plays a fundamental role for the livelihood of the people (Shiferaw, A. et al., 2011). Despite the large livestock population in Ethiopia (CSA 2015), its contribution to the national economy is below potential, owing to a range of factors including availability and quality of feed, poor genetic potential of animals for productive traits, poor health care and poor management practices (Mengistu 2006). Among the recommended mitigation strategies of feed shortage in the country is the utilization of indigenous adaptable multi-purpose fodder species, e.g. desho grass (Pennisetum pedicellatum). This perennial grass is native to tropical Africa and widespread from West to East Africa (Leta et al. 2013). Though often considered to be a noxious weed (ISC 2015), in Ethiopia the grass was first used in Southern Nations Nationalities and Peoples' Region and is currently utilized for soil conservation practices and animal fodder in other regions of the country (Welle et al. 2006; Yakob et al. 2015). The grass has the ability to control water loss effectively and recovers rapidly after watering even under severe drought conditions (Noitsakis et al. 1996; Welle et al. 2006). Keeping these facts in views adaptation trial of desho grass was done by Haro Sebu agricultural research center on different location and recommended top performing varieties to be evaluated under farmer’s management condition. Accordingly, the relative dry and fresh biomass yield of these varieties were 9.98t/ha and 59.36(Dz-592), 8.26t/ha and 48.05t/ha (Dz-591), 8.05t/ha and 51.37t/ha (Dz-589) and 7.78t/ha and 45.73t/ha, respectively.

Participatory technology evaluation is important to identify the best technologies which can fit the local condition. Hence, to promote adoption of improved Desho grass technologies by the small holder farmers, there is a need to evaluate and select the Desho grass varieties at on-farm condition according to the farmers perceptions and demonstrate improved Desho grass production and utilization system to end users. However, Desho grass evaluation and selection were not assessed according to the farmers selection criteria and the Desho grass varieties were not well demonstrated for the farmers in the West and Kellem Wollega zones. Therefore, the study was conducted to demonstrate and evaluate the productivity of Desho grass technologies under farmers’ management conditions, to enhance the skill and knowledge of farmers in Desho grass production and management practices and to build strong relationship between agricultural stakeholders.

MATERIALS AND METHODS

Description of the study area

Dale sadi district

Dale sadi is situated at about550 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 to February) with mean annual rain fall of 1200mm.

Seyo

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

Guliso

Guliso is one of 19 districts of West Wollega Zone, with the capital located at 490 km West of Addis Ababa. It has an estimated area of 631.90square km; it is bounded by Boji Chokorsa in the northeast, Gawo Dale in the west, Aira in the south and Lalo Asabi in the east. Total human population of the district is estimated at 91,471 of whom 45,525are male and 45,946 were female. Of the total households 89.5 % is rural agricultural households (GWAO, 2016). The district has a total of 28 kebeles, of which 26 are rural based peasant associations and 2 are urban dwellers Associations Kebeles. From total rural passant associations 18 of them categorized to mid highland agro-ecology and 8 kebeles allocated to lowlands agro-ecology. The altitude of the Woreda varies from 1650 meters to 1700 meters above sea level. It receives average annual rainfall of 720 mm and has an annual temperature range of 9^0c-18^0c. In terms of agro-ecology, the district is categorized as Mid-high land (69%) and lowland (kola) (31%) (Fanos, 2012). The soils types in the district are predominantly red (58%), black (32%) and mixed (10%).

L/Asabi district

Lalo Asabi is one of the 21 Districts of West wollega zone. It is bordered on the south by Yubdo, on the west by Aira and Guliso, on the north by Boji, on the east by the Benishangul Gumuz, and on the southeast by Gimbi. The administrative center of this woreda 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.

Site and Farmers Selection

Two each districts were selected purposively based on cattle production and animal feed shortage, from both Kellam and West wollega Zone. From Kellam wollega zone, Dale sadi and Sayo districts were selected, whereas from West wollega zone Lalo asabi and Guliso districts were selected. From Lalo Asabi and Sayo districts two each potential peasant associations were selected and from Dale sadi and Guliso districts one each potential peasant associations were selected purposively based on their potential for livestock production, animal feed shortage and accessibility. Before starting field work, formation of FRG (farmers research group) were made purposively based on their representativeness of the majority of smallholder farmers, their interest and motivation in carrying out the recommended management practices (timely weeding and harvesting on time) land ownership and their commitment to deliver the technology to other farmers by considering the gender balance and other important socio economic variables.

Materials used

Four improved varieties of Desho grass ,namely Kindu kosha 2 DZ #591, Kulumsa DZ#592, Kindu kosha 1DZ#589 and Areka DZ#590 were used for demonstration trial with participation of farmers. The recommended fertilizer rate of NPS 50K g/ha was used for this demonstration.

Field design

The trial was carried out on selected farmer’s fields in such a way that four (4) improved varieties of Desho grass were planted side by side on equal sized non replicated plots of 10m x 10m with a gross area of $100m^2$. Fourteen (14) trial farmers were used as replication.

Sowing was done with spacing of 50cm between rows and 25cm between plants replicated by the number of participant farmers.

Technology evaluation and demonstration methods

Training

Before implementing demonstration trial on farmers' field, training was given to farmers on approaches and principles of FRG, the role and responsibility of the FRG members in managing the trial, necessary packages for Desho grass production and management practices, and monitoring required for the trial and during trial establishment and harvesting period, practical training on improved Desho grass production and utilization was given.

Data type and method of data analysis

Fresh weight yield and Dry matter yield of varieties were objectively measured and analyzed to see the performance of varieties under farmer's management condition, number of stakeholders participated on promotional event like training, and participatory varietal selection and evaluation were recorded and analyzed. Field days and field visits were not given due to severe security problem in the study area

RESULT AND DISCUSSION

Training

Theoretical and practical training on improved Desho grass production and utilization was given for FRGs, livestock experts and development agents. Accordingly it was given in D/Sadi and Lalo asabi districts on topic "improved Desho grass production and utilization system". A total of 80 stakeholders participated on training out of whom 62 were male and 18 were female. Practical training was given at the spot (on farm sites) during trial establishment and harvesting time. Farmers and other stake holders were discussing on the importance of Desho grass production and advantage of each Desho grass varieties, their agronomic practices, utilization and the likes. They were very interested to produce the grass to improve their livestock production system and finally, they raised the queries from where they get the grass for future production.

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

District	Participant	Male	Female	Total
Dale Sadi	Farmer	23	4	27
	SMS(Expert+ DA'S)	5	3	8
alo Asabi	Farmer	28	7	35
	SMS(Expert+ DA'S)	6	4	10
Total		62	18	80

Yield performance of demonstrated Desho grass varieties

Fresh weight and dry matter biomass yield were objectively measured and analyzed to evaluate the performance of varieties under farmer's management condition.

Table 2 Yield performance of varieties

No	Varieties	Fresh weight yield ton/ha	Dry matter yield ton/ha
1	Kindu kosha 2 DZ#591	45	6.5
2	Kulumsa DZ#592	49.075	7.12
3	Kindu kosha 1 DZ#589	46.675	6.70
4	Areka DZ #590	44.5	6.89

Source: OnFarm Demonstration Data

The figurative result of combined analysis of variance summarized in the above table revealed the mean fresh biomass yield of Kulumsa DZ#592 is highest among the demonstrated Desho grass with magnitude of 49.075 ton/ha followed by Kindu kosha 1 DZ#589, Kindu kosha 2 DZ#591 and Areka DZ #590 with magnitude of 46.675, 45 and 44.5 ton/ha, respectively. Again the mean dry biomass yield of Kulumsa DZ#592 is higher than the mean dry matter yield of Areka DZ #590, Kindu kosha 1 DZ#589 and Kindu kosha 2 DZ#591 with magnitude of 7.12, 6.89, 6.7and 6.5ton/ha, respectively.

Participatory Varietal selection, preference and ranking of varieties

The target communities were highly inclined to their preference of demonstrated Desho grass varieties which may help them to identify which Variety/Varieties they prefer more and reject varieties which they prefer less. Accordingly different stakeholders (mainly farmers, development agents, and agricultural experts) participated on participatory evaluation and selection. In the process of participatory Varietal selection and evaluation it is not only resource that could be saved but also time and fast adoption of technologies (Dan, 2012), thus a total of 92 participants participated on the process at maturity stage. Yet, before commencing on the selection, brief orientation was given to the evaluators on how to integrate researcher' criteria to their own criteria to select the demonstrated varieties in order of their importance and during the assessment farmers were assisted to list their own selection criteria which may help them to identify best varieties/variety that can fit their demand. Accordingly, Biomass yield, Cattle likeness and Palatability were identified as the most important farmer's selection criteria and Cattle likeness was considered as the most important selection criteria for each Desho grass varieties

Pair wise ranking of varieties trait by farmers.

Code	Variety trait	Biomass Yield	Palatability	Cattle likeness	Frequency	Rank
1	Biomass Yield	X	P	CL	0	3rd
2	Palatability		X	CL	1	2nd
3	Cattle likeness			X	2	1st

P= Palatability and CL=Cattle likeness

Rank of varieties based on farmer's selection criteria

Number	Variety	Rank	Traits
1	Kulumsa DZ#592	1	Cattle preference, Biomass yield, palatability, nature of steam
2	Kindu kosha 1 DZ#589	2	Palatability, cattle preference, Biomass yield(medium) , nature of steam
3	Areka DZ #590	3	Biomass yield (good), cattle preference and palatability(low)
4	Kindu kosha 2 DZ#591	4	Biomass yield (low), cattle preference and palatability(low)

CONCLUSION AND RECOMMENDATION

Pre extension demonstration and evaluation of Desho grass varieties were intended to enable farmers to select Desho grass varieties based on their own selection criteria. Since demonstration is bimodal process stakeholders participated on this demonstration (Farmers, Researchers, Development agents and experts) learned from each other's during the process. Accordingly Biomass yield, Cattle preference and palatability were common traits used to enable farmers to prefer demonstrated Desho grass varieties. Pre extension demonstration, demonstrate farmers ability to convey useful information that helps researchers to provide technology that fit to farmers demand. Farmers preferred varieties which suit their demand and reject varieties which they prefer less. Based on the farmer's preference and ranking Kulumsa DZ#592, Kindu kosha 1 DZ#589, Areka DZ #590, Kindu kosha 2 DZ#591 were selected first, second, third and fourth, respectively. On promotional events like training, an important concept concerning particular technology under consideration should be provided to the stakeholders. That is the best approach to aware participant of that technology. The feedback collected from stakeholders and farmers preference to different trait of varieties and the varieties provided build a base for technology generation and fasten the rate of adoption of that particular technology/ies. Generally based on farmers preference and objectively measured trait varieties Kulumsa DZ#592 and Kindu kosha 1 DZ#589 were selected to be scaled up/out to address many more farmers and popularize these varieties in agro ecology of West and Kellem Wollega Zones.

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Pre-extension demonstration of vertisol management structures with mechanized farm in Adaba district, West Arsi, Ethiopia

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ABSTRACT

Vertisols cover large part of the high rainfall areas of Ethiopia. However, the potential of these soils is not well exploited because of heavy water logging during the main rain season; this problem can be mitigated using different drainage systems. Fromthe field experiment conducted in 2015-2017 G.C.to investigate the effects of different drainage systems on yield of bread wheat on the waterlogged Vertisols; cumber bed drainage system was verified as best vertisol management in Adaba District. Thence; pre-extetion demonstration of this activitywas conducted with Mechanized farm at Hunte Oromia seed enterprise farm . Here;a bread wheat Ogolcho variety were planted on cumber bed land form and flat bade on an equal area of 2500m^2(1/4ha) for both.Camber beds was form to make a raised profile 4.8m wide and 0.3cm high from the furrow to the top of the bed. This was performed by adjusting tractor drown machine so called dicher during land preparation. Also farmer practice land preparation was carried out with tractor drown machine. Initial land preparation, crop management factors was the same for both land form. The result revealed that as,bread wheat grown on improved drainage techniques camber bed had better yield advantage as compared to farmers' practices. The highest bread wheat biomass yield of 8t ha^{-1} which is 37.5% higher over the farmers practice (flat bed) were recorded and the highest grain yield of 6.2 t ha^{-1} which is 35% higher over the famers' practice was obtained when the bread wheat was grown using camber bed.In addition farmers preference toward the technology were collected through supervision and organizing mini field day. To collect their real feeling and opinion,group discussion was undertaken and checklist was used for interviewing. Here also;the results indicated cumber bed vertisol drainage system was selected by farmers on the bases of its yield advantage, good wheat performance and well drained soil compared to flat bed during high rainfall of the growing season. Therefore camber bed land form technology was recommended for further scaling upinmitigating water logging in Vertisols at Adaba for production of bread wheat.

Key words: Camber bed (CB), bread Wheat, water logging, Ogolcho

INTRODUCTION

Vertisols are characterised by their extensive cracking from the surface to depths of 50 cm or more with seasonal drying and also gilgai microrelief or subsoils showing slicker-sides or spheroid structures as evidence of seasonal expansion and contraction (Probert et al, 1987). These soils generally have a weak horizon differentiation.These soils are distributed around the 45°N latitudes, mainly in the tropical and subtropical areas of the world. Driessen and Dudal (1989) report an estimated 311 million ha of Vertisols or 2.4 per cent of the global land area. Vertisols occupy about 105 million ha in Africa (Blokhuis, 1982) and about 12.6 million ha in Ethiopia. Vertisols are amongst the most common, high-potential soils in the highlands of Ethiopia, where over 88% of human and 77% of livestock are located (Erkossa, et al. 2005).

These soils are among the most common, high-potential soils in the highlands of Ethiopia. However, the potential of these soils is not well exploited because of heavy water logging during the main rainy season.

Farmers of the Vertisols area have realized the adverse effects of waterlogging on crop productivity and have developed traditional methods for overcoming the problem.Their strategy to utilize Vertisols has always been to plant late in the wet season, which means harvesting a single crop and leaving the land under-utilized or idle (Tedla *et al.*, 1993).Generally, the traditional management of Vertisols in the Ethiopian highlands varies from place to place depending on the amount and duration of rainfall, extent of drainage problems, soil fertility and slope and farm size (Berhanu, 1985; Mesfin, 1998). Because waterlogging resulted in poor aeration, lower soil microbial activities, loss and unavailability of plant nutrients and poor workability (Trough and Drew, 1982). Nevertheless, these soils are vastly underutilized due to management difficulties using traditional cultivation practices (Mesfine, 1998).

To minimize these difficulties it needs an identification and adoption of appropriate moisture drainage technologies to the study areas for better production up to the potential of the soil. Camber beds, 4.8 m wide and 0.3 m high, were the most successful land form studied, increasing crop yields by 90% compared with flat beds.

From field experiment conducted from 2015-2017 G.C.to investigate the effects of different drainage systems on yield and yield components of bread wheat ("*Madda walabu"*} verities on the waterlogged Vertisols of Adaba.In this study the highest grain yield of 5.8 t ha^{-1} which is 45% higher over the famers' practice was obtained when the bread wheat was grown using camber bed (Negash B, Mulugeta E and Chala C 2017.EC). Generally among the technology developed for good production of vertisol. Cumber bed drainage system has the 1st rank which was also verified as best vertisol management in Adaba District. Even though this drainage system is suitable for mechanized farm; the experiment done by SARC was conducted manually using man power.

Therefore, pre-extetion demonstration of the technology were employed with tractor drown dicher machine to popularize cumber bed land formvertisol drainage system at Hunte Oromia seed enterprise farm in this activities.

METHODOLOGY

Description of the Study Area

The study was conducted at Hunte Oromia Seed enterprise farm found at Adaba district inWest Arsi Zone of Oromia Regional State. Based onAgra-climatic condition the area has three seasons, a shortrainy season that extends from March to June, a long rainyseason extending from July to October and a dry seasonthat extends from November to February (NMSA, 2010).

On average, the annual rainfall in Adaba district is 913 mm. Temperatures in the high plain range between 10 and 30 degrees Celsius with an average of about 15 degrees. With increasing altitude, the climate gets colder and wetter. SARC Sub-site around Adaba is located at 343 km south east of Addis 220 m above sea level

Land Preparation

Pre-extention demonstration of the technology were conducted at Hunte Oromia Seed-Enterprise (replicated over two farm) for one year. A bread wheat Ogolcho variety were planted on cumber bed land form and flat bade on equal area of $2500m^2$(1/4ha) for both. Camber beds was form to make a raised profile 4.8m wide and 0.3cm high from the furrow to the top of the bed. This was performed by adjusting tractor drown machine so called dicher during land preparation. Also farmer practice land preparation was carried out with tractor drown machine. Seed and fertilizer rates were the recommended rates for crop (41/20 N/P). Initial land preparation, crop management factors was the same for both land form.

Farmers and Site Selection

Two farms one kilometer apart from each another at Hunte Oromia Seed-enterprise were purposively selected based on severity of water-logging typical vertisol adjacent to farmers field which are suitable for experience sharing for farmers. A total of fourteen farmers were selected for evaluation based on their interest towards technologies, those who have waterlogged vertisol problem in the area. Technology evaluation by farmers were carried out from land preparation up to harvesting of the crop.

Data Collection Method

Effectiveness of the technology and farmers preference toward the technology were collected through supervision and organizing mini field day. Farmers' and experts' idea was collected at the time of field day. To collect their real feeling and opinion,group discussion was undertaken and checklist was used for interviewing. Finally, the collected data (quantitative data) was analyzed by using descriptive statistics mean and standard deviation .

RESULT AND DISCUSSION

Yield and yield component analysis

Effect of the technology on grain yield and yield components of bread wheat in the waterlogged vertisols of Adaba is indicated in Table 1. As indicated in the table there were mean yield and mean yield component differences between farmer practice and cumber bed drainage systems. Accordingly, plants grown on camber beds land forming with fertilizer application had the highest Plant height, number of seeds per spike, spike length, number of tiller, above-ground biomass and grain yields and plant population per an area of $1m^2$ (Table 1).

Table1.Average yield and yield component of cumber bed and farmer practice

Treatments	Plant height (cm)	Spike length (cm)	NSPS	NT	Biomass yield(t ha^{-1})	Grain yield (t ha^{-1})	Plant/ m^2
Farmer practice	86	6.4	33.5	2	5	4.0	380
Camber bed	105	8.9	49.2	4	8	6.2	532

Generally, bread wheat grown on improved drainage techniques camber bed had better yield advantage as compared to farmers' practices. That means farmers' practices had the lowest yield and yield components, which is due to water logging effect on crop performance.

The highest bread wheat biomass yield of 8tha^{-1} which is 37.5% higher over the farmers practice (flatbed), were recorded under camber bed land form of the demonstration. Similarly the highest grain yield of 6.2t ha^{-1} which is 35% higher over the famers' practice was obtained when the bread wheat was grown using camber bed land management. The application of camber bed practices result significantly higher values of plant height, spike length, number of tiller and spike length (Table1.) of "*Ogolcho*" bread wheat over farmer practice.

Farmers preference of the technology

Min field day was organized to collect the preference of the technology by the farmers and other stakeholders at the end of the season. Accordingly, a total of 60 (46 male, 14 female) participants consisting of farmers, extension agents, experts and researchers were participated.yield advantage, good wheat performance and well drained soil were criterion's set by participants selection process of the technology. The results of groups toward the technology is indicated below (table 2).

Table2.Participants Feedback (N=60)

Land form	Cost effectiveness		Soil drainage		Crop performance		Yield advantage	
	No	%	No	%	No	%	No	%
Cumber Bed	35	58.3	50	83.3	52	86.7	55	91.7
Flat Bed (farmer practice)	25	41.7	10	16.7	8	13.3	5	8

Farmer's feedback results revealed that yield adventage of wheat crop planted on cumber bed land form is much advantageous than flat bed (farmer practice) land form. Farmers were preferred Cumber bed land form due to its good soil drainage, better crop performance and cost defectiveness than flat bed land form.Generally 90% of the participants were selected cumber bed land form as vertisol drainage in the area depending on the parameters given on the table 2.

CONCLUSION AND RECOMMENDATION

Pre-extension demonstration of vertisol management cumber bed structureswas conducted in Adaba district of West Arsi mainly intended to evaluate cumber bed land form and then create linkage & awareness on the crop production. The result of the study revealed that cumber bed land form have showed advantage over others farmer practice in terms of its yield and yield component compered to flat bed land form. In addition, feedback from demonstration, farmers during field day point out that cumber bed land form were selected in terms of good soil drainage, better crop performance and cost defectiveness. Therefore, cumber bed vertisol drainage were recommend for further scale up /out for Adaba district and other similar agro-ecologies. Therefore, agricultural development office, research organization, NGOs, private sector and other organization will have promote and disseminate to end user there to boost production and productivity of banana through contribute to food security of farming households.

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Pre-Extension Demonstration of Soil Test crop response Based Phosphorus Recommendation on Bread Wheat in Yaya Gulele District

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ABSTRACT

Wheat is a major crop produced in Ethiopian high lands which is a staple food crop. Regardless of this fact, average productivity of the crop both at National and Regional level is very low as contrasted with the world average yield due to different factors and among them low soil fertility is a major. Hence, Pre-extension demonstration of soil test based crop response phosphorus calibration study on bread wheat was conducted at Yaya Gulele district of North Shewa zone during 2019/20 cropping season with the objectives to demonstrate P - critical value and P- requirement factor for phosphorus recommendation of bread wheat. Five kebeles were purposively selected based on the wheat production potential in the study area. A total of six farmer's fields with initial phosphorus concentration below critical p-concentration for the district were selected. Five Farmers Research Group (FREG) comprising 75 farmers (55 male & *20 female) were established and thus 1 FREG at each kebeles was organized and training was delivered for farmers, DAs, and district experts on soil test crop response based phosphorus. The bread wheat crop were fertilized by blanket recommendation (100:100 kg/ha of Urea and DAP) and soil test based crop response phosphorus recommendation on 20m*20m plot size. The phosphorus fertilizer rate was calculated based on the formula [(23-pi)*3.76] established for the district. Improved variety of bread wheat Danda'a was used as a test crop with 150 kg/ha seed rate. Grain yield and farmer feedback/preference were collected. The results of the study revealed that the soil reaction (H_2O) were moderately to slightly acidic with the value ranged from 5.54 to 6.54, low to high available P with the value ranged from 7.92 to 20.73 ppm. The result of the study also showed that, the highest grain yield and net income were obtained from application of Soil test based P-fertilizer recommendation supplemented with 92 kg/ha N and which gave 49.48% yield advantage over the blanket fertilizer recommendation. The MRR obtained from Soil test based P-fertilizer recommendation was economically feasible and the highest MRR and net income were obtained from soil test based fertilizer recommendation. Thus, farmers in the district of Yaya Gulele could be advised to use soil test based crop response phosphorus recommendation to increase the bread wheat production.*

Key words: *FREG, Pre-extension demonstration, Soil test based Fertilizer recommendation*

INTRODUCTION

The population of Ethiopia is currently growing at a faster rate and demands an increased proportion of agricultural products. On the other hand, growth in food production is not in equal footings with population pressure (CSA, 2015). Strengthening food production capability of the country by wisely exploiting its existing human and natural resources is critical option to avert the existing situation. But, Ethiopia is one of the sub-Saharan African countries where severe soil nutrient depletion restrains agricultural crop production and economic growth. The annual per-hectare net loss of nutrients is estimated to be at least 40 kg N, 6.6 kg P and 33.2 kg K (Scoones and Toulmin, 1999).

