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Cluste-based Large-scale Demonstration and Popularization of Midland Maize Technology in Gamo and Gofa Zones, Southern Ethiopia

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Abstract

Maize is a staple food for farmers in the Gofa and Gamo Zone in Southern Ethiopia. Cluster-based Large Scale Demonstration of maize technology was conducted at Melokoza, Geressie, and Boreda districts in the 2022/23 cropping season. The maize-growing districts were purposively selected. A total of 41 farmers were selected from the 3 districts covering an area of 20 hectares. A training was provided for a total of 102 farmers, DAs, and experts, and the BH-546 maize seed variety was offered to the participant farmers. Planting was done with a seed price of 25kg ha^{-1}; spacing of 75cm between the rows and 25 cm between the plant and fertilizer rate of NPS: 100 kg ha^{-1} and UREA: 150 kg ha^{-1}. Weeding and other management practices were accomplished as required. Awareness creation, grain yield, and farmers' perceptions were analyzed using mean, percentages, and standard deviations. The adjusted mean grain yield was 4,025, 4,475, and 4,050 Kg ha^{-1} recorded in Melo-Koza, Geressie, and Boreda districts respectively. At each of the demonstration sites, a field day was held where various stakeholders participated, and experiences were shared. Based on the feedback, the demonstration was well understood by farmers and stakeholders further. Therefore, the extension system of the respective districts suggested supplying the improved maize variety (BH546) with recommended practices to the wider community for further expansion.

Keywords

BH-546; cluster; demonstration; midland maize; perception; productivity

1. Background and Justification

Maize is one of the most important cereal crops in the world. It ranks third in world production after wheat and rice [1]. No other cereal crop produced reaches this level in terms of retention for home consumption [2]