Continuous cropping, high proportions of cereals in the cropping system, and the application of suboptimal levels of mineral fertilizers aggravate the decline in soil fertility (Tanner *et al.*, 1991; Hailu *et al.*, 1991; Workneh and Mwangi, 1992). Hence, identification of proper fertilizer mix is beneficial at the macroeconomic level by improving the efficiency of fertilizer procurement and resource allocation.

Therefore, profitable crop production requires adequate levels of phosphorus (P) and other nutrients. For this careful planning is required because of volatile grain and fertilizer prices. So, sound soil test calibration is essential for successful fertilizer program and crop production. It is essential that the results of soil tests could be calibrated or correlated against crop responses from applications of plant nutrients in question as it is the ultimate measure of a fertilization program.

An accurate soil test interpretation requires knowledge of the relationship between the amount of a nutrient extracted by a given soil test and the amount of plant nutrients that should be added to achieve optimum yield for each crop (Sonon and Zhang, 2008). Hence, calibration is a vital tool to attain the objective while calibrations are specific for each crop type and they may also differ by soil type, climate, and the crop variety. That means, fertilizer recommendations on soil test basis for economic crop production should be both location and situation specific and can be modified with changes in soil test value as well as input output ratios. Soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. Therefore, fertilizer application schedules should be based on the magnitude of crop response to applied nutrients at different soil fertility levels (Santhi *et.al*. 2002).

Soil test based crop response phosphorus calibration study and verification of Soil test based phosphorus recommendation on wheat crop was conducted in Yaya Gulale district having different P and N levels and promising result was obtained. The finding of soil test based crop response phosphorus calibration study was verified along with farmer practice and the control on farmers' land holding. Fertilizer application based on soil test promotes increased efficient use of fertilizer for improving agricultural production. Therefore, this activity was initiated to demonstrate P - critical value and P- requirement factor for bread wheat obtained from P-fertilizer calibration study.

MATERIALS AND METHODS

Description of the study areas

The experiment was conducted in Yaya Gullele district during 2011/12 cropping season on Wheat production potential kebeles. The district far 152 kilometers from Finfinne to North West. The geographical location of district ranges from $09^{0}29'30''$ to $09^{0}41'30''$N and $38^{0}30'00''$ to $38^{0}45'00''$ Annual rain fall of 1000mm and the average temperature of 25^{0}C and the soil are characterized as vertisol.

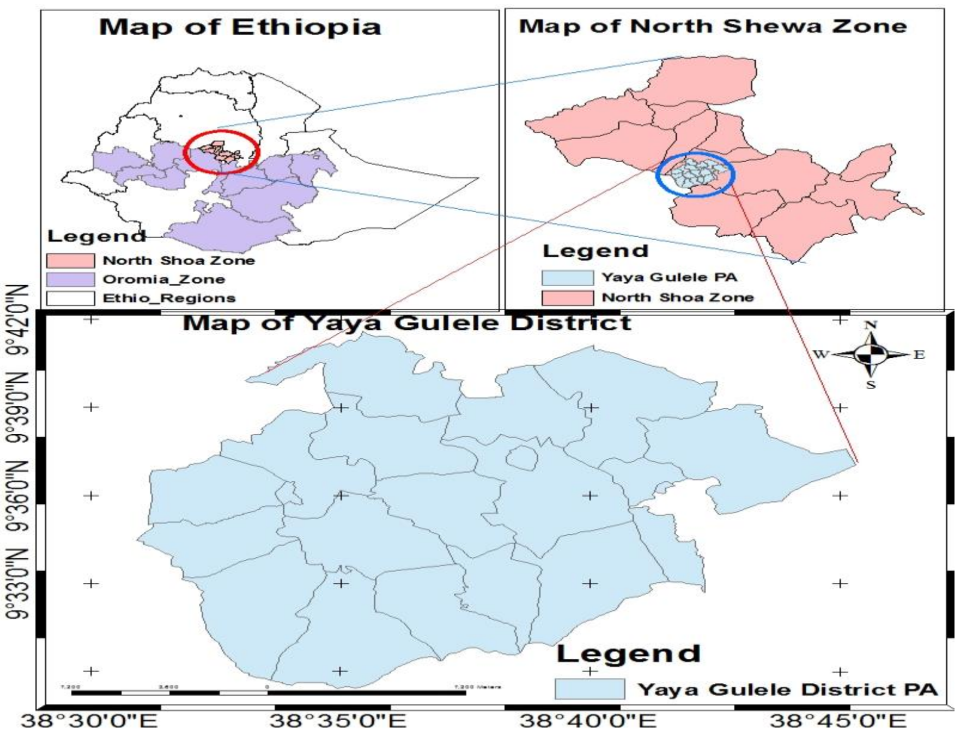

Fig.1 Location map of the study area.

Site Selection and Experimental procedures

To select experimental sites, 30 soil samples were collected from different farmers of the districts following the standard procedures. Soil chemical analysis were done for pH and available phosphorus, and then farmers field with initial phosphorus concentration categories below critical p-concentration was selected. Then Phosphorus fertilizer requirement was calculated using the formula as;

Phosphorus fertilizer rate = (pc-pi)*p_f;

Where; Pc=Critical phosphorus concentration (23 ppm),

Pi = Initial available P,

Pf = Phosphorus requirement factor 3.76 ppm.

Then the experiment was conducted on 9 farmer's fields with 20m*20m ($400m^2$) plot area plot size for each treatment. Blanket recommendation (farmer practice) and soil test based P-fertilizer recommended rate with economic N level (92 kg of N/ha) were used as a treatment. The recently introduced improved bread wheat variety Danda'a with row planting method of 150 kg/ha seed rate was used for the trial. DAP and Urea was used as Source of fertilizer.

Harvesting for grain yield determination was done from 3m x 3m net plot area. All management aspects land preparation, planting, harvesting, and protection against damage by diseases and pest were done according to farmer's practices in the area.

FRG Establishment and Training

The activity was conducted in purposively selected five kebeles from the district based on their wheat production potential, initial available phosphorus level of soil and their accessibility for supervision. The FRG member farmers were selected based on their lands suitable and sufficient to accommodate the trials, willingness to be held as member and share innovations to other farmers. Selection of farmers was done with the collaboration of development agents and district experts. Then the selected farmers in each kebeles were grouped in to Farmers Research Group (FRG) considering gender issues (women, men and youth). In each selected kebeles, one FRG units comprising of 15 farmers and one experimental field was established with the rest of farmers were being participant farmers. Totally, five FRG were established in the district.

After the establishment of FRGs a theoretical training session was arranged to farmers, development agents and experts on a topic of soil test based crop response phosphorus fertilizer recommendation for wheat production and improve farmer's knowledge and Perception towards the technology in the study areas.

Data Collected

Grain yield, farmers' perception towards the performance of fertilizer application through the soil test based crop response phosphorus fertilizer recommendation and total number of farmers participated in training was collected.

Method of Data Analysis

The collected data was analyzed using SPSS and descriptive statistics such as mean and standard deviation. Partial budget analysis was done to identify economically feasible fertilizer recommendation rate between blanket and soil test based fertilizer rates application according to CIMMYT (1988).

RESULT AND DISCUSSION

Soil reaction (pH) and Available Phosphorus of experimental field

The soil pH (H_2O) of the study area was moderately to slightly acidic with the value ranged from 5.54 to 6.54 according to the ratings suggested by Tekalign, 1991 (Table 1). Thus, the pH of the experimental soil was within the range for productive soils. The available phosphorus content of soils was low to high with the value ranged from 7.92 to 20.73 ppm. Therefore, the soil of the study areas needs application of phosphorus containing fertilizers for crop production.

Table 1. Soil pH and Avail. P of experimental field

Farmers field(site)	pH	Avail.P
S1	5.54	7.92
S2	5.64	20.73
S3	5.94	19.9
S4	6.16	14.4
S5	6.54	11.78
S6	5.58	10.44
S7	5.7	13.11
S8	5.56	18.93
S9	5.54	7.92
Average	5.80	13.90

Grain Yield of Bread Wheat

The result of the study shows that wheat grain yield was highly increased with the application of 92 kg/ha N and site specific fertilizer recommendation which gives 49.48% advantage over the blanket type of fertilizer recommendation. The highest mean grain yield (2995.83 kg/ha) was recorded with the soil test based calibration result which was higher than blanket fertilizer application (2004.20 kg/ha).

Table 2. Bread wheat grain yield (kg/ha) during 2019/20 cropping season

Site(Farmers field)	Blanket recommendation	Soil test based P-fertilizer Recommendation	Yield advantage (%)
1	1450	2625	81.03
2	1875	3225	72
3	1450	2750	89.66
4	2125	2500	17.65
5	2500	3125	25
6	2625	3750	42.86
Mean	2004.20	2995.83	49.48
SD	505.33	465.14	
CV (%)	25.21	15.53	

Provision of training

Before implementing the demonstration of Soil test based phosphorus fertilizer recommendation technology, training for the participant farmers and different stakeholders was provided. Eightythree (83) participant farmers from district were selected by collaboration with woreda agriculture and natural resource office. Beneficiary farmers, Kebeles development Agents and district experts were selected for the training. The training was provided on Soil test based phosphorus fertilizer recommendation technology pre extension demonstration of agronomic practices from land preparation to marketing. The main aims of training is to create awareness of farmers, development agents (DA’s) and district as expert and to compare results finally obtained from demonstration. A total of 83 participants (63 farmers, 12 experts and 8 DA‘s) were trained. Also, participants were shared their best experiences on how soil fertility management.

Table 3. Establishment of FRGs and Training

Topic of training	Location	No of FRG	Farmers trained(FRG)		Expert		Total
			M	F	M	F	
Pre-Extension demonstration of soil test crop response based phosphorus recommendation on bread wheat	AGP=II district (Yaya Gulele)	5	63	12	5	3	83

From the training, farmers were learned from researchers, DA's and also from each other. The participants had got better knowledge and skill on soil test based crop response phosphorus fertilizer recommendation for bread wheat production. In addition to this, farmers asked further research work on other major crop to increase the crop production. This showed that, the level of knowledge of farmers improved through trainings. Thus, researchers got feedback for future research work through linkage with development agent, farmers, experts and other stakeholders to strengthen the demonstration of technology. Therefore, all participants in the technology training prefer soil test based crop response phosphorus fertilizer recommendation for bread wheat production over the blanket fertilizer application and show the interest to practice site specific fertilizer recommendation for their future wheat production.

Partial budget analysis

To estimate the economical significant of the different fertilizer rates, partial budget analysis (CIMMYT, 1988) was employed to calculate the Marginal rate of return (MRR) to investigate the economic feasibility of treatments. Based on actual unit prices during the year 2019/20 harvesting season (personal observation) farm gate price of 20 ETB (Ethiopian Birr) per kg of wheat, 12.73 and 10.4 Birr per kg of DAP and Urea, respectively were used to calculate variable cost. The Marginal Rate of Return (MRR) was found to be 545.98% for soil test based phosphorus fertilizer recommendation rate (Table 4). The economic analysis showed that the highest net income (56488.40 ETB) was obtained from soil test based P-fertilizer recommendation with marginal rate of return (545.98%) which is greater than the minimum rate of return (MRR) 100% (CIMMT, 1998). Thus, the MRR showed that it would yield 5.45 birr for every birr invested.

Table 4. Partial Budget Analyses of bread wheat Grain yield

Fertilizer rate	**Variable Input(Kg/ha)**		**Unit price (ETB)**		**TVC**	**Output (Kg/ha)**	**Unit price (ETB)**	**Gross Income**	**Net Income**	**MRR (%)**
	DAP	Urea	DAP	Urea						
Blanket recommendation	100	100	12.73	10.4	2313.0	2004.2	20	40084	37771.0	-
Soil test based P-recommendation	156.27	138.35	12.73	10.4	3428.2	2995.83	20	59916.6	56488.4	545.98

TVC=Total variable cost; MRR=Marginal rate of return

CONCLUSION AND RECOMMENDATION

Depletion of soil fertility leads to declining crop yields and rise in the number of food insecure people. Thus, in order to improve soil fertility and subsequently increase crop yields more attention has been given to external inputs to the soil through site specific soil test based crop response fertilizer recommendation. The experiment was conducted in Yaya Gulele district during 2019/20 cropping season to demonstrate research finding obtained from P-fertilizer calibration study on bread wheat. Five FRG were established in purposively selected

kebeles and training was provided on the topic of soil test based crop response fertilizer recommendation for farmers, developmental agents, experts and stakeholders in the district.
From the study result, the highest grain yield and net income were obtained from Soil test based P-fertilizer recommendation and 92 kg/ha Nitrogen rate. The MRR of Soil test based P-fertilizer recommendation was economically feasible and the highest MRR and net income were obtained from soil test based fertilizer recommendation.

Although, based on the training delivered, all participants prefer soil test based crop response phosphorus fertilizer recommendation for bread wheat production show the interest to practice site specific fertilizer recommendation for their future wheat production.
In general, the study indicated that soil test based crop response fertilizer recommendation is superior than the farmers practice/blanket fertilizer recommendation in terms of yield, net benefit and MRR. Therefore, site specific soil test based crop response fertilizer recommendation could be recommended for further demonstration and scaling up in Yaya Gulele district on North Shewa Zone.

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Cluster Based Pre-Scaling Up of Soil Test Crop Response Based Phosphorus Recommendation on Teff (Eragrostis Tef (Zucc.)) in Were Jarso District of North Shewa, Zone, Oromia

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ABSTRACT

Cluster Based Pre-scaling up of Soil Test Crop Response Based Phosphorus Recommendation on Teff in Were Jarso District of North Shewa Zone was conducted during 2011/2012 cropping season. The main objective of this study was to enhance rapid diffusion, adoption and dissemination of the technology, to collect farmer's feedback and perceptions of the area. To achieve the objective, three cluster fields was established in different kebeles of the district based on teff production potential. Three FRG were established in a selected kebeles comprising of 15 members and before planting training was provided for farmers, DA's, experts from zone and districts on issues like soil fertility, crop production and soil test based fertilizer recommendation technology. Land was donated from farmers by their willingness and sown on 18 farmers' field. The phosphorus fertilizer rate was calculated based on the formula [(10-pi)*16.33] established for the district and recommended nitrogen for the area was applied. Improved variety of teff Kuncho and Dagim was used as a test crop. At maturity stage of the crop, field day was arranged to visit the crop field jointly with farmers, DAs, SMS, district and zonal expert. Data on soil pH, available phosphorus, total number of farmers participated on training, field visits and field days, farmers' perception towards technology, stakeholder's participation and grain yield was collected. The study showed that, the soil pH of experimental field was found between 5.54 to 6.42 which is ranged from moderately to slightly acidic. The available phosphorus content of soils of the study areas was found between 5 to 9.74ppm which is low. The highest grain yield (1656 kg/ha) was obtained from kuncho teff variety at cluster-1(Abbu Kekku site) and also 1125 and 937.5 kg/ha was obtained from Dagim variety at cluster-2 (Wale Cilalo site) and cluster-3 (Lenco Borsu) respectively. Data with regards to perception, all participants prefer the technology during field day and training. Therefore, the farmers in the district of Were Jarso could be advised to use soil test based crop response phosphorus recommendation and to be scaled up in all demonstration sites to increase the teff production.

Key words: Cluster based Pre-Scaling, FREG, Soil Test Based Phosphorus Recommendation

INTRODUCTION

Strengthening food production capability of the country by wisely exploiting its existing human and natural resources is critical option to avert the existing situation. But, Ethiopia is one of the sub-Saharan African countries where severe soil nutrient depletion restrains agricultural crop production and economic growth. The annual per-hectare net loss of nutrients is estimated to be at least 40 kg N, 6.6 kg P and 33.2 kg K (Scoones and Toulmin, 1999).

Continuous cropping, high proportions of cereals in the cropping system, and the application of suboptimal levels of mineral fertilizers aggravate the decline in soil fertility (Tanner et al., 1991; Hailu *et al.,* 1991; Workneh and Mwangi, 1992). Hence, identification of proper fertilizer mix is beneficial at the macroeconomic level by improving the efficiency of fertilizer procurement and resource allocation. Therefore, profitable crop production requires adequate levels of phosphorus (P) and other nutrients. For this careful planning is required because of volatile grain and fertilizer prices. So, sound soil test calibration is essential for successful fertilizer program and crop production.

An accurate soil test interpretation requires knowledge of the relationship between the amount of a nutrient extracted by a given soil test and the amount of plant nutrients that should be added to achieve optimum yield for each crop (Sonon and Zhang, 2008). Hence, calibration is a vital tool to attain the objective while calibrations are specific for each crop type and they may also differ by soil type, climate, and the crop variety. That means, fertilizer recommendations on soil test basis for economic crop production should be both location and situation specific and can be modified with changes in soil test value as well as input output ratios. Soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops. Therefore, fertilizer application schedules should be based on the magnitude of crop response to applied nutrients at different soil fertility levels (Santhi *et.al*. 2002). As in all other regions of the country, fertilizer recommendations in Were Jarso district is also not based on soil test results.

Soil test based crop response phosphorus calibration study and verification of Soil test based phosphorus recommendation on teff crop was conducted in Were Jarso district having different P and N levels and promising result was obtained. The finding of soil test based crop response phosphorus calibration study was verified along with farmer practice and the control on farmers' holding. Partial budget analysis indicated that soil test based phosphorus-fertilizer recommendation is economically feasible for Teff production in the district.

Different research center releases different technologies of teff. But farmers doesn't accept the released technology because the F-E-R (farmers-extension-researchers) relations are weak, fear for newly coming technologies and fear of failure and such trials did not took place in the study area before Scaling up of the technology on farmers field are the main tools for enhancing the adoption of technology, so that the aim of this study were to enhance rapid diffusion, adoption and dissemination of the technology, to collect farmers feedback and perceptions of the area.

MATERIALS AND METHODS

Description of the Study Area

The experiment was conducted in Were Jarso district during 2011-12 cropping season on teff potential kebeles, 185 kilometers far from Addis Ababa to North West. The soil of study area is classified as vertisol according to FAO soil classification system.

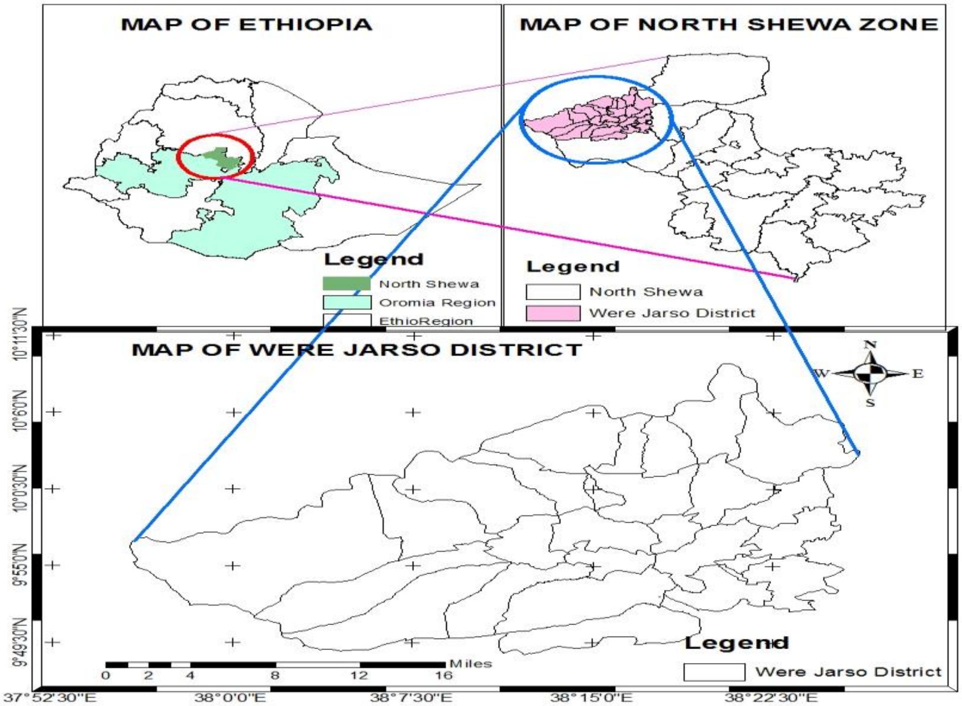

Fig 1. Map of Were Jarso District

Site/Cluster and farmer's selection

The activity was conducted in purposively selected kebeles of Were Jarso districts which is based on potentiality for teff production, Initial available soil phosphorus, accessibility for supervision and management criteria. Accordingly, 21 soil samples were collected from different farmers of the districts following the standard procedures. After soil was analyzed for available phosphorus, 3 cluster fields with initial phosphorus concentration categories below critical p-concentration for the district were selected. Then Phosphorus fertilizer requirement was calculated using the formula given below.

Phosphorus fertilizer rate = (pc-pi)*p_f;

Where; **Pc**=Critical phosphorus concentration (10 ppm);

Pi = Initial available P from each farmer's field;

Pf = Phosphorus requirement factor (16.33)

Then, the experiment was conducted on 18 farmers' field with 3 clusters. Also, the farmers were selected based on the initial available phosphorus level of soil, suitable and sufficient land to accommodate the trials and their accessibility. Selection of farmers was done with the collaboration of development agents and district experts. Then 0.5 ha areas of the land per farmer and 2ha per cluster were selected. The total plot area was 6 ha. DAP and Urea was used as a source of fertilizers. Amount of applied phosphorus was calculated based on soil test based Phosphorus fertilizer recommended rate and economic N level (92 kg of N/ha) was applied. The improved teff variety Dagim and Kuncho was used as a test crop. 30 kg/ha of seed rate were used and totally 180 kg teff seed was used for 6 ha. The farm field was prepared according to farmer's practice of the area. Harvesting for grain yield determination was done from a net plot area of 3m x 3m.

FRG Establishment and Training,

In each Kebele, one FRG comprising of 12-15 farmers were established. The FRG member farmers were also selected based on their willingness to be held as member. Then the selected farmers in each kebeles were grouped in to Farmers Research Group (FRG) considering gender issues (women, men and youth). In each FRG unit one experimental (Cluster) field was established with the rest being participant farmers. Three FRG were established in three different kebeles. Total numbers of farmer were 45 per three clusters including 30% women.

After the establishment of the FRGs a theoretical training session was arranged to farmers, development agents, and experts from zone and districts on issues like soil fertility, crop production and soil test based fertilizer recommendation technology.

Field Day and Visit

Field day is a method of encouraging farmers and stakeholders to adopt new practices by showing the reality under field conditions. Also it is used to show the performance of new technologies and to convince about the applicability under farmers' conditions. Therefore, field days were organized at cluster site by involving farmers and key stakeholders to enhance better linkage among relevant actors. Discussion session and communication forum were also organized.

Data Collection

Both qualitative and quantitative data were collected using appropriate data collection methods such as FRG and direct field measurements. Grain yield were measured from the plots. Total number of farmers participated on the events such as training and field days were recorded. Farmers' perception towards the technologies was also identified.

RESULT AND DISCUSSION

Soil reaction (pH) and Available Phosphorus of Cluster field

The soil pH (H_2O) of the cluster-1 field was ranged from 5.84 to 6.42, cluster-2 field was ranged from 5.54 to 6.14 and cluster-3 field was ranged from 5.88 to 6.17 (Table 1). In general, the soil pH of experimental field was found between 5.54 to 6.42. According to the ratings given by Tekalign, (1991), the soil pH (H_2O) were varied from moderately to slightly acidic and existed within the range for productive soils. The available phosphorus content of soils of cluster-1 field was ranged from 5.00 to 9.74ppm, cluster-2 was ranged from 7.80 to 8.77ppm and cluster-3 was ranged from 8.12 to 8.78ppm (Table 1). In general, the available phosphorus content of soils of the study areas was found between 5 to 9.74ppm. According to the ratings given by Cottenie, (1980), the soil available phosphorus content of the fields was low and thus it needs application of phosphorus containing fertilizers for crop production.

Table 1. Soil pH and Avail. P of cluster field

Cluster-1	pH(H_2O)	Avail.P	Cluster-2	pH(H_2O)	Avail.P	Cluster-3	pH(H_2O)	Avail.P
S1	6.40	9.00	S1	5.75	7.80	S1	5.88	8.75
S2	6.27	8.10	S2	5.54	8.00	S2	6.05	8.77
S3	6.18	5.00	S3	5.61	8.77	S3	6.17	8.76
S4	6.21	9.00	S4	5.59	8.77	S4	6.00	8.74
S5	5.84	9.74	S5	5.81	8.76	S5	5.99	8.78
S6	6.42	8.00	S6	6.14	8.70	S6	5.97	8.12
Mean	6.22	8.14	Mean	5.74	8.47	Mean	6.01	8.65

S=site (farmers field)

Training on Capacity Building

The main aims of training were to create awareness of farmers, development agents (DA's) and district as expert and to compare results to nearby farmers practice. Before implementing the scale up of Soil test based phosphorus fertilizer recommendation technology, training was provided for the participant farmers and different stakeholders by the researchers. A total of 89 participants (farmers, DA, Expert, Researcher, supervisors) were participated on the training.

The training was provided on the topic of Soil test based phosphorus fertilizer recommendation technology, importance of the technology, agronomic practices followed from land preparation to harvesting.

Field day Organized

At physiological maturity stage, field day was organized in the district to observe experimental site and create awreness on the importance of the technology in a real ground. A total of 92 participants (farmers, DAs, SMS, district and zonal experts) were participated on the promotional events. Demonstration fields were done on three kebeles. Dagim improved varieties of teff were used was showed on the fields. On the other hand, the participants were attracted and appreciates the kuncho teff variety fertilized with soil test based P-fertilizer recommendation

Table 2. Number of participant participated during the field day at Were Jarso district

No	Type of technology scale up	Participant								Total
		Farmers		DA's		SMS		Others		
		M	F	M	F	M	F	M	F	92
1.	Soil Test Based phosphorus recommendation study on teff	22	5	7	3	3	1	43	8	

Yield Performance

Onfarm field the overall field of mean yield was recorded. The highest grain yield (1656 kg/ha) was obtained from kuncho teff variety at cluster-1(Abbu Kekku site) and also 1125 and 937.5 kg/ha was obtained from Dagim variety at cluster-2 (Wale Cilalo site) and cluster-3 (Lenco Borsu) respectively.

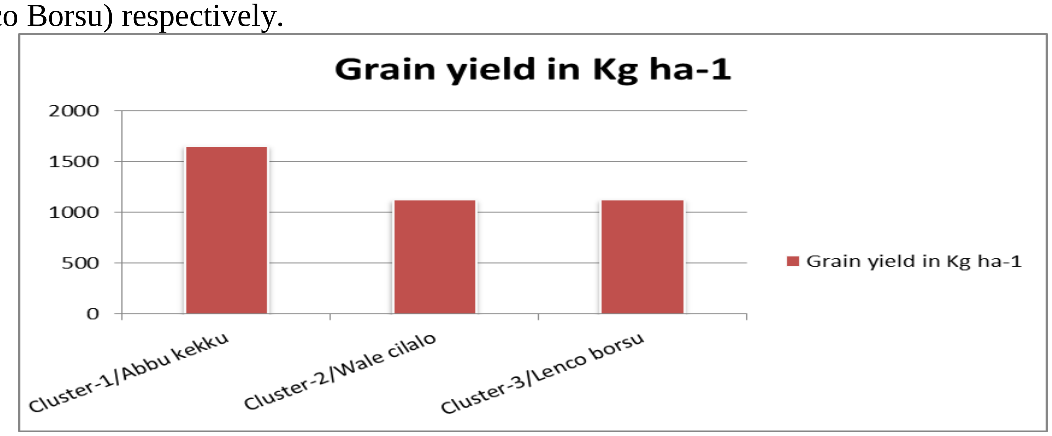

Fig 1. Mean yield data of the demonstrated technology in the districts

CONCLUSION AND RECOMMENDATION

Cluster Based Pre-scaling up of Soil Test Crop Response Based Phosphorus Recommendation on teff in Were Jarso District during 2011/2012 cropping season. Field day was conducted and different cluster field were observed by Farmers closest to cluster field, DA's, Experts from Wereda and Zone of Agricultural Office. Participants reflect their feedback to the undertaken activity. They appreciate the technology, however; they fear to adopt newly released variety and request adaptation of any crop to be conducted on the district.

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Pre-extension Demonstration of Vertisol Management Structures under Mechanized Farm in Adaba district, Southeastern Ethiopia

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ABSTRACT

Vertisols cover large part of the highlands of Ethiopia. However, the potential of these soils is not well exploited because of heavy water logging during the main rain season; this problem can be mitigated using different drainage systems. From the field experiment conducted in 2015-2017 G.C. to investigate the effects of different drainage systems on yield of bread wheat on the waterlogged Vertisols; cumber bed drainage system was verified as best Vertisol management in Adaba District. Hence; pre-extension demonstration of this activity was conducted with Mechanized farm at Hunte Oromia seed enterprise farm. Bread wheat Ogolcho variety planted on raised camber bed and flatbed on an equal area of 2500 m^2(1/4ha) for both. Camber beds were formed to make a raised profile of 4.8 m wide and 0.3 cm high from the furrow to the top of the bed. This was performed by adjusting tractor drawn machine so called ditcher during land preparation. Also, the flat bed was carried out with tractor drawn machine. Initially, land preparation operation and crop management factors were the same for both seedbed methods. The result revealed that bread wheat grown on improved drainage techniques camber bed had better yield advantage as compared to farmers' practices. The highest bread wheat biomass yield of 8 t ha^{-1} which is 60% higher over the farmers practice (flatbed) was recorded and the highest grain yield of 6.2 t ha^{-1} which is 55% higher over the famers' practice was obtained when the bread wheat was grown using camber bed drainage technology. In addition, farmers preference toward the technology were collected through supervision and organizing mini field day. Here also; the results indicated camber bed Vertisol drainage system was selected by farmers on the bases of its yield advantage, good wheat performance and well-drained soil compared to flatbed especially during high rainfall growing season. Therefore, Camber bed land drainage technology was recommended for further scaling up in mitigating drainage problem in Vertisol and reduces waterlogging at Adaba district and similar condition for production of bread wheat.

Key words: Camber bed, Bread Wheat, Waterlogging

INTRODUCTION

Vertisols are characterized by their extensive cracking from the surface to depths of 50 cm or more with seasonal drying and also gilgai microrelief or subsoils showing slicker-sides or spheroid structures as evidence of seasonal expansion and contraction (Probert et al, 1987). These soils generally have a weak horizon differentiation. These soils are distributed around the 45°N latitudes, mainly in the tropical and subtropical areas of the world. Driessen and

Dudal (1989) report an estimated 311 million ha of Vertisols or 2.4% of the global land area. Vertisols occupy about 105 million ha in Africa (Blokhuis, 1982) and about 12.6 million ha in Ethiopia. Vertisols are amongst the most common, high-potential soils in the highlands of Ethiopia, where over 88% of human and 77% of livestock are located (Erkossa, et al. 2005). However, the potential of these soils is not well exploited because of its heavy workability during dry season and high waterlogging condition during the main rainy season.

Farmers residing in Vertisols dominated areas have realized the adverse effects of waterlogging on crop productivity and have developed some traditional methods for overcoming the problem. Their strategy to utilize Vertisols has always been to plant late in the wet season, which means harvesting a single crop and leaving the land under-utilized or idle (Tedla *et al.*, 1993). Generally, the traditional management of Vertisols in the Ethiopian highlands varies from place to place depending on the amount and duration of rainfall, extent of drainage problems, soil fertility and slope and farm size (Berhanu, 1985; Mesfin, 1998). Waterlogging resulted in poor aeration, lower soil microbial activities, loss and unavailability of plant nutrients and poor workability (Trough and Drew, 1982). Thus, these soils are vastly underutilized due to management difficulties using traditional cultivation practices (Mesfine, 1998). edto that enhance optimum soil water and good crop and productivity

During 2015-2017 as were evaluate (Cumber Bed, Broad Bed Furrow) variety and Agarfa districts of Bale Zone, Southeastern Ethiopia. The results revealed that the highest grain yield of 5.8 t ha^{-1} which is 45% higher over the famers' practice was obtained when the bread wheat was grown using Camber Bed (Negash et al., 2017). Among the technology evaluated for Vertisol drainage management, Cumber bed drainage system (i.e., constructed with 4.8 m wide and 0.3 m high in dimension) has successfully increased crop yields as compared with farmers' practice (flat beds). Though Camber bed drainage system is suitable for mechanized farming (i.e., can be constructed using tractor mounted implements); the evaluation done so far was conducted manually using man power. Therefore, pre-extension demonstration of the Camber bed drainage technology which was constructed with tractor drown implements (ditcher) was done so as to popularize the drainage technology for Vertisol drainage management system at Hunte (Oromia seed enterprise farm) in Adaba district, Southeastern Ethiopia.

METHODOLOGY

Description of the Study Area

The study was conducted at Hunte (Oromia Seed enterprise farm) found at Adaba district of Southeastern Ethiopia. Based on Agro-climatic condition the area has three seasons, a short rainy season that extends from March to June, a long rainy season extending from July to October and a dry season that extends from November to February (NMA, 2010).

On average, the annual rainfall in Adaba district is 913 mm. Temperatures in the high plain range between 10 and 30 degrees Celsius with an average of about 15 degrees. With increasing altitude, the climate gets colder and wetter.

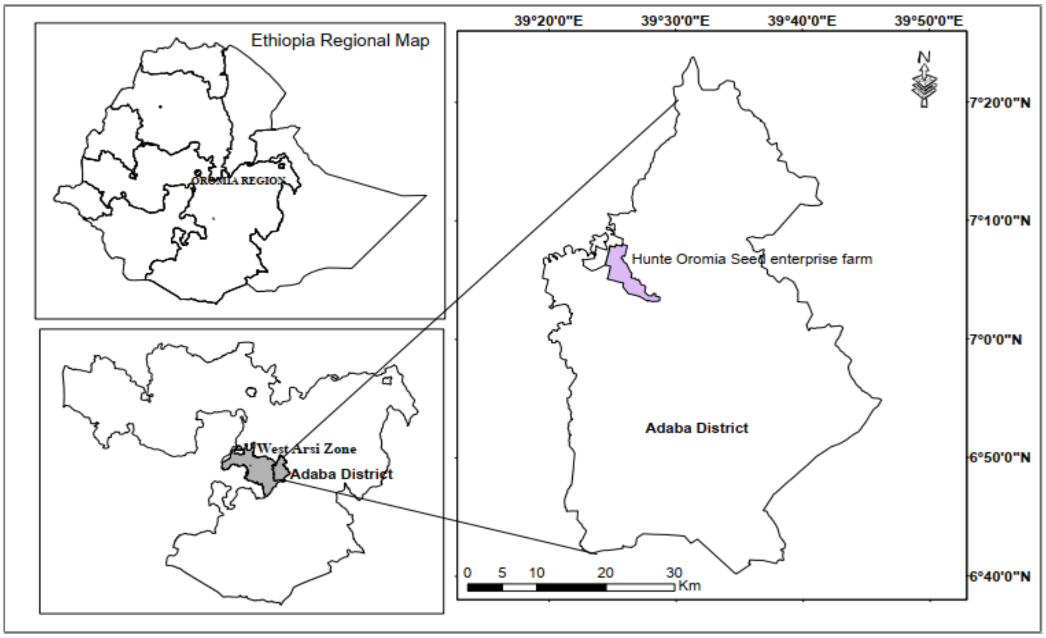

Figure 1: Map of the study Area

Land Preparation

Pre-extension demonstration of the technology was conducted at Hunte, Oromia Seed-Enterprise farm (replicated over two farm) for one year. A bread wheat Ogolcho variety were planted on camber bed land form and flatbed with equal area of 2500 m^2 (1/4ha) for both. Camber beds was formed to make a raised profile 4.8m wide and 0.3cm high from the furrow to the top of the bed. This was performed by adjusting tractor drown machine so called ditcher during land preparation. Also, farmers' practice land preparation was carried out with tractor drown machine. The recommended Seed rate used was 150kg/h and the recommended fertilizer rates used were 45 N kg/h and 20 P kg /h. Initial land preparation, crop management factors was the same for both seed bed methods.

Farmers and Site Selection

Two farms one kilometer apart at Hunte (Oromia Seed-enterprise farm) were purposively selected based on severity of water-logging (typical Vertisol soil) adjacent to farmers field which are suitable for experience sharing for farmers. A total of sixty (60) farmers were selected for evaluation based on their interest towards technologies, those who have waterlogging problem in their farm. Technology evaluation by farmers was carried out from land preparation up to harvesting of the crop.

Data Collection Method

Effectiveness of the technology and farmers preference toward the technology were collected through supervision and organizing mini field day. Farmers' and experts' opinion was collected at the time of field visit. To collect their real feeling and opinion, group discussion was undertaken and checklist was used for interviewing. Finally, the collected data (quantitative data) was analyzed by using descriptive statistics mean and standard deviation.

RESULT AND DISCUSSION

Yield and yield component analysis

Effect of the technology on grain yield and yield components of bread wheat in the waterlogged Vertisol of Adaba is indicated in Table 1. As indicated in the Table there were mean yield and mean yield component differences between farmer practice and camber bed drainage systems. Accordingly, plants grown on camber beds had the highest Plant height (PH), number of seeds per spike (NSPS), spike length (SL), number of tiller (NT), above-ground biomass (BM) and grain yields (GY) and plant population per an area of 1 m^2 (Table 1).

Table1. Average yield and yield component of cumber bed and farmer practice

Treatments	PH (cm)	SL (cm)	NSPS	NT	BM (t ha^{-1})	GY (t ha^{-1})	Plant/m^2
Camber bed	105	8.9	49.2	4	8	6.2	532
Farmer practice	86	6.4	33.5	2	5	4.0	380
Difference/advantage					**3 (60%)**	**2.2 (55%)**	

Generally, bread wheat grown on improved drainage techniques camber bed had better yield advantage as compared to farmers' practices. That means farmers' practices had the lowest yield and yield components, which is due to water logging effect on crop performance.
The highest bread wheat biomass yield of 8 t ha^{-1} which is 60% higher over the farmers' practice (flatbed), was recorded under camber bed planting methods. Similarly, the highest grain yield of 6.2 t ha^{-1} which is 55% higher over the famers' practice was obtained when the bread wheat was grown using camber bed land management. The application of raised camber bed practices gave significantly higher values of plant height, spike length, number of tiller and spike length over farmer practice (Table 1).

Farmers preference of the technology

Mini-field day was organized to collect the preference of the technology by the farmers and other stakeholders at the end of the season. Accordingly, a total of 60 (46 male, 14 female) participants consisting of farmers, extension agents, experts and researchers were participated on the field day event. Yield advantage, crop performance and drainage condition were criteria's set by participants to aid selection process of the best technology. The feedback of the field day participants toward the technology are as indicated in Table 2.

Table 2. Participants Feedback (N=60)

Seedbed Methods	Cost effectiveness of the technology		Improved soil drainage condition		Crop performance		Yield advantage	
	N	%	N	%	N	%	N	%
Cumber Bed	35	41.7	50	83.3	52	86.7	55	91.7
Flat Bed (farmer practice)	25	58.3	10	16.7	8	13.3	5	8

From farmer's feedback assessment, it is revealed that the yield of wheat crop planted on camber bed is much advantageous than flatbed. Farmers' were also reported that Camber bed enhance good soil drainage condition and better crop performance. Even though the cost effectiveness of the Flat bed is higher, farmers prefer Cumber bed because of the problem of water logging. Generally, 90% of the participants were selected raised camber bed as Vertisol drainage management technology options.

CONCLUSION AND RECOMMENDATION

Pre-extension demonstration of camber bed technology Vertisol management was conducted in Adaba district of West Arsi zone with the objectives of evaluating the technology and creates linkage & awareness for bread wheat crop production. The result of the study revealed that camber bed land form have showed advantage over others farmer practice in terms of its yield and yield component as compared to flatbed. In addition, feedback from farmers during field day point out that camber bed technology was selected in terms of good soil drainage, better crop performance and cost effectiveness. Therefore, camber bed Vertisol drainage were recommend for further scale up/out for Adaba district and other similar agro-ecologies. Therefore, agricultural development office, research organization, NGOs, private sector and other organization will promote and disseminate to end user so as to boost bread wheat production and productivity where there is poor soil drainage and waterlogging are problem.

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AGRICULTURAL ENGINEERING RESEARCH

Pre-Extension Demonstration and Evaluation of Engine Operated Cereal Crop Winnower

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ABSTRACT

The study was conducted in Jimma Zones of Oromia Regional State, Ethiopia in 2018 and 2019.The objective of the study was to demonstrate and evaluate the engine operated winnower performance for cereal crops (wheat, teff, maize & sorghum) under the farmers' condition in the study area. Four sites were selected as hosting centers for the popularization of the technology namely Chalte, Doyo Yaya,Sito and Soya Adami selected from two districts (Dedo, and Nada). A total of 174 farmer (60 Female, 114Male) households had attended the field demonstration at different sites involving men and women participation. The evaluation result showed that the machine has saved farmers' labor and time having average time taken 18.67, 38, 45.33 and 40.66 seconds for maize, wheat, teff and sorghum, with winnowing capacity 9.28, 4.14, 3.37 and 3.83 kg/min, cleaning efficiency (%) of 96.33, 87.44, 84.78 and 86.67, showing different performance for the different crops. This implied that the machine perform winnowing activity in a better way than the local methods with relatively less percentage of the product loss of 0.35, 3.58, 6.06 and 7.10 for maize, wheat, teff, and sorghum seeds, respectively. The participant farmers' perception responses being in the range of 56% to 82 % showed that the engine operated winnower has good capacity whereas 18 to 44 % responded to medium level while no respondents ranked it to poor capacity for the entire crops. As a result, most of the farmers have positively perceived to this machine towards its capacity. Concerning the cleaning efficiency of the machine, 56 % to 78 % of the participant farmers perceived that it has good cleaning efficiency. But 22 to 44 % respondents perceived that the machine ranked to have a medium cleaning efficiency for the four crop types under the study while no respondents perceived the machine has poor cleaning efficiency.

Keywords: Capacity, Cleaning Efficiency, Crops, Engine operated, Grain Loss, Winnower

INTRODUCTION

The crops are the first cultural grasses belonging to the poaceae family. In Ethiopia several agricultural production constraints are encountered at different crop growth stages. Energy and the timeliness are the major practical problem encountered in crop production activities, mainly due to lack of appropriate technologies. Post harvest loss is estimated to be about 25% of the total production (FAO, 1976). Improving the post harvest systems will reduce the post production losses. It has a great contribution to food security, raises the living standards in rural and urban areas. In urban area it makes the food available, more effectively and at a lower cost benefiting the poor member of the society in particular through to its c contribution to the generation of farm and non-farm income (Nuru, I (1980).

In wide ranging view, the post harvest activities comprises threshing, winnowing, grading, transport and storing. The winnowing operation, commonly known as grain cleaning is traditionally practiced in most part of the country using local equipment such as darba, afersa, korbi, gundo, hatola, sieve and other accessories. Problems like timeliness, high energy requirement, loss while blowing and removing larger chaff/straws fallen on the clean seed, seed and chaff mixing are happened while using these local equipments. Because the activity will depend on the natural wind, at times the threshed crop is left in hogdi (threshing field) for about 1-2 days in the absence of wind and when the wind speed is high, the seed can be taken away by with the straw/chaff. The average threshing and cleaning out put per man-hour for wheat is sorghum, millet, and maize is 5.5, 6.5, 4.0, 1.5 km/man-hour respectively (R.N.Kaul et al 1994).

However, on the contrary to the above facts, literatures show that multipurpose post harvest farm cleaning and equipments constituting, winnowing grading capabilities are now available at global level in a wide range performance levels (Shimelis, A., 2001.). Similarly in some part (institutions) of our country, though not widely promoted and used by farmers, there are some improved winnowers, which can help to alleviate the operational problems encountered in winnowing. Likewise Bako Agricultural Engineering research Center developed engine operated cereal crop winnower machine. Therefore, based on the demand from the farmers of the research mandate area, the machine is demonstrated in selected Dedo and Nada districts of Jimma Zone.

MATERIAL AND METHOD

Material

The prototype for engine operated winnower that made by Bako Agricultural Engineering Research Center was manufactured in Jimma Agricultural Engineering Research Center used for demonstration purposes of different grain size crops.
FREG establishment and training was conducted during crop threshing season in two Kebeles selected from each districts of Dedo (Calte&Sito) and Nada (Doyo Yaya) in Jimma Zone. A participatory FREG that consists of fifteen (15) members was formed in every identified Site.

The technical training on general cereal crop processing technology was given to farmer groups at the FTCs and the hosting farmers' site that was followed by demonstration and participatory evaluation of the technology. Finally, the evaluation data and feedback on the farmers' perception on the technology was collected and analyzed. A sample of three kilograms was taken from crops namely maize, wheat teff, and sorghum at three test sites that were used to know the machine performance. Three kilograms of crops were used in each case to generate performance data.

Field Evaluation

The evaluation of engine operated cereal crops was conducted in farmer's field at Dedo and Nadda of Jimma zone districts under the farmers' field condition. Separation and cleaning process was made along the sieve length as grain and chaff straw were transported over the sieve. The performance evaluation of the separating and cleaning machine was made on the basis of the following parameters; separating, cleaning efficiency, grain loss and cleaning capacity. Where: M1= the mass of impurities after cleaning (kg), M2= the mass of impurities before cleaning (kg), M3= the mass of grains after cleaning (kg), M4= the mass of grains before cleaning (kg), CE = cleaning efficiency (%) and GL = grain loss (%)

Data collected

Quantitative data on the machine performance based in terms of time and labor consumed in Man-hr per kg/hr. Qualitative data through: observation and interview and Feedback data and comments from participant farmers

Method of data analysis:

The quantitative and qualitative data collected on the technical performance and the perception through interview, observation and group discussion and analyzed by using descriptive statistics.

RESULTS AND DISCUSSION

Training Farmers, Sms And Das On The Engine Operated Crop Winnower Machine

Both practical and theoretical trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) that exist at the selected Kebele level on the operation and maintenance of the engine operated crop winnower machine to create awareness before actual demonstration carry out at large. Accordingly a total of 51 farmers, 8 DAs and 6 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS

No	**Location**		**Training Participants**				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Nada	Doyo Yaya	4	8	2	2	16
		Soya Adami	5	7	2	1	15
2	Dedo	Calte	7	6	2	1	16
		Sito	8	6	2	2	18
	Total		**24**	**27**	**8**	**6**	**65**

On-farm Evaluation of improved crop cereal winnower

Winnowing involves removal of larger chaff/straws to have the clean seed separately. It can be adjusted as per the crop variety by changing the sieve with different size. This winnower is specially designed to maze, teff, sorghum, wheat and barley crops. The performance of the winnower was calculated as follow: Winnowing capacity = weight of winnowed grain/time taken Cleaning efficiency =total weight of winnowed grain /total weight of the sample (input) x 100 Loss = total weight of the sample (impute)-output per input x100

Table2. Average performance of engine winnower for cereal crops (maize wheat, teff, and sorghum) under the farmer's management

Rep	Time taken(sec)	Winnowed grain (kg)	Chaff blown(kg)	Cleaning Efficient (%)	Winnowing capacity (kg/min)	Loss (%)
Ma	17	2.85	0.12	95	10.05	0.71
Mb	19	2.89	0.08	96.33	9.12	0.11
Mc	20	2.93	0.07	97.66	8.77	0.24
Av	18.67	2.89	0.09	96.33	9.28	0.35
Wa	40	2.71	0.21	90.33	4.07	3.51
Wb	36	2.56	0.25	85.33	4.27	3.23
Wc	38	2.60	0.24	86.67	4.11	3.99
AV	38	2.62	0.23	87.44	4.14	3.58
Ta	45	2.55	0.33	85	3.4	3.19
Tb	49	2.58	0.28	86	3.16	7.01
Tc	43	2.53	0.33	84.33	3.53	7.98
Av	45.33	2.55	0.31	84.78	3.37	6.06
Sa	37	2.54	0.31	84.67	4.12	6.85
Sb	43	2.69	0.24	89	3.75	5.47
Sc	42	2.57	0.29	85.66	3.67	8.99
Av	40.66	2.60	0.28	86.67	3.83	7.10

The letters a, b and c indicate the winnower evaluated at four different sites were as the letter M, W, T and S represent maize, wheat, teff and sorghum respectively.

On farm evaluation and demonstration of the improved engine operated winnowertechnology was made in teamwork with participant farmers, SMs and DAs. The improved machine is evaluated for maize wheat, teff, and sorghum seeds. The evaluation of the technology was made in terms of the machine clearing efficiency, clearing capacity and the grain loss percentage.

In view of that it has shown the average time taken 18.67, 38, 45.33 and 40.66 seconds for maize wheat teff and sorghum, with winnowing capacity of 9.28, 4.14, 3.37 and 3.83 kg/min having the cleaning efficiency (%) of 96.33, 87.44, 84.78 and 86.67showing significantly different across all crops and the machine perform the activity in a better way than the local methods with relatively less percentage of the product loss 0.35, 3.58, 6.06 and 7.10 for maize, wheat, teff, and sorghum seeds respectively.

Demonstration of the improved cereal crops winnower

In this study, the farmers' feedback after the demonstration of winnower machine is collected based on evaluation criteria jointly set by researchers and farmers. These includes, values for optimum pulpier output capacity, visible grain loss, and cleaning efficiency considered for them and farmers' perception in respective of these criteria. Farmer to farmer learning is used to promote the technology simply by arranging winnowing program at the host farmer's farm site. Evaluation of the technology was made together with the participant farmers, based on the attributes recognized as important mainly clearing efficiency, clearing capacity and Loss (%) as per their perception.

Mini-field days conducted

Table 3 Participants on mini field days

No	Location		Stakeholders field day participation									
			Farmers				DAs & SMS		Others		Total	
			Adult		Youth							
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Nada	Doyo Yaya	21	9	10	8	2	2	2	1	35	20
		Soya Adami	16	8	14	12	2	1	2	1	34	22
2	Dedo	Calte	14	7	15	10	2	1	2	1	33	19
4		Sito	13	3	11	3	2	0	3	0	29	6
	Total		64	27	50	33	8	4	9	3	131	67

Mini-field days were made at different sites namely Doyo Yaya, Soya Adami, Calte and Sito which attended by different stalking holders. In view of that, 174 farmers (60 Female, 114 Male), 12 agricultural workers (SMS and DAs), 12 others (Kebele Administrators and Researchers) have attended the mini field days.

Pictorial Representation

Farmers' perception on the technology attributes

Data on technical operation and social perception aspects were collected and analyzed. The primary data on crop winnower were collected during and after demonstration on perception or farmers' opinion. Some of the attributes used about the technology was winnower efficiency (%), winnower capacity (kg/hr) and Grain loss (%). Farmers have positively perceived concerning the winnowing efficiency (%) of 96.33, 87.44, 84.78 and 86.67, winnowing capacity (kg/hr) 9.28, 4.14, 3.37 and 3.83 and Grain loss (%) of 0.35, 3.58, 6.06 and 7.10 values for maize, wheat, teff and sorghum respectively as it has good performance compared to the method of manual winnowing to clean the threshed grains of the rural farmers at the study areas.

Table4. Farmers' Perception on improved winnower for Maize, Wheat, Teff and Sorghum crops

Attributes used for acceptance degree	scale measurement	participants' reaction per Crop Variety (No=32)			
		Wheat Column Fr %	Teff Column Fr %	Maize Column Fr %	Sorghum Column Fr %
Winnowing capacity (kg/hr)	Poor	- -	- -	- -	- -
	Medium	13 41	14 44	4 18	10 31
	Good	19 59	18 56	28 82	22 69
Cleaning efficiency %	Poor	- -	- -	- -	- -
	Medium	10 31	14 44	7 22	14 44
	Good	22 69	18 56	25 78	18 56
Grain loss (%)	Poor	- -	- -	- -	- -
	Medium	5 16	7 22	6 19	8 25
	Good	27 82	25 78	26 81	24 75

The participant respondents replied that the winnower machine has good cleaning capacity are in the range of 56% to 82 % whereas 18 to 44 % responded medium level while no respondents ranked it to poor cleaning capacity for the four crop varieties. Thus it showed that most of the farmers have positively perceived to this machine towards its cleaning capacity.

Furthermore, the participant respondent farmers were also perceived in the range of 56% to 78 % that it has good cleaning efficiency. Respondents of virtually 22 to 44% had perceived that the machine was ranked to have a medium cleaning efficiency for the four varieties under the study while no respondents perceived the machine has poor cleaning efficiency for all the varieties.

The response on the winnower also showed its strength and drawbacks as to the farmers' observation during the field work. Farmers just liked it in its less grain loss while winnowing or cleaning the seed and easy to operate and other time and labor reducing attributes.

However, they commented on its construction and strength so as to avoid easily damage during operation. The machine needs some refining work based on the users' remark to upgrade its winnowing capacity and efficiency for more accuracy per the required desire.

CONCLUSION AND RECOMMENDATION

The machine has saved farmers' labor and time having average time 18.67, 38, 45.33 and 40.66 seconds, capacity of 9.28, 4.14, 3.37 and 3.83 kg/min, cleaning efficiency (%) of 96.33, 87.44, 84.78 and 86.67 with relatively less percentage of the product loss 0.35, 3.58, 6.06 and 7.10 for maize, wheat, teff, and sorghum seeds respectively. Most farmers have positively perceived to this machine for its good capacity, cleaning efficiency, less grain loss during cleaning the seed, easy to operate, save time and labor. Accordingly, based on the study result, the machine need be scaled up to the cereal crop producer farmers of the region with special care in properly following the appropriate designee during the manufacturing.

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Pre-Extension Demonstration of Portable Poultry House for Rural Women in Jimma Zone

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ABSTRACT

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia in 2018 and 2019.The objective of the study was to demonstrate the portable poultry house and hay-box brooder for rural women in western Oromia. Two sites were selected from two districts (Omo Nada and Dedo) and 2 FREGs comprising 25 women farmers were established. Training was given to 25 female farmer participants, 5 DAs and 4 Subject Matter Specialists. Total of 95 farmer (83 Farmers, 4 Das, 3 SMS and 5 from Kebele administrative) households attended field demonstration at different sites. Among the participant farmers, 67 % had responded that the movable poultry house and the hay box brooder were highly preferred to their local system mainly using living house that is easily susceptible to wild predators. While 33 % of the respondents leveled in medium that the technology need technical knowledge to use and make maintenances when it damages. In terms of poultry health condition, 92 % of the farmers responded that the Chicken/hen's death or disease incidence is very low as the necessary vaccination was given at the early age of the chicken and thus 87.5 % of the participants were motivated to start poultry production individually. Furthermore, 41.7 % of the respondent farmers having medium level interest indicated that it was challenging to entertain group interest in managing the poultry regularly in providing feed and protection while only 20.8 % of the group members claimed continuity of working in groups stating that they need to share the chickens and have independent poultry.

Key words: Chicken brooder, Demonstration, Hay-box

INTRODUCTION

Women have an important role in agriculture. Their contributions to agriculture vary from society to society (Benor and Bexter, no date). In general, women contribute to the total household income. This fact implies that rural women have to be served by research results and extension services. Why focus on women? This question is used to be answered and can be looked in to from two perspectives. The first argument is about equity since women are part of a given society they should have equal access to resources. Women's work is not visible to men so that they can get equal rewards to their contributions to agricultural production. But in reality women do not have equal access to resources. The other argument can be expressed in terms of efficiency. If we look at the farming system, women are the main food producers while men are cash crop producers. Women also form the major part of the labor supply for agriculture. Thus, any development efforts geared to the productivity as well as their living standard should serve rural women (Diga Korara Beyene, 2001).

Despite women's central role in Africa's food production, there has been persistent under investment in increasing their productivity. Women's contributions to agriculture remain under acknowledged under supported. In most parts of Africa, the obsolete technology rural women still use makes their farm work labor extensive and time consuming. This limits their productive capacity and ability to cultivate large tracts of land. Male farmers have greater contact with extension services than do female farmers. Unfortunately, extension advice to one member of the family is usually not passed on to other people. Because of difference in access to technology between male and female, women's agricultural output will continue indicating low outcome. With low output, little income can be realized from whatever is marketed will have virtually nothing to plow back in to their economic activities (Women, agriculture intensification, and Household food security, 2000).

The insufficiency of female oriented technology generation and extension program is serious concern of gender discrimination in Ethiopian agricultural development. A major chunk of women's labor force in production system was invested in weeding, irrigation, harvesting, household chore, animal care, marketing, post-harvest handling etc. The traditional methods consume much of energy and time of rural women, for which due attention is not paid in technology generation process. Generally, sufficient extension packages are also not seen taken up for the disseminations of women friendly, labor and time saving and drudgers reducing technologies (FAO, 1992).

The rural women in Ethiopia work for 13-17 hours per day, which is almost two-fold of men (The transitional government of Ethiopia, 1993). Almaz (2000) indicates that, globally, women perform 67% of the world's working hours, and on the contrary, women own less than 30% of the agricultural labor is performed by women and male-headed households constitutes more than 22% of the family.

Rural women confront obstacles that limit their ability to participate in community development programs. They frequently lack the self-confidence or a forum in which to speak up publicly for themselves and for their families. They often lack access to education, credit and land tenure, which limits them, more than it does, limits the men of their own families (FAO. 1989).
Rural women are constrained by unequal access to productive resources and services and inadequate or in accessible infrastructure. The limitations rural women face in turn impose huge social, economic and environmental costs on society as a whole and rural development in particular including lags in agricultural productivity (Herald 13 January 2013).

As a remedy, empowerment of the poor (women) is a global agenda this day. Empowerment is the expansion of assets and capabilities of poor people to participate in, negotiate, with influence, control, and hold accountable institutions that affect their lives (World Bank, 2002).poor women and men need a range of assets and capabilities to increase their wellbeing and security, as well as their confidence, so they can negotiate with those more powerful. Assets and capabilities can be individual or collective. For poor people, the capacity to organize and mobilize to solve problems is critical collective capabilities that help them overcome problems of limited resources and marginalization in society.

Poultry is the one women dominated in Ethiopia. The gender base line survey undertaken by IPMS revealed that women perform most of the production activities such as hatching, hygiene, and feeding, watering, protection and egg collection. Poultry production and marketing is suitable for women, since they have traditional knowledge and enterprise does not require much land. One of the main problem o0f poultry productions in Ethiopia is low productivity and high mortality rate as high as 80-90% due to disease and predation (Tegegne et al, 2010).

Production of poultry rearing, baby chickens by using the natural brooding and lack of appropriate house have been indicated as major constraints by different researchers. For instance, according to Hoyle 1992 as cited in Selemon 2007, the mean survival rate to age 3 months of baby chicks reared under the natural brooding condition in Ethiopia is only about 40% andmost of chickens affected by disease and predators because of lack of appropriate house.

According to Herald (30 August 2012) Promotion of women and youth empowerment with equity is a key multidirectional component in the Growth and Transformation Plan (GTP) for achieving sustainable economic growth. The objective of development plan can be achieved only when the multidimensional problems faced women and youth are concurrently addressed and resolved. Hence, the government will scale up its efforts to implement women and youth policy, which is necessary to release the untapped potential of this population segment, in a holistic and integrated manner.

Cognizant of the above facts one of the most successful ways of working with rural women is through group. The natural tendency may be to form mixed groups, with both male and female members. In this situation they do not always provide the best learning environments. Women's group is culturally and socially acceptable in most places, and can overcome even the most rigid taboos. In addition to this, it can facilitate pooling of resources. Women feel free to speak in groups of women than they do when men are present. However the existing activities are not gender balanced hence women are poorly represented in the groups. Therefore, it is important to form women's group.

MATERIALS AND METHODS

Materials used in this study were two prototypes of portable poultry houses and six hay-box brooders that manufactured in Jimma Agricultural Engineering Research Center so as to use for demonstration purposes. Moreover, a total of forty-eight chickens of two months aged and 200kg feed were bought and distributed at two selected sites of farmer groups. The demonstration was conducted in the two selected Kebeles namely Sito and Toli Beyam of Dedo and Nada districts of Jimma Zone respectively. Participatory FRGs that consists of eleven and thirteen members was formed in two groups together with the DAs from respective Keble, SMS from agency of animal sciences of the respective districts, women's affairs office, and administration bodies in selection of interested women farmer participants for the technology demonstration and training. Finally, the feedback data about the farmers' perception on the technology was collected and analyzed.

Data management and Statistical analysis

The collected data was arranged in a raw data and the quantitative and qualitative data was analyzed using descriptive statistics.

RESULT AND DISCUSSION

Training Farmers, SMS and DAs on the improved portable poultry house and hay-box brooder technology

The technical training on portable poultry house and hay-box brooder technology was given to farmer groups at the hosting farmers' site. Subject Matter Specialists (SMS) and Development Agents (DAs) that exist at the selected Kebele level also trained on the operation, repair and maintenance of the portable poultry house and hay-box brooder technology and the chicken management to create awareness before actual demonstration carry out at large.

Table1. Training given to farmers, DAs & SMS

No	Location		Training Participants				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Nada	Toil-beyam 13	8	4	2	2	16
2	Dedo	Sito 11	7	5	3	2	17
		Total	15	9	5	4	33

Accordingly, a total of 24 farmers, 5DAs and 4 Subject Matter Specialists were participated in training.

Demonstration of improved portable poultry house and1 hay-box brooder technology

The demonstration of portable poultry house andhay-box brooder technology was made in teamwork with participant farmers, SMs, DAs and the farmers' feedback was collected based on criteria jointly set by researchers and farmers. The poultry house is suitable to easily move and allocate at the desired position when necessary. The hay-box brooder technology provides the required heat for the premature chicken facilitating condition for development and better handling. This hay-box brooder is specially designed serve 10 to 15 chickens during their early age while the poultry house is used for the adult hens.

In this study, mini field days also conducted on portable poultry house and hay-box brooder technology in participation of farmers, DAs, SMS and Others stalk-holder.

Table 3 Participants of field days on portable poultry house and hay-box brooder

No	Location		Farmers		workers		Others	Total
	District	Kebele	Adult	2	DAs	SMS		
1	Nada	Toil-beyam	21	1	2	2	3	46
2	Dedo	Sito	24	4	2	1	2	49
	Total		45	38	4	3	5	95

The demonstration was made at hosting farmers sites namely Sito and Toli-beyam that attended by different stakeholders. In view of that, 83 farmers (45 adult, 38 youth), 7 SMS and DAs, and others 5 Kebele Administrative members have attended the demonstration works.

Farmers' perception on the technology attributes

Table 3: Farmers' perception and satisfaction level

Attributes & their acceptance degree by farmers	**Farmers' response (No=24)**	Low	Medium	High	Total
Poultry house advantage	Frequency	-	8	16	24
	%	-	33	67	100
Chicken/hen death or disease	Frequency	22	2	-	24
	%	92	8		100
Need to Poultry production	Frequency	-	3	21	24
	%	-	12.5	87.5	100
Need to group continuity	Frequency	9	10	5	24
	%	37.5	41.7	20.8	100
Average	Frequency	7.75	5.75	10.5	24
	%	**32.29**	**23.96**	**43..75**	**100**

CONCLUSION AND RECOMMENDATION

The improved movable poultry house was demonstrated for mainly female farmer group so as to create awareness in poultry production and management in order to enhance female farmers' income for betterment of their livelihood. The 67% participant farmers had responded that technology was highly preferred in relation to local system mainly using living house which easily susceptible to wild predators. While 33 % of leveled in medium indicating technology need technical knowledge to use and maintain when it damages. Regarding poultry health condition, 92% of the farmers responded Chicken/hen's death incidence is very low as the necessary vaccination was given at their early age motivating 87.5% of the participants to start poultry individually. Still, some farmers showed medium level interest indicating group interest was challenging in managing the poultry regularly in feeding and protection while only 20.8 % of members claimed continuity of working in groups stating that they need share the hens and have individual poultry.

All stakeholders and concerning bodies should strongly work in introducing the technology to the farmers by creating linkage among poultry producers and technology manufacturers in order to enable them use the improved technology for poultry production activities. Micro enterprise and agricultural development offices in the respective districts and Kebeles should maintain sustainable partnership in order to strength the linkage among producers and technology manufacturers.

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Participatory Demonstration & Evaluation of Milk Churner through FREG in South Western Oromia In Jimma and Buno-Bedelle Zones

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ABSTRACT

The study was conducted in Jimma and Buno Bedele Zones of Oromia Regional State in 2018 and 2019.The objective of the study was to demonstrate and evaluate improved plastic milk churner so as to reduce women's workload in churning practice. Twelve Kebeles were selected for the study as hosting sites in two zones and four districts (Nada and Gera of Jimma as well as Gechi and Bedele of Buno-Bedele Zones). A total of 12 FREGs were established comprising 186 farmers (66 male & 120 female). Training was given to all FREG members, 22 DAs (8 Female and 14 male) and 8 Subject Matter Specialists. A total of 245 farmer (101 Female, 144 Male) households attended field demonstration at different sites. The result showed that in average it took 24.04 minute and 23.54 minute to churn three liter of milk for local and improved, respectively. Churning resulted in 0.154 kg and 0.256 kg of butter production or output from the three litter milk for local and improved churner, respectively. Most of the participant farmers had responded that using the improved churner is easy, labor saving and give reasonable butter yield as compared to the traditional tedious method of churning, operated with minimum energy and can be affordable by the average farmers. Furthermore the respondent farmers also indicated the possibility to repair and maintain by local technicians or by themselves if there will be any damage to churner components.

Key words: Demonstration, Evaluation, Milk churner, Participatory

INTRODUCTION

In Ethiopia, milk production and processing is an important activity of small holder farmers. On the other hand, a fraction of total milk production enters the formal processing channel. Thus most of the milk produced in the country is either sold as fluid milk or processed using traditional practices mainly clay pot churners. In many households, milk is accumulated in the clay pot and kept at room temperature for several days by adding fresh milk in to the already accumulated until is sour for processing. Because the small holder traditional milk processing is based on sour milk.

A clay pot is then used to churn the sour milk to get butter and other products. Processing milk in to such stable and marketable product generates cash income for smallholders' producer in the rural areas and enables them to conserve milk solids as butter for sale and consumption (lemma 2004). Yet, the clay pot churners are not efficient either in their butter production, in saving time and labor. Studies indicated that the traditional method of churning is time consuming, perhaps, taking more than an hour (O. conner et al 1993, Feyisa et al, 2009 and Yilma z et al 2007).

O'connor et al (1993) reported that in on-farm trails in the Debre Birhan areas, Ethiopia, an average churning time of 139 minutes. Likewise, Yilma z et al (2007) reported 191 minutes for traditional clay pot churner while Feyisa et al (2009) reported 65 min on average when using the traditional clay pot churners in central rift valley areas of the country. Mahony and peters (1987) also reported that traditional clay pot churners give low yield butter per unit of sour milk and require high labor input.

Similarly the amount of butter obtained from traditional milk churner is lower than the yield obtained from improved churner as reported by (lemma 2004). Nevertheless different on farm participatory type research activities were conducted by different institutions to try new types of churners by comparing their time saving potential and butter yield along with traditional clay pot churners. Studies conducted by O'connor et al (1993) reported as 57 minutes obtained with the agitator fitted into the traditional clay pot churner.

In a related research conducted by Alganesh (2002), using the internal agitator reduced churning time by 22% from an average of 28 minutes to 23 minutes. The same author reported that the average butter obtained the internal agitator was 359.7 grams and 376.9 grams per 6 liters of sour milk, respectively. Yilma z et al (2007) also reported that 475g of butter was obtained using clay pot with the churning time of 191 minutes (3.7hr) whereas 492g of butter was obtained from internal wooden made agitator which is developed by international livestock research institute (ilri) with the churning time of 80 minute (1.3hr). The milk was churned after 62hr of fermentation and ten (10) litters of milk were used for both butter making methods (Yilma z et al, 2007).

Through the on farm trial made around Adami Tulu area of central rift valley of Ethiopia the average time taken by traditional milk churner was reported as 65min and the modified milk churner which was wooden made was reported to be 43.54±5.06 (Tesfaye et al., 2008). In the same place, but using different improved churner made from plastic (developed by Adami Tulu agricultural research) Teyisa et al (2009) reported reduced churning time by 58.89%% from the average 80.97min to 33.29 using traditional and plastic milk churner respectively. In all the above research activities promising results have been found by using the improved milk churners. At Adami Tulu agricultural research center the plastic milk churner evaluated by farmers also showed a promising result round Adami Tulu areas as reported by Feyisa et al, (2009) and Tesfaye et al. (2008).

Yet the milk churners were not evaluated and demonstrated under farmers' circumstances in milk producing areas of Buno Bedele & Jimma zones. Therefore, participatory demonstration and evaluation of improved plastic milk churner made in the study areas.

MATERIAL AND METHOD

Totally twelve plastic milk churners of six liters were produced in JAERC metal workshop for demonstration purpose and distributed for host farmers.

Description of the study area

The study was conducted in Nada (Burka Asandabo, Toli Sabata, and Lalo Beyam) and Gera (Wanja Kersa, Qaco Anderecha and Ganji Caalla) districts from Jimma zone and Beddele (Burka-Haro, Bedele-1and Bedele-2) and Gachi (Gito, Bido & Gechi) districts from Buno Beddele zone of Oromia Regional State. Four dairy potential four districts were selected from Nada & Gera of Jimma likewise Bedele and Gechi from Buno Beadle zones. A total of 12 Kebeles were purposively identified from the selected districts of the two zones based on dairy production trends and participants' willingness forming a group which has 15-20 members of farmers mainly, female farmers to undertake demonstration of the churners (See table 1 blow). Finally, twelve plastic milk churners were distributed to the participant farmer of the 12 established FREGs.

Data collected

The primary quantitative data on the churner performance was collected and supported by qualitative data on the farmers' perception feedback with regard to the technology accessible, convenience, affordability etc in relation to the local practices.

Method of data analysis:

The quantitative and qualitative data collected on the technical performance and perception through interview, observation and group discussion and analyzed by using descriptive statistics.

RESULTS AND DISCUSSION

Both practical and theoretical trainings were given for the participant farmers, Subject Matter Specialists (SMS) and Development Agents (DAs) that exist at the selected Kebele level on the churning process, operation and maintenance of the plastic milk churners to create awareness before actual demonstration carry out at large. Accordingly, a total of 220 trainees consist of 190 farmers, 22 DAs and 8 Subject Matter Specialists were participated in training.

Table1. Training given to farmers, DAs & SMS on plastic milk churner technology

No	Location		Participants trainees						Total	
			Farmer				Others		Total	
			Adult		Youth		DAs	SMs		
	District	Kebele	M	F	M	F			M	F
1	Gera	Wanja Kersa	5	9	1	2	3	2	11	11
		Kacho Anderecha	4	9	2	2	2	0	8	11
		Ganji Caalla	5	10	1	1	3	2	11	11
2	Nada	Burka Asandabo	3	10	3	1	2	0	6	13
		Lalo Beyam	4	9	2	2	2	1	7	13
		Toli Sabataa	3	9	3	2	3	1	9	12
3	Bddele	Burka-Haro	4	8	2	3	0	0	6	11
		Bedele-1	4	6	0	2	0	1	5	8
		Bedele-2	3	7	0	3	1	1	5	10
4	Gachi	Gito	4	9	2	2	2	0	7	12
		Bido	5	9	1	2	3	0	9	11
		Gechi	3	5	1	3	1	0	5	8
	Total		47	100	18	25	22	8	89	131

Farmers, DAs and SMS participated in training of technical use and maintenance of the churner. They participated throughout the whole demonstration period.

On-farm Evaluation of improved plastic churner

Churning involves removal of cream or fat part the milk butter to have the fresh butter separately. The churner can be prepared in different sizes as per the farmers demand based on the number of the dairy cows they have. This churner is specially designed to farmers that cam churn five to six liters of milk daily or at a time in average.

Table2. Average performance of the improved plastic churner compared to the local under the farmer's management

No	Rep	Milk in lit	Types of milked cow	Butter obtained (kg)		Time/min	
				Local	Improved	Local	Improved
1.	Bda	3	local	182	200	40	38
	Bdb	3	local	60	160	20	14
	Bdc	3	local	178	140	18	15
	Av.	3	local	0.14	0.167	26	22.33
2.	Gca	3	local	169	189	20	33
	Gcb	3	local	119	138	15	11
	Gcc	3	local	100	862	15	14
	Av.		local	0.129	0.396	16.67	19.33
3.	Gra.	3	local	210	175	27	28
	Grb	3	local	225	200	27	29
	Grc	3	local	220	200	26.5	24.5
	Av.		local	0.218	0.191	26.83	27.16
4.	Nda	3	local	260	263	27	27
	Ndb	3	local	267	279	27	25
	Ndc	3	local	267	273	26	24
	Av.	3	Local	0.26	0.271	26.67	25.33
	Average Total	3	Local	0.154	0.256	24.04	23.54

The letters a, b and c indicate the churner evaluated at four different sites were as the letters Bd, , Gc, Gr and Nd represent the Bedele, Gechi, Gera and Nada Districts where the study was made respectively.

On far evaluation and demonstration of the improved plastic churnertechnology was made in teamwork with participant farmers, SMs and DAs. The improved plastic churner is evaluated against the locally used churner and churning practice that mainly implement by women and children moving the device on their upper leg body part. The evaluation of the technology was made in terms of capacity, time and labor saving advantage compared to the local churning device.

Accordingly it has shown the average time taken (man-mint) 24.04 and 23.54 for local and improved churner, with capacity of (kg/man-mint) 0.154, and 0.256, of the churner were significantly different among tow churners that the improved churner can perform the activity in a better way than the traditional methods with relatively less time shows compared to the local method.

Demonstration of the improved plastic churner Technology

In this study, the farmers' feedback after the demonstration of improved plastic churner technology collected based on evaluation criteria jointly set by researchers and farmers. These include values for optimum better obtained (kg) within the time taken per min, in relation to the type of the churner used and farmers' perception in respective of these criteria.

Farmer to farmer learning is used to promote the technology simply by arranging churning program at the host farmer's farm site. Evaluation of the technology was made together with the participant farmers, on the attributes recognized as important mainly, time and labor saving with ease of operation and maintenance as per their perception.

Mini-field days conducted

In this study, mini-field day was made at different sites namely Bedele-1, Burka Asendabo, Kecho Anderecha and Gito which attended by different stalking holders.

Table 3 Participants of field days on improved plastic milk churner

No	Location		Participants of field days								Total	
			Farmer				DAs & SMs		Other		Total	
			Adult		Youth				Stalk-holders			
	District	Kebele	M	F	M	F	M	F	M	F	M	F
1	Gera	K/Anderecha	14	28	4	5	7	0	3	2	28	35
2	Nada	B/Asendabo	10	28	8	5	5	5	5	4	28	42
3	Bddele	Bedele-1	11	21	2	8	3	0	5	3	21	32
4	Gachi	Gito	12	23	4	7	5	3	3	2	24	35
	Total		47	100	18	25	20	8	16	11	101	144

In view of that, 190 farmers (125 Female, 65 Male), 28 agricultural workers (SMS and DAs), 27 others (Kebele Administrators and Researchers) have attended the mini field days.

Farmers' perception on the technology attributes

Farmers' perception

Data on technical operation and social perception aspects were collected and analyzed. The primary data on improved plastic churner collected during and after demonstration on perception or farmers' opinion.

Table4. Farmers' perception on improved plastic milk churner (no= 60)

No	Districts	Response level	No. of respondents	Percentage (%)
1	Ease of operation	Simple	48	80
		Not Simple	12	20
2	Repair and maintain	Easy	41	68.33
		Difficult	19	31.67
3	Affordability (to the average farmers)	High	11	18.33
		Medium	40	66.67
		Low	9	15

The participant respondents replied that the improved plastic milk churner is easy, time and labor saving in relation to using the local tedious method as it can be operated with minimum force requirement and can be affordable by the average farmers. Furthermore the respondent farmers also indicated possibility to repair and maintain by local technicians or by themselves even if the churner component damages. Accordingly, 80 % of the respondents replied that it was easy to use for churning five to six litter of milk at a time. Similarly, repair and maintenance of the churner was found easy subjected by 68.33 % of the respondents.

Furthermore, respondents of virtually 66.67% had perceived that the churner was ranked to have a medium affordability to the average farmers where as 18.33 % leveled it to high while only 15 % of the respondents perceived the device has low fate of affordability.

As to the overall farmers' observation during the field work, it showed that most of the farmers have positively perceived the improved plastic milk churner for its easy to operation, repair and maintain when damaged, time and labor saving and affordability buy from the manufacturers.

CONCLUSION AND RECOMMENDATION

The demonstration result showed that in average it took (man-mint) 24.04 and 23.54 to churn three liter of milk for local and improved churner having kg of 0.154 and 0.256, of butter production or output respectively. Most of the participant farmers had responded that using the improved churner is easy, time and labor saving in relation to using the local tedious method as it can be operated with minimum force requirement and can be affordable by the average farmers. Furthermore the respondent farmers also indicated possibility to repair and maintain by local technicians or by themselves even if the churner component damages. All stakeholders and concerning bodies should strongly work in technology introducing to the farmers by creating linkage among dairy producer farmers and the manufacturers to enable them use the improved milk churner for farmer household dairy activities. Micro enterprise and agricultural development offices in the respective districts and Kebeles should maintain sustainable partnership in order to strength the linkage among dairy producers and technology manufacturers.

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Pre-Extension Demonstration of Portable Poultry House and Hay-Box Brooder for Rural Women in Jimmaa Zone

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ABSTRACT

The study was conducted in Jimma Zone of Oromia Regional State, Ethiopia in 2018 and 2019. The objective of the study was to demonstrate the portable poultry house and hay-box brooder for rural women in western Oromia. Two sites were selected from two districts (Omo Nada and Dedo) and 2 FREGs comprising 25 women farmers were established. Training was given to 25 female farmer participants, 5 DAs and 4 Subject Matter Specialists. Total of 95 farmer (83 Farmers, 4 Das, 3 SMS and 5 from Kebele administrative) households attended field demonstration at different sites. Among the participant farmers, 67 % had responded that the movable poultry house and the hay box brooder were highly preferred to their local system mainly using living house that is easily susceptible to wild predators. While 33 % of the respondents leveled in medium that the technology need technical knowledge to use and make maintenances when it damages. In terms of poultry health condition, 92 % of the farmers responded that the Chicken/hen's death or disease incidence is very low as the necessary vaccination was given at the early age of the chicken and thus 87.5 % of the participants were motivated to start poultry production individually. Furthermore, 41.7 % of the respondent farmers having medium level interest indicated that it was challenging to entertain group interest in managing the poultry regularly in providing feed and protection while only 20.8 % of the group members claimed continuity of working in groups stating that they need to share the chickens and have independent poultry.

Key words: *Chicken brooder, Demonstration, Hay-box*

INTRODUCTION

Women have an important role in agriculture. Their contributions to agriculture vary from society to society (Benor and Bexter, no date). In general, women contribute to the total household income. This fact implies that rural women have to be served by research results and extension services. Why focus on women? This question is used to be answered and can be looked in to from two perspectives. The first argument is about equity since women are part of a given society they should have equal access to resources. Women's work is not visible to men so that they can get equal rewards to their contributions to agricultural production. But in reality women do not have equal access to resources. The other argument can be expressed in terms of efficiency. If we look at the farming system, women are the main food producers while men are cash crop producers. Women also form the major part of the labor supply for agriculture. Thus, any development efforts geared to the productivity as well as their living standard should serve rural women (Diga Korara Beyene, 2001).

Despite women's central role in Africa's food production, there has been persistent under investment in increasing their productivity. Women's contributions to agriculture remain under acknowledged under supported. In most parts of Africa, the obsolete technology rural women still use makes their farm work labor extensive and time consuming. This limits their productive capacity and ability to cultivate large tracts of land. Male farmers have greater contact with extension services than do female farmers. Unfortunately, extension advice to one member of the family is usually not passed on to other people. Because of difference in access to technology between male and female, women's agricultural output will continue indicating low outcome. With low output, little income can be realized from whatever is marketed will have virtually nothing to plow back in to their economic activities (Women, agriculture intensification, and Household food security, 2000).

The insufficiency of female oriented technology generation and extension program is serious concern of gender discrimination in Ethiopian agricultural development. A major chunk of women's labor force in production system was invested in weeding, irrigation, harvesting, household chore, animal care, marketing, post-harvest handling etc. The traditional methods consume much of energy and time of rural women, for which due attention is not paid in technology generation process. Generally, sufficient extension packages are also not seen taken up for the disseminations of women friendly, labor and time saving and drudgers reducing technologies (FAO, 1992).

The rural women in Ethiopia work for 13-17 hours per day, which is almost two-fold of men (The transitional government of Ethiopia, 1993). Almaz (2000) indicates that, globally, women perform 67% of the world's working hours, and on the contrary, women own less than 30% of the agricultural labor is performed by women and male-headed households constitutes more than 22% of the family. Rural women confront obstacles that limit their ability to participate in community development programs. They frequently lack the self-confidence or a forum in which to speak up publicly for themselves and for their families. They often lack access to education, credit and land tenure, which limits them, more than it does, limits the men of their own families (FAO. 1989). Rural women are constrained by unequal access to productive resources and services and inadequate or in accessible infrastructure. The limitations rural women face in turn impose huge social, economic and environmental costs on society as a whole and rural development in particular including lags in agricultural productivity (Herald 13 January 2013).

As a remedy, empowerment of the poor (women) is a global agenda this day. Empowerment is the expansion of assets and capabilities of poor people to participate in, negotiate, with influence, control, and hold accountable institutions that affect their lives (World Bank, 2002).poor women and men need a range of assets and capabilities to increase their wellbeing and security, as well as their confidence, so they can negotiate with those more powerful. Assets and capabilities can be individual or collective. For poor people, the capacity to organize and mobilize to solve problems is critical collective capabilities that help them overcome problems of limited resources and marginalization in society.

Poultry is the one women dominated in Ethiopia. The gender base line survey undertaken by IPMS revealed that women perform most of the production activities such as hatching, hygiene, and feeding, watering, protection and egg collection. Poultry production and marketing is suitable for women, since they have traditional knowledge and enterprise does not require much land. One of the main problem o0f poultry productions in Ethiopia is low productivity and high mortality rate as high as 80-90% due to disease and predation (Tegegne et al, 2010).

Production of poultry rearing, baby chickens by using the natural brooding and lack of appropriate house have been indicated as major constraints by different researchers. For instance, according to Hoyle 1992 as cited in Selemon 2007, the mean survival rate to age 3 months of baby chicks reared under the natural brooding condition in Ethiopia is only about 40% and most of chickens affected by disease and predators because of lack of appropriate house. According to Herald (30 August 2012) Promotion of women and youth empowerment with equity is a key multidirectional component in the Growth and Transformation Plan (GTP) for achieving sustainable economic growth. The objective of development plan can be achieved only when the multidimensional problems faced women and youth are concurrently addressed and resolved. Hence, the government will scale up its efforts to implement women and youth policy, which is necessary to release the untapped potential of this population segment, in a holistic and integrated manner.

Cognizant of the above facts one of the most successful ways of working with rural women is through group. The natural tendency may be to form mixed groups, with both male and female members. In this situation they do not always provide the best learning environments. Women's group is culturally and socially acceptable in most places, and can overcome even the most rigid taboos. In addition to this, it can facilitate pooling of resources. Women feel free to speak in groups of women than they do when men are present. However the existing activities are not gender balanced hence women are poorly represented in the groups. Therefore, it is important to form women's group.

MATERIALS AND METHODS

Materials used in this study were two prototypes of portable poultry houses and six hay-box brooders that manufactured in Jimma Agricultural Engineering Research Center so as to use for demonstration purposes. Moreover, a total of forty-eight chickens of two months aged and 200kg feed were bought and distributed at two selected sites of farmer groups.The demonstration was conducted in the two selected Kebeles namely Sito and Toli Beyam of Dedo and Nada districts of Jimma Zone respectively. Participatory FRGs that consists of eleven and thirteen members was formed in two groups together with the DAs from respective Keble, SMS from agency of animal sciences of the respective districts, women's affairs office, and administration bodies in selection of interested women farmer participants for the technology demonstration and training. Finally, the feedback data about the farmers' perception on the technology was collected and analyzed.

Data management and Statistical analysis

The collected data was arranged in a raw data and the quantitative and qualitative data was analyzed using descriptive statistics. A team of Researchers, TAs assigned by JAERC and stakeholders from the respective districts were managed the project. The team comprised of agricultural and rural development experts (SMS & DAs), Agricultural Extension and technical Research Teams of the Centre.

RESULT AND DISCUSSION

Training Farmers, SMS and DAs on the improved portable poultry house and hay-box brooder technology

The technical training on portable poultry house and hay-box brooder technology was given to farmer groups at the hosting farmers' site. Subject Matter Specialists (SMS) and Development Agents (DAs) that exist at the selected Kebele level also trained on the operation, repair and maintenance of the portable poultry house and hay-box brooder technology and the chicken management to create awareness before actual demonstration carry out at large.

Table 1. Training given to farmers, DAs & SMS

No	**Location**		**Training Participants**				
			Farmers		Others		Total
	District	Kebele	Adult	Youth	DAs	SMS	
1	Nada	Toil-beyam 13	8	4	2	2	16
2	Dedo	Sito 11	7	5	3	2	17
		Total	15	9	5	4	33

Accordingly a total of 24 farmers, 5DAs and 4 Subject Matter Specialists were participated in training.

Demonstration of improved portable poultry house and hay-box brooder technology

The demonstration of portable poultry house and hay-box brooder technology was made in teamwork with participant farmers, SMs, DAs and the farmers' feedback was collected based on criteria jointly set by researchers and farmers. The poultry house is suitable to easily move and allocate at the desired position when necessary. The hay-box brooder technology provides the required heat for the premature chicken facilitating condition for development and better handling. This hay-box brooder is specially designed serve 10 to 15 chickens of 1 to 3 months while the poultry house is used for the adult hens.

In this study, mini field days also conducted on portable poultry house and hay-box brooder technology in participation of farmers, DAs, SMS and Others stalk-holder.

Table 3 Participants of field days on portable poultry house and hay-box brooder

No	Location		Farmers		workers		Others	Total
	District	Kebele	Adult	2	DAs	SMS		
1	Nada	Toil-beyam	21	1	2	2	3	46
2	Dedo	Sito	24	4	2	1	2	49
	Total		45	38	4	3	5	95

The demonstration was made at hosting farmers sites namely Sito and Toli-beyam that attended by different stakeholders. In view of that, 83 farmers (45 adult, 38 youth), 7 SMS and DAs, and others 5 Kebele Administrative members have attended the demonstration works.

Farmers' perception on the technology attributes

Table 3: Farmers' perception and satisfaction level

Attributes & their acceptance degree by farmers		**Farmers' response (No=24)**			
		Low	Medium	High	Total
Poultry house advantage	Frequency	-	8	16	24
	%	-	33	67	100
Chicken/hen death or disease	Frequency	22	2	-	24
	%	92	8		100
Need to Poultry production	Frequency	-	3	21	24
	%	-	12.5	87.5	100
Need to group continuity	Frequency	9	10	5	24
	%	37.5	41.7	20.8	100
Average	Frequency	7.75	5.75	10.5	24 100
	%	32.29	23.96	43..75	

CONCLUSION AND RECOMMENDATION

The improved movable poultry house was demonstrated for mainly female farmer group so as to create awareness in poultry production and management in order to enhance female farmers' income for betterment of their livelihood. The 67% participant farmers had responded that technology was highly preferred in relation to local system mainly using living house which easily susceptible to wild predators. While 33 % of leveled in medium indicating technology need technical knowledge to use and maintain when it damages. Regarding poultry health condition, 92% of the farmers responded Chicken/hen's death incidence is very low as the necessary vaccination was given at their early age motivating 87.5% of the participants to start poultry individually. Still, some farmers showed medium level interest indicating group interest was challenging in managing the poultry regularly in feeding and protection while only 20.8 % of members claimed continuity of working in groups stating that they need share the hens and have individual poultry. All stakeholders and concerning bodies should strongly work in introducing the technology to the farmers by creating linkage among poultry producers and technology manufacturers in order to enable them use the improved technology for poultry production activities. Micro enterprise and agricultural development offices in the respective districts and Kebeles should maintain sustainable partnership in order to strength the linkage among producers and technology manufacturers.

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www.slideshare.net/women and poultry value chain development

Pre-extension Demonstration of Poultry Feed Mixer in Selected Districts of Arsi and West Arsi Zones Oromia Ethiopia

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ABSTRACT

This demonstration activity was conducted with the objectives of evaluating the profitability of the poultry feed mixer technology under farmers' management, enhance farmers' knowledge and use of the technology and awareness on the use technology at Dodola, Gedeb Hasasa and Tiyo districts of west Arsi and Arsi zone. The demonstration site and representative farmers were selected based on location and suitability to involve more farmers to visit the demonstration activity. Field day was organized to enhance farmer to farmer learning, information exchange and experience sharing among Farmers and other stakeholders on technology. Training of youth, DAs and Experts to enhance their knowledge, skill and attitude towards the poultry feed mixer technology were the main methods used. A total of 81 participants of which 54 (67%) male and 27 (33%) female were participated on both theoretical and practical training from three districts. The training was mainly focused on how to operate the technology and its relative advantage. Likert scale was used to measure respondent's opinion/views towards of the new technology. Among the interviewed farmer, 50% had responded that poultry feed mixer is simple to operate, 33.3% of farmers responded that it was medium. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 41.7% of farmers responded that maintenance of technology was medium to maintain while 25% answered as it was simple to maintain the technology. Affordability of technology to larger portion of farmers also considered to measure farmers' view towards technology. On price to afford technology; about 46.7% of respondent farmer responded that the cost of poultry feed mixer technology was medium that it can be affordable by the average farmers and 23.3 % of farmers responded that the price of technology was low to purchase whereas 30% of respondent farmers responded that the price of technology was high to afford. As far as communication of the result concerned; min-field days, regular monitoring and evaluation, regular visit of farmer's research extension group and other extension partners were undertaken to enhance farmer to farmer information exchange. The result of the demonstration activity was evaluated jointly with FRGs members and other stakeholders. To facilitate linkage between different stakeholders like poultry producers, input suppliers and poultry feed producers which were Farmers Research Groups (FRG) one from each district were contacted each other to solve their market related problem. Finally, different mainstreaming Medias like Oromia Broadcasting Network (OBN) and Ethiopian Broadcasting service (EBC) invited and broadcasted to facilitate farther dissemination of technology. Therefore, this technology recommended for scaling up to reach poultry producer farmers.

Key words: Poultry feed mixer, Demonstration, Likert scale

INTRODUCTION

Technically, poultry is a collective term for those species of birds that have been domesticated to reproduce and grow in captivity and that render products of economic value. They include varied species such as chicken, turkey, ducks, geese, pheasants, pigeons, quail, etc. Poultry is an important farm species in almost all countries. It is an important source of animal protein, and can be raised in situations with limited feed and housing resources. Chickens are 'waste converters', they 'convert' a scavenged feed resource base into animal protein. They are, therefore, by far the most important species for generating income for rural as well as urban families. Poultry meat and eggs have become the most important sources of protein in the human diet by using it directly or after passing through food processing industries. "Doro Wet" which is prepared from poultry meat and eggs is one of the favorite dishes of the Ethiopian population

Poultry production, though small in scale at the farm level, it plausibly is quite important for the rural economy. Rural poultry production contributed to 98.50 and 99.20% of the national egg and poultry meat production, respectively (Alemu and Tadelle, 1997), with an annual output of 72,300 metric tons of poultry meat and 78,000 metric tons of eggs (Hailemariam*et al.*, 2006). Essentially, feed mixing can be done either manually or mechanically. The use of manual labour to mix crushed poultry feed by the traditional agricultural sector that is characterized by subsistence farming was perhaps the first form of poultry feed mixer. The manual method of mixing feed entails the use of shovel to intersperse the feed's constituents into one another on open concrete floors. This method was subsequently developed by the use of manually operated machine after the advent of industrial revolution. The manual method of mixing feed ingredients is generally characterized by low output, less efficient, labour intensive and may prove unsafe, hence, hazardous to the health of the intended animals, birds or fishes for which the feed is prepared. If feed is not completely mixed, portions of the feed will contain either too much or too little of the formulated ingredients. This excess variability causes economic losses to users of the feed (Barashkov *et al*., 2007).

Augusto *et al*. (1973), Fagbenro (1988), Kwari and Igwebuike (2001), Diarra *et al*. (2001) and many other researchers have indicated the feasibility of the utilization of various forms of farm and agro-industrial wastes and by-products in the formulation of complete feeds for poultry. Although the major essential raw materials required for the formulation of complete feeds from the results of such researches are within easy reach of poultry producers and at low cost, the major limiting factor to taking the full advantages offered by the results of such researches has been the lack of appropriate equipment to process the identified raw materials into the required feeds. This activity was under research in the last two years and a promising result that has to be demonstrated to farmers and other stakeholders was obtained. Therefore, this activity was initiated to demonstrate of poultry feed mixer technology in the selected districts of Arsi and west Arsi zones.

MATERIALS AND METHOD

Site and farmer selection

To conduct the demonstration of poultry feed mixer four districts from Arsi (Tiyo and Digelu-Tijo from Arsi and Adaba and Gedeb Asasa from west Arsi). From each district one representative peasant association was purposively selected. Then a total of four farmer research groups (FRG) one per each district was established. Each FRG has (15) members of which forty precent of them are female headed farmer and sixty percent of them are male headed farmers. The demonstration of poultry feed mixer was held in the selected districts in the presence of different stakeholders like farmers, DA, district expert, zone expert, researchers and small scale enterprises to facilitate further dissemination of the technology.

Demonstration method/techniques

Evaluation of poultry feed was held demonstration method or techniques was followed. In the demonstration process the mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day.

Data type and method of data collection

This study employed both qualitative and quantitative data from primary and secondary data sources. Primary data such as uniformity of mixed poultry feed, time consumed to mix poultry feed, labor reduced, affordability of poultry feed option to rural as well as urban small scale poultry producer, total number of farmers participated in training, field visits and field days by gender, numbers of farmers become aware of the relative advantage of the technology by gender, Role of farmers and other stakeholders in technology demonstration, change in level of knowledge and skill of farmers and farmers' opinion was collected using different appropriate data collection method/technique such as field observation, household/participant interview, focus group discussion. Secondary data was collected through review of different published and unpublished documents.

Method of data analysis

The study employed simple statistical analytical tools like percentage for data analysis.

RESULT AND DISCUSSION

A total of 81 participants of which 54 (67%) was male and 27 (33%) female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology as indicated in the (Table 1) below.

Farmer perception

Among the farmer interviewed (50%) had responded that it was simple to operate the poultry feed mixer, (33.3%) of farmers responded that it was medium and (16.7%) of respondent farmers were responded that it was very easy to operate poultry feed mixer technology (Table 2). Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; 41.7% of farmers responded that maintenance of technology was medium, 25% and 10% answered as it was simple to maintain technology. Whereas only 15% and 8.3% of the respondent responded that it was difficult and very difficult to maintain it. Regarding affordability of the technology; about 46.7% of respondent farmer responded that the cost of technology was medium that it can be affordable by the average farmers and 23.3% of farmers responded that the price of technology was low to purchase. About thirty percent (30%) of respondent said that the price of technology was high to afford as depicted in the (table 2) below.

Table 1. Training for farmers and to stakeholders on poultry feed mixer

Disticts	Description of participants	Male	Female	Total
Dodola	Farmers	9	6	15
	Agricultural Experts	2	1	3
	Development agents	2	1	3
	Supervisor	1	-	1
Gedeb Asasa	Farmers	9	6	15
	Agricultural Experts	2	-	2
	Development agents	2	-	2
	Supervisor	-	-	-
Digelu-Tijo	Farmers	9	6	15
	Agricultural Experts	2	-	2
	Development agents	2	-	2
	Supervisor	-	-	-
Tiyo	Farmers	9	6	15
	Agricultural Experts	3	-	3
	Development agents	2	1	3
	Supervisor	-	-	-
Grand total		54	27	81

Table 2 .Farmer's response towards the technology

N^{o}	Criteria	Attributes	N^{o} of respondent	Percentage (%)
1	Ease of operation	Very simple	10	16.7
		Simple	30	50
		Medium	20	33.3
		Difficult	0	0
		Very difficult	0	0
2	Maintenance	Very simple	6	10
		Simple	15	25
		Medium	25	41.7
		Difficult	9	15
		Very difficult	5	8.3
3	Price to afford technology	Very low	0	0
		Low	14	23.3
		Medium	28	46.7
		High	18	30
		Very High	0	0
4	Portability of technology	Very simple	12	20
		Simple	18	30
		Medium	20	33.3
		Difficult	10	16.7
		Very difficult	0	0

Framers` feedback and reaction

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

CONCLUSION AND RECOMMENDATION

From the demonstration it was found that about 50%, 33.3% and 16,7% of respondents were responded that the operation of the poultry feed mixer technology is simple, medium & very simple respectively As far as the maintenance of the technology is concerned 41.7%, 25%, 10%, 10% of respondent farmers were said that the maintenance of the technology medium, simple very simple & 15% difficult and 8.3% reported that the technology is difficult and very difficult respectively to maintain. Because of above stated quality poultry feed mixer has many advantages. As a result, all participant farmers and stakeholders liked and accepted poultry feed mixer technology. Therefore, poultry feed mixer technology is recommended for further scaling up and wider utilization.

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Pre-extension Demonstration of Top Hammer Miller for Poultry Feed Crushing in Selected Districts of Arsi and west Arsi Zones

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ABSTRACT

This study was conducted with the objectives evaluating the profitability of the Top Hammer Miller for Poultry Feed Crusher under farmers' management, enhancing farmers' knowledge and use of the technology and creating awareness on the importance of Top Hammer Miller for Poultry Feed Crusher technology in Dodola, Gedeb Hasasa and Tiyo districts of west Arsi and Arsi zone. The experimental site and representative farmers were selected based on location, suitability for more farmers to visit the demonstration. Min field day was organized to enhance farmer to farmer learning, information exchange and experience sharing among Farmer and other stakeholders on the evaluation and demonstration of the technology. Training on knowledge, skill and attitude were the main methods that was used to create awareness among youth to enable youths', DAs' and experts' knowledge and skill on technology. On organized training a total of 81 participants of which 41 (66%) was male and 21 (34%) was female from three districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology. Likert scale method was used to measure respondent's opinion/views towards new technology. Among the farmer interviewed (33.3%) had responded that it was simple to operate the Top hammer miller for poultry feed crushing, (22.2%) of farmers responded that it was medium and (44.4%) of respondent farmers were responded that it was very easy to operate the technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. On price to afford technology; about (44.4%) of respondent farmer responded that the cost of technology was low that it can be affordable by the average farmers, about (33.3%) of farmers responded that the price of the technology was medium to afford the technology. Whereas, about (23.3 %) of farmers responded that the price of technology was high to purchase. As far as Communication of the result concerned; min-field days, regular monitoring and evaluation, regular visit of farmer's research extension group and other extension partners were undertaken to enhance farmer to farmer information exchange. The result of the demonstration activity was evaluated jointly with FRGs members and other stakeholders. Therefore, this technology recommended for scaling up to reach poultry producer farmers.

Key words: *Demonstration, Likert scale, Top hammer miller*

INTRODUCTION

Ethiopia is a home for many livestock species and suitable for livestock production. It is believed to have the largest livestock population in Africa. An estimate indicates that the country is a home for about 56.7 million cattle, 29.33 million sheep, 29.11 goats, 56.87 million poultry, 2.03 million horses, 7.43 million donkeys, 0.4 million mules and 1.16 million camels (CSA,2014/15). In Ethiopia poultry production is an important part of the mixed crop-livestock farming system practiced by most households where it makes a vital function through the provision of meat and eggs for home consumption and for the generation of cash income through market exchange (Birhanu etal, 2015). The sector in the country can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-security. These are village or backyard, small scale commercial and large scale commercial poultry production system (Tadele etal, 2003). In Ethiopia there is huge demand of poultry meat and eggs which has led to an emerging establishment and expansion of modern and organized poultry farms in the entire country particularly in peri-urban and urban areas (Dana etal, 2010). These emerging farms have vital contribution to improve the livelihood, food security and poverty reduction as well as providing a handsome return in peri-urban and urban areas in the tropics (Picca and Otte, 2010). Factors affecting chicken under intensive production systems are numerous. However, feed, marketing constraints, diseases and biosecurity are the most important one (Matawork, 2016). Feed is a critical input for chicken production and account 60-70% of production costs under intensive production systems (Yenesew etal, 2015).

Poultry feed is one of the most critical constraints to poultry production under both the rural small holder and large-scale systems in Ethiopia. The problem is mainly associated with lack of processing facilities, inconsistent availability and distribution and sub-standard quality of processed feeds when available (Habtu, 2016). In addition, smallholder farmers from different corners of the country have limited access to the formulated rations and when available, purchase it with its high cost and transportation expenditure. This makes the sector poor in production (Sololomon, 2008). Asella Agricultural Engineering Research Center was constructed and distributed poultry related technology such as hay box brooder, runner, and poultry feed mixer and poultry house to the farmers and trains the small micro enterprise on the construction of these technologies. On the other hand Asella Agricultural Engineering Research Center adapted top hammer miller for poultry feed crusher. Therefore; this research activity initiated with the objective of demonstrating Top hammer miller for poultry feed crusher.

MATERIALS AND METHODS

Materials

Stop watch, Tachometer, Digital camera, Digital weighing balance, and poultry feed materials and Calculator.

Methods

To conduct the demonstration of Top hammer miller technology for poultry feed crushing; three districts from Arsi and west Arsi zones namely Tiyo Arsi zone and Gedeb Asasa and Dodola from west Arsi zone was purposively selected based on their poultry potential and existing demand. The study also was conducted in two PAs from each district and in each PAs one FREG was established that in composes different category of farmers like male, female and youth. The technology was tested and compared with existing traditional way of crushing poultry feed at selected PA station. In the demonstration process the mechanisms used to enhance farmer to farmer learning and information exchange was field visit/tour and field day. The experiment was done on one treatment with its local practices and it was replicated on eight experimental sites two from each districts.

Method of data collection

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

Method of data analysis

This study was used simple statistical analytical tools like percentage for data analysis.

RESULT AND DISCUSSION

On organized training a total of 62 participants of which 41 (66%) was male and 21 (34%) female from four districts participated on both theoretical and practical training. The training was mainly focused on how to operate technology and relative advantage of technology.

Table 1. Training to stakeholders on Top hammer miller for poultry feed

Disticts	Description of participants	Male	Female	Total
Dodola	Farmers	9	6	15
	Agricultural Experts	2	1	3
	Development agents	2	1	3
	Supervisor	1	-	1
Gedeb Asasa	Farmers	9	6	15
	Agricultural Experts	2	-	2
	Development agents	2	-	2
	Supervisor	-	-	-
Tiyo	Farmers	9	6	15
	Agricultural Experts	3	-	3
	Development agents	2	1	3
	Supervisor	-	-	-
Grand total		41	21	62

Farmer perception

Likert scale method was used to measure respondent's opinion/views towards new technology. Among the farmer interviewed (33.3%) had responded that it was simple to operate the Top hammer miller for poultry feed crushing, (22.2%) of farmers responded that it was medium and (44.4%) of respondent farmers were responded that it was very easy to operate the technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; (27%) of farmers responded that maintenance of technology was very simple, (33%) and (20%) answered as it was simple and medium to maintain technology. Whereas only twenty percent (20%) was difficult to maintain it. On price to afford technology; about (44.4%) of respondent farmer responded that the cost of technology was low that it can be affordable by the average farmers, about (33.3%) of farmers responded that the price of the was medium to afford the technology. Whereas, about (23.3 %) of farmers responded that the price of technology was high to purchase.

Table 2 .Farmer's response towards the technology

N$^{\underline{o}}$	Criteria	Attributes	N$^{\underline{o}}$ of respondent	Percentage (%)
1	Ease of operation	Very simple	15	33.33
		Simple	10	22.22
		Medium	20	44.44
		Difficult	0	0
		Very difficult	0	0
2	Maintenance	Very simple	12	27
		Simple	15	33
		Medium	9	20
		Difficult	9	20
		Very difficult	-	-
3	Price to afford technology	Very low	0	0
		Low	20	44.4
		Medium	15	33.3
		High	10	22.2
		Very High	0	0

Framers` feedback and reaction

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

CONCLUSION AND RECOMMENDATION

From the result of this finding among the farmer interviewed (33.3%) had responded that it was simple to operate the Top hammer miller for poultry feed crushing, (22.2%) of farmers responded that it was medium and (44.4%) of respondent farmers were responded that it was very easy to operate the technology. Maintenance of the technology was also considered as one criterion to see the simplicity of technology. Regarding to the simplicity of maintenance of technology; (27%) of farmers responded that maintenance of technology was very simple, (33%) and (20%) answered as it was simple and medium to maintain technology. Whereas only twenty percent (20%) was difficult to maintain it. On price to afford technology; about

(44.4%) of respondent farmer responded that the cost of technology was low that it can be affordable by the average farmers, about (33.3%) of farmers responded that the price of the was medium to afford the technology. Whereas, about (23.3 %) of farmers responded that the price of technology was high to purchase. In the course of field day different stakeholders and researcher participated and reacted on what they observed during operation. Criteria's were availability of feed and cost of feed in relation to their feed shortage and feedback were collected and analyzed. Because of above stated quality poultry feed mixer has many advantages. As a result, all participant farmers and stakeholders liked and accepted poultry feed mixer technology. Therefore, Top hammer miller for poultry feed recommended for further scaling up for wider utilization.

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Pre-extension Demonstration of Modified Animal Drawn Potato Lifter in Selected Districts of Arsi Zone

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ABSTRACT

The study was conducted in Digelu-Tijo and Lemu-Bilbilo districts of Arsi zone with the objectives of demonstrating and evaluating the profitability of the modified animal drawn potato lifter under farmers' management, enhancing farmers' knowledge and use of the technology and creating awareness on the importance of modified animal drawn potato lifter technology. The experimental site and representative farmers were selected based on location, suitability for more farmers to visit the demonstration. Mini field day was organized to enhance farmer to farmer learning, information exchange and experience sharing among farmer and other stakeholders on the evaluation and demonstration of the technology. All necessary data were recorded by researchers and development agent and analyzed using simple statistical tools. The result of the study revealed that the modified animal drawn potato lifter technology minimize the frequency of plowing/digging potato from four to two times as compared to local plowing implement. The result also revealed that potato digger gave the highest average exposing efficiency (95%) and tuber damage (1%). Whereas traditional potato lifter had exposing efficiency of 60.5 and tuber damage 0.8%. So the modified animal drawn potato lifter was more exposing efficiency which is ninety (90%) than the traditional one. Likert scale was used to measure respondent's opinion/views towards the new technology. Among the farmer interviewed 43.3%, 33.3% and 23.3% had responded that it was very simple, simple and medium to operate the potato digger to dig potato from the ground respectively. About 42%, 50% and 8% of respondent farmer responded that the cost of modified animal drawn potato digger technology was very low, low and medium respectively. In addition, about 75% and 25% of the respondent farmers also responded it was very simple and simple to repair and maintain the technology in nearby blacksmith. Therefore, this technology recommended for scaling up to reach wider potato producer farmers.

Key words: Demonstration, Potato Lifter, Pre-extension

INTRODUCTION

The introduction of the potato to Ethiopia was in 1858 by a German immigrant, Wilhelm Schimper. However, adoption by Ethiopian farmers occurred very gradually over several decades (Kidane-Mariam 1980). Among African countries, Ethiopia has possibly the greatest potential for potato production: 70 percent of its arable land – mainly in highland areas above 1500 meter .above sea level is believed suitable for potato production (FAO, 2008). An upward trend in potato production might be partly due to the continuing increase in population and subsequent decline in the average size of farm holdings, hence pressure for agriculture to become more labor intensive (Medhin *et. al.* 2001). These data should be treated with caution, since the potato, in spite of its growing importance to Ethiopia's food security, it is still widely regarded as a secondary non-cereal crop for which production data are not well documented.

Despite its economic and nutritional value, potato is totally harvested traditionally with hand and traditional plough, which is very primitive and tiresome as it is clearly seen and reported by the farmers in potato producing areas. According to the information gathered from farmers, harvesting a hectare of potato needs about 30 people whose daily labour cost is 30-50 birr/day. The harvesting system is tiresome, resulting in different injuries.

Furthermore, a practical research conducted on hand dug potato harvesting method around Shashemene district confirmed harvesting potato using traditional method and by the local digging tool known as Qotoo/Geso resulted in great left over and damages that brings about 15-20 % yield loss reducing its marketable yield to about to 80-85% (Kulumsa Research Center field report unpublished). Therefore to minimize the harvesting loss, demonstrating appropriate equipment (technology) is essential.

RESEARCH METHODOLOGY

Description of the Study Area

The research was conducted in two district of Arsi zone namely Lemu-Bilbilo and Digelu-Tijo districts which were selected purposively based on their potato production potential. Lemu-Bilbilo and Diglu-Tijo are found 56 km, and 25 km to south of Asella, the capital of Arsi zone.

Site and farmer selection

Four kebels (two from each district) were selected for demonstration. Then experimental site and representative farmers were selected based on location, suitability for more farmers to visit the demonstration site with DA and district expert. Finally, four farmers' research groups (FRG) were established and one trial farmer was selected from each FRGs to host the demonstration.

Technology evaluation and demonstration method

Evaluation of the modified animal drawn potato digger was undertaken by comparing it with traditional potato lifting implement. To do this, both result and method demonstrations were followed. Field day was organized to enhance farmer to farmer learning, information exchange and experience sharing. The experimental field was carefully selected with visual observation in such a way that each experimental plot would have the same density of potato.

Data type and method of data collection

Both qualitative and quantitative data was collected from primary data source. Primary data such as frequency plowing/potato lifting reduced, labor reduced, economic return/profitability, total number of farmers participated in training and field days, numbers of farmers who become aware of the relative advantage of the technology, role of farmers and other stakeholders in technology demonstration, skill of farmers and farmers' opinion were collected through field observation, household interview, focus group discussion.

Method of data analysis

Simple descriptive statistics such as percentages, mean values and frequencies were used to analyze the collected data.

RESULTS AND DISCUSSIONS

Training for farmers and extension workers

A total of 80 participants, 4 development agent, 4 experts and 2 supervisors were participated on the training. The training was given on potato harvesting methods and tools, importance and application of improved potato digging technologies.

Table1. Training given to farmers and extension workers

Districts		Male	Female	Total
Digelu-Tijo	Farmers	30	10	40
	Development agent	1	1	2
	Supervisors	1	-	1
	Expert	2	-	2
Lemu-Bilbilo	Farmers	35	5	40
	Development agent	2	-	2
	Supervisors	1	-	1
	Expert	2	-	2
	Grand Total	74	16	90

Frequency of digging and Labor reduced

As shown in table 2 below use of improved modified animal potato digger had reduced labor required and frequency of digging. The average frequency of plowing/digging required to dig one hectare of potato minimized from five (5) to two (2) times. In addition, digging by improved modified animal potato digger minimized labor required from 8 persons to 4 persons.

Table 2. Average labor required (in persons) and frequency of digging

Parameters	**Improved potato digger**	**Traditional method**
Labor required	4	8
Frequency of digging	2	5

Damage and Exposing Efficiency

As shown in table 3 below, the demonstrated modified animal drawn potato digger had the highest average exposing efficiency (93%) and tuber damage (1%). Whereas traditional potato digger technology had average exposing efficiency of 60.5% and tuber damage of 0.8%.

Table 3. Damage and exposing efficiency (in %)

Parameters	**Improved potato digger**	**Traditional method**
Damage of tubers (%)	1	0.8
Exposing Efficiency (%)	95	60.5

Profitability analysis of potato digger

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

Table 4: Economic analysis using partial budget analysis

Column 1	Column 2
Increased income due to change:	Increased costs due to change:
Income increased due to increased:	Cost increased due to purchase of machine: 125 Birr
Subtotal = 0 Birr	Subtotal = 125 Birr
Reduced costs due to change:	Reduced income due to change:
Reduced wage: 12person X 80 Birr= 960 Birr	
Oxen rent: 8 Oxen X 100Birr = 800Birr/hec.	
Subtotal = 1,760 Birr	Subtotal = 0 Birr
Change in income:	
(subtotal from Column 1 minus subtotal Column 2)	
1,760 – 125 = (1635.00)	

Farmers' perception

Likert scale was used to measure respondent's opinion/views towards the new technology. Among the farmer interviewed 43.3%, 33.3% and 23.3% had responded that it was very simple, simple and medium to operate the potato digger to dig potato from the ground respectively. About 42%, 50% and 8% of respondent farmer responded that the cost of modified animal drawn potato digger technology was very low, low and medium respectively. In addition, about 75% and 25% of the respondent farmers also responded it was very simple and simple to repair and maintain the technology in nearby blacksmith.

Table 4. Farmer's response towards the technology

No	Criteria	Attributes	No of respondent	Percentage (%)
1	Ease of operation	Very simple	26	43.3
		Simple	20	33.3
		Medium	14	23.3
		Difficult	-	-
		Very difficult	-	-
2	Maintenance	Very simple	45	75
		Simple	15	25
		Medium	-	-
		Difficult	-	-
		Very difficult	-	-
3	Price to afford technology	Very low	20	33.3
		Low	23	38.3
		Medium	17	28.3
		High	-	-
		Very High	-	-

CONCLUSIONS AND RECOMMENDATIONS

The result of the study revealed that the modified animal potato digger technology minimized frequency of plowing/digging potato by more than a half as compared to local plowing implement. The modified animal drawn potato digger technology was also known to have the highest average exposing efficiency (95%) and lowest tuber damage (1%). Whereas traditional potato digging implement had the average exposing efficiency of 60.5% and 0.8 tuber damage. Farmers in the area had shown interest in using potato digging technology. The Profitability analyses of potato digger was calculated using partial budget analysis which was useful tools in the decision process and manage to decide on alternative uses of resources. The net return obtained from deduction of increased income from increased cost due to introduction of modified animal potato digger technology. Thus, potato producer obtained net benefit of one thousand six hundred thirty five birr from one hectare of land. As a result, all participant farmers and stakeholders liked and accepted modified animal drawn potato digger technology. Therefore, modified animal drawn potato digger technology recommended for further scaling up for wider utilization.

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Pre-Extension Demonstration and Evaluation of Hand Operated Wet Coffee Pulper in Wayu Tuka and Digga districts of East Wollega

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ABSTRACT

In Ethiopia, coffee quality suffers because of less care being taken for the trees and during harvesting and processing. The methods of coffee processing are sun-dried and wet processing. Demonstration of hand operated coffee pulper was conducted in East Wollega Zone of Oromia, Ethiopia with the objectives to demonstrate, create awareness and collect feedback on hand operated coffee pulpier in the study area that contributes to improve the quality of wet coffee processing. Sites were selected purposively based on coffee production potential and used as hosting centers for popularization of technology from Wayu Tuka district **(**Megna Kura, Wara Babo Megna kebeles**)** and Digga district **(**Jirata and Gemechis kebeles**)**. Four FREGs comprising 55 members (50 male and 5 female) were established. Training and Demonstration was organized for 55 farmers, 11 DAs and 7 SMS on usage, management & operation of the pulpier**.** Focus Group Discussion was conducted with FREG members to collect feedback on the demonstrated hand operated coffee pulper**.** The evaluation result showed that the machine has pulping capacity of 150 kg hr^{-1} red cherries with relatively less grain breakage for the pulped wet coffee. Farmers recognized the importance of the pulper and they have willingness to use hand pulpers for pulping coffee seed but the farmers are not willing to use the pulper for market purpose because there is no price difference based on quality in the area. Efforts have to be made to differentiate coffee processed on the basis of quality to enable farmers producing high quality coffee to earn a premium price. During FGD discussion, farmers stated that the adjustment of the pulper needs skilled operator. This can be addressed through training of the farmers on adjustment of the hand pulper according to the size of the red cherries as well as other adjustment skills. Based on the feedback collected from the FREG members and farmers attended demonstration, the hand operated coffee pulper is recommended for pre scaling up.

Key words: Coffee pulpier, demonstration, FREG

INTRODUCTION

Coffee is one of the leading traded commodities on the global market in both volume and value (Zewdu, 2016). Oromia is the leading region in coffee production in Ethiopia with a total production area of 489,799.36 hectares, with an annual production of 3,101,927.33 quintals (CSA, 2018).

Processing is a very important activity in coffee production and plays a crucial role in quality determination (Mburu, 1999). Coffee is either processed by the wet or dry methods, which vary in complexity and expected quality of the coffee (Wrigley, 1988). Both sun-drying as well as wet-processing methods are operated in Ethiopia, which accounts for 70% and 30% of coffee produced in the country, respectively (Jacquet *et al*., 2008).The methods of coffee processing are sun-dried (natural) and wet (washed) processing. Under sun-dried processing, the ripe cherry is dried completely, while for wet processing the cherry is pulped before drying.

In Ethiopia, both dry and wet processing methods are operated, which accounts for 70% and 30% of coffee production respectively (Jacquet et al., 2008). According to Bytof et al. (2007), report the defined ambient conditions of any post-harvest processing can have a high effect on the time course of the metabolic reactions that occur during that processing period. Recently, it has shown that the variation in the drying procedure in the course of dry and wet processing strongly affects the abundance of various sugars, representing essential aroma precursors (Kleinwächter and Selmar, 2010).

During post-harvest processing and handling practices period the chemical structure of green coffee and consequently the final coffee quality adequately determined using postharvest treatment of the wet and dry processing.This underscores the importance of primary processing in enhancing the quality and subsequent value of coffee.

The costs of producing 1 kg of pulped coffee are twice the costs of a similar quantity of sun-dried coffee. The corresponding prices of pulped coffee are more than double those of sun-dried coffee, which therefore makes pulped coffee more profitable to the farmers. The quality of coffee processed by hand pulpers was significantly different and better than sun-dried coffee (Musebe et al., 2011). The result obtained during demonstration and evaluation of min-disc small scale wet coffee pulper in Jimma Zone by Kemeru D. and Tamiru D. (2018) showed that it has good performance with Average pulping efficiency, breakage and pulping capacity of 95.5%, 0.09% and 173.06kg/hr respectively. Therefore, this activity is aimed at demonstrating hand operated coffee pulper in Wayu Tuka and Digga districts of East Wollega.

MATERIALS AND METHODS

Materials

The technology/implements used for demonstration purpose was Hand operated coffee pulper that was brought from Jimma Agricultural Engineering Research Center and copied in our metal shop.

Description of the study area

The demonstration was conducted in Wayu Tuka and Digga districts of East Wollega zone. East Wollega zone stratified into three agro ecological zones based on agroclimatic conditions namely: low land 56.4% (1200-1799 m), mid land 28.2% (1800 -2450 m), and high land 15.4% (2460-3178 m). The selected sites are major coffee producer in the zone.

Sites selection, farmer selection and FREG formation

Site selection

Purposive sampling was employed to select two districts from East wollega zone namely Digga and W/Tuka based on potential production of coffee. From each District, two representative kebeles were selected purposively based on accessibility and production potential of coffee as demonstration site. Accordingly, Megna Kura, Wara Babo Megna kebeles from Wayu Tuka district and Jirata and Gemechis kebeles Digga district.

Table 1: Selected Sites

Zone	Districts	Kebeles
East Wollega	Digga	Megna Kura
		Wara Babo Megna
	Wayu Tuka	Jirata
		Gemechis

Farmers' selection and FREG formation

Sixty farmers, 15 farmers per Kebele, were selected purposively based on their willingness to host demonstration on their farm and potential production of coffee and organized in to groups. Totally, four FREGs were established. Selection of Kebeles and farmers were done with experts and Development agents in the respective kebeles.

Data collection method

Data was collected through Semi-structured interview, Focus Group Discussion with farmers who attended training and participated on demonstration. Observation was also used for data collection by using a topic guide prepared for this purpose.

Method of data analysis

The collected data was grouped, summarized, discussed and interpreted by theme based on the data collected during interview and FGD check lists as well as field notes recorded during observation. Then it was analyzed qualitatively based on the findings from observation, semi-structured interview and focus group discussion. Quantitative data was analyzed using simple descriptive statistics.

RESULTS AND DISCUSSION

Farmers, SMS and DA's training and on farm demonstration

Training (capacity building) session is the integral part of the activity and was organized for FREG members. It was given to upgrade their knowledge and skills on operation, handling and usage of hand operated coffee pulper. Accordingly, theoretical and practical training and Demonstration was organized for 55 farmers, 11 DAs and 7 SMS on usage, management & operation of the pulpier. 102 farmers, 16 DAs and 7 SMSs participated on training. The training was very useful to create awareness and improve their understandings that help them to give suggestions and feedback during demonstration and focus group discussion. After farmers and experts got training, demonstrations were organized on FTC and host farmer's field. Host farmers and non-hosting farmers attended demonstration.

Table 2: Farmers, SMS and DA's training

Training topic	Participants	Male	Female	Total
Hand operated Coffee pulper usage and management & cares to be given during operation	Farmers	50	5	55
	Development agents	8	3	11
	Experts	7	0	7
	Total	**65**	**8**	**73**

Capacity of hand operated pulpers

The evaluation result of the capacity of hand operated pulper on four FREG members showed that the machine has pulping capacity of 150 kg hr-1 red cherries with relatively less grain breakage for the pulped wet coffee. This capacity depends on feeding rate. Grain breakage also depends on adjustment of the pulper and uniformity of red cherries.

Table 3: capacity of hand operated pulper

FREGs	Pulping capacity in kg hr^{-1}
Megna Kura	159.06
Wara Babo Megna	154.80
Jirata	143.10
Gemechis	145.34
Average	150.6

Source, Own field data, 2020

Farmers Feedback Farmer perceptions of the hand pulpers

There was high interest among the farmers regarding use of the hand pulpers. Farmers preferred hand pulpers to other coffee processing methods. Farmers recognized the importance of the pulper and they have willingness to use hand pulpers for pulping coffee seed but the farmers are not willing to use the pulper for market purpose because there is no price difference based on quality in the area. Efforts have to be made to differentiate coffee processed on the basis of quality to enable farmers producing high quality coffee to earn a premium price.

During Focus group discussion, farmers stated that the adjustment of the pulper needs skilled operator. This can be addressed through training of the farmers on adjustment of the hand pulper according to the size of the red cherries as well as other adjustment skills.

CONCLUSIONS

Based on the feedback collected from the FREG members and farmers attended demonstration, the hand operated coffee pulper is recommended for pre scaling up.

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Pre-extension Demonstration of Animal Drawn Wheat Row Planter in Horo Guduru Wollega and West Shewa Zones

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ABSTRACT

In Ethiopia, smallholder farmers do not use farm implements for sowing the wheat crop. Usually, before the last pass with the traditional plow or maresha, farmers hand broadcast the DAP fertilizer (100 kg ha^{-1}) followed by hand broadcasting the seed (130-150 kg ha^{-1}) and cover the seeds with oxen plow. This operation is not very efficient and as the result, seed is placed at uneven soil depths leading to irregular germination across the field. Therefore, this demonstration aims to create awareness and improve farmers' knowledge and skills on animal drawn wheat row planter in Horo Guduru Wollega and West Shewa Zones, Oromia, in 2018 & 2019. Sites were selected purposively and three FREGs were established each comprising 15 members. Training and demonstration were conducted to create awareness and evaluate the planter under farmers' condition. Data was collected through semi-structured interviews, FGD, and observation. The collected data was grouped, summarized, discussed and interpreted. Data was analyzed qualitatively based on the findings. Farmers and experts participated in the demonstration compared the planter with traditional hand broadcast and recognized that the animal drawn wheat row planter has advantageous. However, it needs modification on some parts of the planter. Accordingly, there should be appropriate stopper on turning, the planter needs seed cover and the angle of the handle and beam of the plough should be modified to appropriate degree. It is concluded that the demonstrated animal drawn wheat row planter saves time and energy as compared broadcasting and manual row planting. The animal drawn wheat row planter is recommended for pre-scaling up as there is high farmers demand created and it has also advantage when compared to manual planter and hand broadcast.

Keywords: On farm demonstration, wheat row planter

INTRODUCTION

Ethiopia is the second largest wheat producer in Sub-Saharan Africa next to South Africa. Wheat is one of the major staple crops in the country in terms of both production and consumption. In terms of caloric intake, it is the second-most important food in the country behind maize (FAO, 2014).

Oromia accounts for over half of national wheat production (54 percent), followed by Amhara (32 percent); Southern Nations, Nationalities and Peoples (SNNP) (9 percent); and Tigray (7 percent) (CSA, 2013). Of the current total wheat production area, about 75 percent is located in the Arsi, Bale and Shewa wheat belts (MOA, 2012).

The productivity of wheat in Ethiopia is low compared to other wheat producing countries of the world. Reasons for this are: (1) the use of traditional production systems; (2) the influence of biotic (e.g. diseases particularly rust) and abiotic factors; and (3) the lack of production inputs (e.g. improved seeds) and/or suboptimal use of recommended packages. (Wheat technology document)

The study conducted by Alan de Brauw, Gashaw T.A. and Minot, N. (2016) to examine the impact of the Wheat Initiative technology package on 482 wheat growers in the highlands of Ethiopia found that only one third of the farmers said they would use row planting on all their wheat next year. The main objection was indicated that even if row planting increases yields, the additional labor requirement coupled with higher labor costs of row planting are the main reasons for their preference for traditional hand broadcasting. The study concluded that the development of labor-saving tools for row planting could accelerate the adoption of this practice.

To overcome the problem of wheat row planting, Asella, Jimma and Melkasa research centers have been experimenting to develop, evaluate and adapt prototypes of wheat row planters. Tamrat G., Ayalew B., Ephrem B. (2017) collected and evaluated seven-wheat row planters under farmers' conditions for their social, economic and technical feasibility. These planters were AAERC type, JAMRC animal and JAMRC hand, MARC, Sisay, Mamuye 3 rows and Mamuye single rows. Accordingly, AAERC type planter was selected as first and recommended for the systematic transfer of this technology for further multiplication and wider dissemination.

Animal drawn wheat row planter OARI-AAERC type has four rows and 25 cm row spacing with fertilizer application system. The planter has the performance of 111 kg/ha seeding rate and 8.33 hours to plant one hectare, 5 cm planting depth, 1.2 million/ha plant population. On average yield obtained was 41 quintal/ha. The labor required per operation is one person and a pair of animals. Compared to traditional wheat row planting practice, the technology shows advantage in saving labor, time and seed (Ayalew, B. et al., 2017). Therefore, this study was proposed with an objective of demonstrating Animal wheat row planter in the selected AGP-II districts of west shawa and H/G/Wollega.

MATERIALS AND METHODS

Materials

The technology that was demonstrated is OARI-AAER animal drawn Wheat row planter.

Description of the study area

The demonstration of animal drawn wheat planter is conducted in Jimma Ganati and Horro districts of Horro Guduru Wollega zone. The two districts known for wheat production in the zone.

Horo Guduru Welega is one of the zones of the Oromia region. It is named after the former province of Welega, whose eastern part lay in the area Horo Guduru Welega now occupies.

Sites selection, farmer selection and FREG formation

Site selection

Purposive sampling was employed to select two districts from H/G/Wallaga zone and one district from west Shewa. From each District, two representative kebeles were selected purposively based on accessibility and wheat production potential in collaboration with the respective district BoANR and Development agents. Accordingly, Lakku iggu kebele from Horro district, Nagaro kebele of Jima Ganati district and Munyo kashambal from Liban Jawwi district were selected.

Table 1: Selected Sites

Zone	Districts	Kebeles
H/G/Wallagga	Horro	Laku Igu
	Jimma Ganati	Nagaro
West Shewa	Liban Jawwi	Kashambal

Farmers' selection and FREG formation

Sixty farmers, 15 farmers per Kebele, were selected purposively based on their willingness to host demonstration on their farm and potential production of wheat and organized in to groups. Totally, three FREGs were established. Selection of Kebeles and farmers were done with experts and Development agents in the respective kebeles. Host farmers was selected based on their willingness, accessibility of their field and capacity to allocate the required experimental land (20m×20m), oxen and properly manage the fields.

Data collection method

Data was collected through Semi-structured interview, Focus Group Discussion with farmers who attended training and participated on demonstration. Observation was also used for data collection by using a topic guide prepared for this purpose.

Method of data analysis

The collected data was grouped, summarized, discussed and interpreted by theme based on the data collected during interview and FGD check lists as well as field notes recorded during observation. Then it was analyzed qualitatively based on the findings from observation, semi-structured interview and focus group discussion.

RESULTS AND DISCUSSION

Farmers, SMS and DA's training and on farm demonstration

Training is the integral part of the activity and was organized for FREG members. It was given to build their knowledge and skills on operation, handling and usage of wheat row plater. Accordingly, theoretical and practical training and Demonstration was organized for 44 farmers, 8 DAs and 3 SMS on usage, management & operation of the planter. The training was very useful that it creates awareness. It also improves their understandings for using animal drawn wheat row planter that help them to give suggestions and feedback during demonstration and focus group discussion. After farmers and experts got training, demonstrations were organized on host farmer's field during seeding and its status at early maturity stages. Accordingly, 131 male and 62 females totally 192 farmers attended demonstration.

Table 2: Farmers, SMS and DA's training

Training topic	Participants	Male	Female	Total
Animal drawn wheat row planter usage and management & cares to be given during operation	Farmers	40	5	45
	Development agents	7	1	8
	Experts	3	0	3
	Total	50	6	56

Farmer's feedback on animal drawn wheat row planter

All FREGs members were interested on the demonstrated wheat row planter. They prefer the introduced row planter because it saves labor required, saves seed, precise placement of the seed and fertilizer/evenly distribution of the seed and fertilizer as compared to row planting using local materials/hand. Farmers and experts participated in the demonstration compared the planter with traditional hand broadcast and recognized that the animal drawn wheat row planter has advantageous. They indicated that the demonstrated planter has advantage as it has seed and fertilizer mechanism simultaneously. However, participated farmers suggested that the planter needs modification on some parts of the planter. Accordingly, there should be appropriate stopper on turning, the planter needs seed cover and the angle of the handle. The beam of the plough should also be modified to appropriate degree.

CONCLUSIONS

It is concluded that the demonstrated animal drawn wheat row planter saves time and energy as compared broadcasting and manual row planting. With the modification of the suggested parts animal drawn wheat row planter is recommended for pre-scaling up as there is high farmers demand created and it has also advantage when compared to manual planter and hand broadcast.

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Pre-extension Demonstration and Evaluation of Engine Driven Feed Chopper Technology in the selected AGP-II districts of Harari region and Dire Dawa Administration

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ABSTRACT

Feed chopper Machine is hay cutting machine which is used for uniform chopping of fodder for livestock of farmer .The demonstration of feed chopper was undertaken in 2018/19 in Harari and Dire dawa administration council. A total of 80 trial farmers were selected from Sofi and Wahil potential sorghum and maize growing kebeles of Harari region and Dire Dawa administration council. Four FRGs having 80 farmers were established and two FRGs containing 40 farmers was established per Kebele. Training on which a total of 70 participants took part were organized at Harari Region. The machine was developed by Fadis Agricultural Research Center with Time of chopping 0.03hr, Chopping efficiency 95%, Wt. of off cut length 0.19 to 31.54 %. Output capacity 88.24 kg/hr. and also the machine ensure safety of feed, provide good fodder for animal, save work time, and get protection of feed from dust and make the feed easily palatable. Hence the trial farmers interested in using the machine across locations

Key words: Demonstration, Engine Driven, Feed chopper, Harari and Dire Dawa

INTRODUCTION

Crop residue has become the used term in tropical research and development circles for describing the fibrous by-products of cereals, sugarcane, roots and tubers, pulses, oilseeds, oil plants, vegetable and fruits. With notable exemptions e.g. sugar beet pulp and citrus pulp, utilization of residues as feed has been the subject of intense research and development since the mid-1970s (Owene and Jayasuriya M.C.N1989). All ruminants depend on two major feed resources. These are crop residues and agro-industrial by-products and they play significant role in the nutrition of ruminant animals (Onyeonagu and Njoku 2010). Crops residues are distinct from agricultural by-products (such as bran, oil cakes etc) which are generated when crops are processed. Generally any plant materials that remain after food crops have been harvested are classified as a crop residue.

Apart from being a source of animal feed, residues are used as building, in the case of wheat, oath or barley straws; as building material for walls of local houses, roofing and Sorghum and Maize used for fencing materials, as fuel or surface mulch in crop land (Jibrin., 2013).Goats, sheep and cattle are constantly faced with problem of feed shortage during the dry season. The herd constantly relies on crop residue, but these are usually in short supply. Hence ruminants experience seasonal weight gain/loss during the wet/dry periods respectively during the year (Philip *et al* 2009). Utilization of stalks and stovers of cereal crops is sure to improve the availability of the product. Ruminants despite their unique and highly efficient digestive system are not able to extract sufficient energy to grow and produce milk from low quality or high lignified residues. Hence these must be properly processed or treated in some way to make them useful for production (Jibrin, 2013).

A Feed Chopper is mechanical device used to cut the straw or hay into small pieces so as to mix it together and fed to cattle. This improves animal digestion and prevents animal from rejecting any part of their food. So to increase the productivity and reduce the physical effort required for running the machine and motorized machineries came into existence it is best for dairy farmers. Presently fodder cutting machines are electric driven as well as hand operated or engine driven (Nilesh Sankpal, 2017). Therefore, this activity was aimed at demonstrating and evaluate engine driven feed chopper technology to the target area.

MATERIALS AND METHODS

This pre-extension demonstration of feed chopper technology was in selected districts of Harari region and Dire Dawa administration.

Site Selection

Research sites were selected purposively based on the potentiality of livestock production, appropriateness of the area by considering lodging, slop's land escape, access to road, accordingly Kile kebele from Sofi and Wahil kebele from Dire Dawa were selected.

Farmers Selection

Farmers were selected based on their interest, innovation he/she has in using feed chopper production and willingness to use the technology in collaboration with the Development Agents. The selected farmers were grouped in form of Farmers Research Group (FRG) with the member of 40 farmers per PAs in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 4FRGs (2FRG/ kebele) from one kebele 40 farmers and a total of 80 farmers were grouped in 4FRG.

Table 1 Selected site and farmers

Kebeles	Number of Trial Farmers	Male	Female
Wahil	40	27	13
Sofi	40	30	10
Total 80 57 23			

Data Collection

Quantitative data Time of chopping (hr), chopping rate kg/hr, chopping efficiency (%), Wt. of off cut, output capacity (kg/hr), and number of farmers participated in FRG, number of stakeholders participated on the training data were collected by data sheet tools and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist.

Data analysis

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

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

Multidisciplinary research team; Agricultural Mechanization researchers, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists in publicity of the work done, Development Agents, experts and farmers were participated on the training given on feed chopper theoretical and practical training, management, and post-harvest handling.

Table 2: number of participants on training

No.	Participants	Male	Female	Total
1	Farmers	40	25	65
2	DAs	7	-	7
3	District experts	4	1	5
4	Journalists	3	0	3
	Total	54	26	80

Among the training participant stakeholders, 81.25% were farmers. From those farmers, 38.46% are female farmers' participant. Different extension materials were utilized and distributed for the participants. For those individuals, 30 leaflets and 20 small manuals on the technology in Afaan Oromoo (local) and English languages were distributed.

Table 3 performance of the machine

No	Parameters	Feed Materials			
		Sorghum Stalk		Maize Stalk	
		Wet	Dry	Wet	Dry
1	average weight of input (kg) W1	3.00	3	3	3.00
2	Average weight of feed Output (kg) W2	2.85	2.65	2.86	2.85
3	Average weight of material in the chamber (kg) W3	0.24	0.35	0.14	0.24
4	Time of chopping (hr)	0.03	0.040	0.03	0.03
5	Chopping rate kg/hr	83.82	66.17	87.85	83.82
6	Chopping efficiency (%)	95.00	88.2	95.33	95.00
7	Wt. of off cut length (%)	0.19	0.26	31.54	0.19
8	Fuel consumed (liter/hr)	0.7	0.98	0.65	0.7
9	Output capacity (kg/hr)	88.24	75.00	92.15	88.24
10	Moisture Content % (db)	19.1	63.5	18.2	19.1

Farmers' Opinion/Perception

The opinion of those farmers on the machine performance was collected from participants during variety demonstration. The major criteria used by farmers were time of chopping (hr), chopping rate, chopping efficiency, output capacity by observing the machine during its operation. Therefore, most farmers preferred the machine. The following table describes farmers' selection criteria and their perception (feedback) toward the machine.

Table 4: Ranks of the feed choppers based on farmers' selection criteria

Implement	Farmers rank	Reasons
Engine driven feed chopper	1st	Better Chopping efficiency, less time of chopping, high chopping rate, high output capacity, reduce labor use
Traditional chopping	2nd	Low chopping efficiency, extended time of chopping, low chopping rate, low output capacity, maximize labor use

Table 5: Pair-wise ranking matrix result to rank variety traits

Code no.	Traits	Chopping efficiency	Time of chopping	Chopping rate	Output capacity	labor use	Frequency	Rank
1	Chopping efficiency		1	1	1	1	4	1st
2	Time of chopping			2	4	2	2	3rd
3	Chopping rate				4	3	1	4th
4	Output capacity					4	3	2nd
5	labor use						0	5th

The two feed choppers engine driven and traditional one were evaluated by farmers based on traits the implements behave for both sorghum's and maize's dry and wet stalk. Accordingly, the engine driven feed chopper show that good efficiency 88.2%-95.33%, chopping rate 66.17 kg/hr-87.85kg/hr, output capacity from 75.00 kg/hr-92.15kg/hr and moisture content from 18.2% to 63.5%. This indicates that the machine has more advantage in efficiency, saving time for farmers in chopping, prepare feed in good quality without much loss and conserve the moisture content of forage that is sorghum and maize stalk.

CONCLUSION AND RECOMMENDATION

This research activity found that the engine driven feed chopper was very effective than the traditional copping in terms of different traits like time of chopping, output capacity and conservation of the content in maize and sorghum stalk. As a result, farmers selected the engine driven on the first rank because of the chopping efficiency, time chopping, moisture conservation and traits. Therefore, it is recommended to multiply the machine, works on further promotion and distribute to small holder farmers.

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Pre-extension Demonstration and Evaluation of Engine Maize Sheller Technology in the selected AGP-II districts of Harari region and Dire Dawa Administration

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ABSTRACT

The pre-extension demonstration of engine driven maize sheller was conducted in 2019 with the objectives of promoting and popularize improved engine driven maize sheller technology and to create awareness through giving training and enhance stakeholder's participation. A total of eighty (80) trial farmers were selected from two potential maize growing kebeles Wahil of Dire Dawa administration council and Sofi from Harari region. Four FRGs having 20 farmers were established. Training on which a total of 188 participants took part were organized at Wahil and Sofi to create awareness. The machines were fabricated by Fadis agricultural research center were demonstrated and found to be about 95.88-97.2% efficient with output capacity of about 1800 -2000kg/hr. Traditionally maize shelling carried out manual rubbing maize cobs against one another, using human finger, stone, biting the cob with wooden plank, treading with animal this is inefficient; do not support large-scale shelling of maize requiring a lot of labor and time with low productivity and also it is one of the major problems which facilitate physical damage. Hence farmers preferred an engine driven maize for alleviating maize post-harvest loss, increase production and productivity, less labor and time consumption was observed. Therefore based on farmer's idea it is better to popularization and scaling up is necessary and capacity building (training) could be required for farther promotion

Key words: *Maize Sheller, Engine driven, Demonstration, Harari and Dire Dawa*

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in the world agricultural economy. It is called as "Queen of cereals" and "King of fodder" due to its great importance in human and animal diet (B. Ashwin Kumar and Shaik Haneefa, 2014). Maize is next to *rice and wheat with* regard to area and production. It is being used for manufacturing industrial products like starch, syrup, alcohol, acids, etc. It is a rich source of starch (60-80%), protein (8-12%), fat (3-5%) and minerals (1-2%) (Ashwin and Shaik, 2014).In Ethiopia, maize grows from moisture stress to high rainfall areas and from lowlands to the highlands. It is one of the most important cereal crops grown in the country and is the main staple food in rural areas. It accounts over 14 % and 18% in terms of land area coverage and productivity respectively with higher annual growth rate (Demeke M, 2012). The overall productivity of maize is affected by many factors including lack of post-harvest technologies, such as shelling. Maize kernels should be removed from cob to be used as seeds, prepare value addition, improve handling and storage as well as maintain its quality. Maize shelling which refers removal of kernel from cob is an important post-harvest operation in maize production. Shelling can be carried out in the field or on the farm. A more efficient shelling is achieved when the grain has been suitably dry to 13 to 14 % moisture content (Danilo Mejia, 2003). Maize shelling in Ethiopia is mainly carried out using traditional methods. The most commonly employed methods include manual rubbing maize cobs against one another, using human finger, stone, biting the cob with wooden plank, treading with animal and wire mesh by using iron cylinder. All these are time consuming methods involving drudgery and exposure of crop over a time leads to natural hazards like rain, fire and also loss of grains to animals, birds and insects. It is also highly tedious, inefficient; do not support large-scale shelling of maize requiring a lot of labor and time with low productivity as a worker can only shell a few kilograms per hour (TASTRA, I. K., 2009.Therefore this proposal initiated to demonstrate engine Driven Maize Sheller Technology to alleviate farmers from those problems of traditional Maize shelling technologies in Harari region and Dire dawa administration council

MATERIALS AND METHODS

Description of the study area

Pre-extension demonstration of Maize Sheller technology was conducted in Agricultural growth program-II nationally selected districts of Harari region and dire dawa administration council. Harari regional state is located on distance of 526 kms from capital city Finfine in direction of country's eastern part; it is all in all bordered by Oromia region and hosts one capital town of Oromia Regional state's zone that is East Hararghe. The climatic condition of the region includes highland, midland and lowland; the soil type exist in the region is different in different ecologies of the region that is clay, loam, sandy and black types. The selected districts are where the potentiality of the program was succeeded in consideration of residents' problems, potential succession of the technologies these fit problems and solve; including the outcomes prevailed in AGP-I. Dire Dawa Administration is located on distance of 515kms from capital city Finfine in direction of county's Eastern part; it is bordered by Somali, and Oromia regions in all directions. Dire Dawa Administration has both urban and rural set governance system. The climatic condition of Dire Dawa is almost dry land with the maximum and minimum temperature 38^{0c} and 25^{0c} respectively (EBC broadcasting on metrology allocated time). The selected districts are where the potentiality of the program was succeeded in consideration of residents' problems, potential succession of the technologies these fit problems and solve; including the outcomes prevailed in AGP-I.

Farmers Selection

Farmers were selected purposively based on their interest, innovation he/she has in using maize Sheller technology and willingness to use the technology in collaboration with the DAs and SMS. The selected farmers were grouped in the form of Farmers Research Group (FRG) with the member of 20 farmers per FRG in consideration of gender issues (women, men and youth). In the establishment of FRG in the study areas total of 4FRGs (2FRG/ PA) from one PA 40 farmers and a total of 40 farmers were grouped in 2 FRGs in two PA. For two FRG containing of 40 farmers one maize Sheller technology was delivered (25 male trial farmers and 15 female trial farmers) were participate in the operation of the machine.

Site Selection

Harari regional and Dire Dawa district were purposively selected by AGP-II nationally. PAs will be selected purposively based on the potentiality of Maize production, appropriateness of the area by considering lodging, slop's land escape, access to road. One district from Harari region (Sofi) was selected and Wahil selected from Dire Dawa purposively.

Table 1: Summary of selected site and farmers

Districts	PAs	Number of trial farmers	Male	Female
Wahil	Wahil	40	25	15
Sofi	Kile	40	25	15

Technology evaluation and demonstration methods/technique

The evaluation and demonstration of the technology was conducted on farmers' fields to create awareness about the maize Sheller technology operation.

Data Collection

Quantitative data Output capacity (kg/h), threshing efficiency (%), grain damage (%),number of farmers participated in FRG, number of stakeholders participated on the training and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. While qualitative data were farmers' perceptions towards the new technology and ranked using pair wise ranking and Matrix ranking.

Data analysis

Quantitative data was summarized using 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. Finally, data from different sources was triangulated to get reliable information.

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

Multidisciplinary research team; Agricultural mechanization, Crop, extension and socio-economic research team and other stakeholders (Offices of Agriculture and Natural Resource) actively participated by sharing their experience and knowledge and journalists for the sake of publicity of the work done .Development agents, experts and farmers were participated on the training given on maize Sheller operating and management, post-harvest handling of maize.

Table 2: Type of profession and number of participants during the training at the two Districts, 2018/19

		Kile		Wahil		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	40	20	60	40	160
2	DAs	7	-	5	-	12
3	District experts	4	1	5	-	10
4	Journalist	3	0	3	-	6
	Total	54	21	73	40	188

Among the training participant stakeholders, 85.1% were farmers. From those farmers, 37.5% are female farmers' participant. Different extension materials were utilized and distributed for the participants. For those individuals, 70 leaflets and 40 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. During the training different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards the technology. Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Table: 3.The performance of engine driven maize sheller machine

Descriptions		**Dimension**
Over all dimensions	Length(mm)	920
	Width(mm)	1050
	Height(mm)	1130
Power source		Honda engine
Power requirement(HP)		5
Fuel consumption(lit/qt)		0.1
Drum concave clearance	Inlet (mm)	60
	Out let (mm)	50
Recommended drum speed(RPM)		500
Performance of the machine	Output capacity (kg/h)	1800-2000
	Threshing efficiency (%)	95.88-97.2
	Grain damage (%)	Negligible

Farmers' Opinion/Perception

The opinion of those farmers on the maize sheller performance was collected from participants during machine demonstration. The major criteria used by farmers were the machine capacity, threshing efficiency, grain damage, reduce labor, minimize human effort/tiredness and reduce time of thrashing. Therefore, most farmers preferred engine driven maize sheller than traditional shelling mechanisms

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

Implements	Farmers rank	Reasons
Engine Driven maize sheller	1st	High Machine capacity, high threshing efficiency,low grain damage, reduce labor, minimize human effort/tiredness and reduce time of thrashing
Traditional Maize shelling	2nd	Low threshing capacity, low threshing efficiency, high grain damage, maximize human effort/tiredness and increase time of thrashing

Table 5: Pair-wise ranking matrix result to rank variety traits.

Code no.	Traits	Machine capacity	Threshing efficiency	Reduce labor	Minimize human	Reduce time of thrashing	Reduce grain	Frequency	Rank
1	Machine capacity		2	1	1	1	1	4	2nd
2	Threshing efficiency			2	2	2	2	5	1st
3	Reduce labor				3	3	4	2	4th
4	Minimize human effort/tiredness					5	5	1	5th
5	Reduce time of thrashing						5	3	3rd
6	Reduce grain damage							0	6th

The demonstration of engine driven maize sheller reducing human interaction with the process. The machine has a great future scope for farmers due to its ease of use. The main the advantage is its low operating costs, tame and energy saving. Savings of money resulting from the use of machine can pay for itself within the short period of time.

CONCLUSION AND RECOMMENDATION

Maize harvesting and post-harvest operation usually consists of a series of operations comprising removal of kernel from cob. Traditionally maize shelling carried out manual rubbing maize cobs against one another, using human finger, stone, biting the cob with wooden plank, treading with animal this is inefficient; do not support large-scale shelling of maize requiring a lot of labor and time with low productivity and also it is one of the major problems which facilitate physical damage. Hence the available engine driven maize sheller important to harvest maize and the technology on farm evaluation and demonstration best solution for alleviating maize post-harvest loss, increase production and productivity constraint under smallholder. In addition less labor and time consumption was observed when compared with manual shelling.

Therefore, based on farmer’s idea and importance of this technology the following recommendations were drawn:

- More popularization and scaling up is necessary
- Capacity building (training) could be required for farther promotion

More Effort is required on availability, distribution and demonstration of the technology should be made on .Future study could require on technology in different area for more post-harvest loss minimization and busting production and productivity.

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Pre-extension Demonstration and Evaluation of Engine Driven Sorghum Thrasher Technology in the selected AGP-II districts of Harari region and Dire Dawa Administration

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ABSTRACT

Engine driven sorghum thresher machine was demonstrated in Harari Region and Dire Dawa administration council with the objectives of saving labor, cost & time of threshing, and reduce post-harvest losses. The demonstration of sorghum thrasher was undertaken in 2018/19 in Harari and Dire Dawa administration council. A total of 80 trial farmers were selected from Sofi and Bishan Bahe the potential sorghum growing kebeles of Harari region and Dire Dawa administration council. Four FRGs having 80 farmers were established and Two FRGs containing 40 farmers was established per Kebele. Training on which a total of 178 participants took part were organized at Sofi and Bishan Bahe. The result indicated that the average efficiency, output capacity were 88.97 to 97.08%, 6 to 8.36qt/ha and grain damage less than 1%. Hence farmers preferred the machine to overcome sorghum threshing challenges such as beating with stick, moving tractor on sorghum as it take longtime, consume human energy consuming, hardly detach the grain from sorghum head, thereby decreasing tremendous sorghum grain post-harvest loss because of traditional threshing method and it is better to develop cost sharing mechanisms to reach more number of farmers

Key words: *Sorghum Thrasher, Engine driven, Demonstration, Harari and Dire Dawa*

INTRODUCTION

Sorghum, *Sorghum bicolor* (L) Moench, is the fifth most important cereal after rice, wheat, maize, and barley. It constitutes the main food grain for over 750 million people who live in the semi-arid tropics of Africa, Asia, and Latin America. The largest group of producers are small-scale subsistence farmers with minimal access to production inputs such as fertilizer(s), pesticides, improved seeds (hybrids or varieties), good soil and water and improved credit facilities for their purchase(FAO,2010).

In rural Africa, threshing involves beating the dried sorghum panicles with sticks on the ground or in sacks, or using a mortar and pestle. Grain is separated from dirt and chaff by winnowing. The time required for threshing depends on variety, the degree of dryness of the grain, and the method of threshing. In some places in India, a common practice for threshing the grain is to place it on the road for vehicles to run over (Simonyan, 2006).A motorized stationary sorghum thresher was developed and tested. The sorghum thresher had the following components: frame, hopper, and threshing unit, sieve, reciprocating mechanism, blower and the collecting trays. The performance variables investigated were: threshing efficiency, cleaning efficiency and cleaning loss (Simonyan, 2009).).The improved small-engine driven sorghum thresher was designed and produced at Fadis Agricultural Research

Center with an intention to solve critical threshing problem of farmers consecutively reducing cost of threshing, labor power and grain loss (Tekalign, 2018) Hence, this activity is aimed at demonstrating and evaluate engine driven Sorghum thrasher technology to the target area

MATERIALS AND METHODS

Description of the study area

Pre-extension demonstration of sorghum thrasher technology was conducted in Agricultural growth program-II nationally selected districts of Harari region and Dire Dawa administration council. Harari regional state is located on distance of 526 kms from capital city Finfine in direction of country's eastern part; it is all in all bordered by Oromia region and hosts one capital town of Oromia Regional state's zone that is East Hararghe. The climatic condition of the region includes highland, midland and lowland; the soil type exist in the region is different in different ecologies of the region that is clay, loam, sandy and black types. Dire Dawa Administration is located on distance of 515kms from capital city Finfine in direction of county's Eastern part; it is bordered by Somali, and Oromia regions in all directions. Dire Dawa Administration has both urban and rural set governance system. The climatic condition of Dire Dawa is almost dry land with the maximum and minimum temperature 38^{0c} and 25^{0c} respectively (EBC broadcasting on metrology allocated time). The selected districts are where the potentiality of the program was succeeded in consideration of residents' problems, potential succession of the technologies these fit problems and solve; including the outcomes prevailed in AGP-I.

Site and farmers' selection

Dire Dawa administration and Harari Regional District were purposively selected by AGP-II nationally. PAs were selected purposively based on the potentiality, appropriateness of the area by considering lodging, slop's land escape, access to road, suit for repeatable monitoring and evaluation in progress of sowing to harvesting. One District from Harari Region (Sofi) and one district from Dire Dawa Administration Bishan Bahe selected. 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 40 farmers per PAs in consideration of gender issues (women, men and youth). In the study areas total of 4 FRGs (2FRG/ PAs- from one PA 20 farmers and totally 80 farmers were grouped in 4 FRG).

Table 1

District	**PAs**	**Number of trial farmers**	**Male**	**Female**
Dire Dawa	Bishan Bahe	40	30	10
Harari	Sofi	40	30	10

Data Collection

Quantitative data Output capacity (qt/h), shelling efficiency (%), grain damage (%),number of farmers participated in FRG, number of stakeholders participated on the training and qualitative data were collected through personal field observation, individual interview, Focus Group Discussion by using checklist and data sheet tools. While qualitative data were farmers' perceptions towards the new technology and ranked using pair wise ranking and Matrix ranking.

Data analysis

Quantitative data was summarized using 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. Finally, data from different sources was triangulated to get reliable information.

RESULTS AND DISCUSSION

Training of farmers and other stalk holders

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

Table 2: Type of profession and number of participants during the training at the two Districts, 2018/19

		Kile		Bishan Bahe		
No.	Participants	Male	Female	Male	Female	Total
1	Farmers	35	20	60	35	150
2	DAs	7	-	5	-	12
3	District experts	4	1	5	-	10
4	Journalist	3	-	3	-	6
	Total	49	21	73	35	178

Among the training participant stakeholders, 84.2 % were farmers. From those farmers, 36.6% are female farmers' participant. Different extension materials were utilized and distributed for the participants. For those individuals, 50 leaflets and 30 small manuals on the technology that are organized in Afaan Oromoo and English languages were distributed. During the training different questions, opinions and suggestions were raised and reacted from the concerned bodies. Most farmers showed high interest towards the technology .Therefore, all concerned bodies were shared their responsibility for the future intervention and wider reach out of the technology.

Farmers' Opinion/Perception

The opinion of those farmers on the sorghum thrasher performance was collected from participants during machine demonstration. The major criteria used by farmers were the machine capacity, threshing efficiency, grain damage, reduce labor, minimize human effort/tiredness and reduce time of thrashing. Therefore, most farmers preferred engine driven sorghum thrasher than traditional thrashing mechanisms

Table 3: The performance of engine driven sorghum thrasher machine

Descriptions		Dimension
Over all dimensions	Length(mm)	1340
	Width(mm)	840
	Height(mm)	1130
Power source		Honda engine
Power requirement(HP)		5
Fuel consumption(lit/qt)		0.096 - 0.103
Drum concave clearance	Inlet (mm)	23
	Out let (mm)	10
Recommended drum speed(RPM)		700-900
Performance of the machine	Output capacity (qt/h)	6-8.36
	Threshing efficiency (%)	88.97 to 97.08%
	Grain damage (%)	<1

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

Implements	Farmers rank	Reasons
Engine driven sorghum thrasher	1^{st}	High Machine capacity, high threshing efficiency, low grain damage, reduce labor, minimize human effort/tiredness and reduce time of thrashing
Traditional sorghum thrasher	2^{nd}	Low threshing capacity, low threshing efficiency, high grain damage, maximize human effort/tiredness and increase time of thrashing

Table 5: Pair-wise ranking matrix result to rank variety traits

Code no.	**Traits**	**Machine capacity**	**Threshing efficiency**	**Reduce labor**	**Minimize human**	**Reduce time of**	**Reduce grain**	**Frequency**	**Rank**
1	Machine capacity		2	1	1	1	1	4	2^{nd}
2	Threshing efficiency			2	2	2	2	5	1^{st}
3	Reduce labor				3	3	4	2	4^{th}
4	Minimize human effort/tiredness					5	5	1	5^{th}
5	Reduce time of thrashing						5	3	3^{rd}
6	Reduce grain damage							0	6^{th}

Conclusion and Recommendation

The performance of the demonstrated machine, it could be concluded that the Output capacity threshing efficiency and grain damage are 6-8.36 qt/hr.,88.97to97.08%,less than1%

respectively .This machine has been fabricated with the use of locally available materials. The machine is simple, less bulky and effective. Grains loss and mechanical visible damage have been very minimal and ease the work. The demonstration of engine driven sorghum thrasher reducing human interaction with the process. The machine has a great future scope for farmers due to its ease of use. The main the advantage is its low operating costs, tame and energy saving. Savings of money resulting from the use of machine can pay for itself within the short period of time.

Therefore, based on farmer's idea and importance of this technology the following recommendations were drawn: More popularization and scaling up is necessary, Capacity building (training) could be required for farther promotion. More Effort is required on availability, distribution and demonstration of the technology should be made on. Future study could require on technology in different area for more post-harvest loss minimization and busting production and productivity, and it is better to promote as this research paper recommendation.

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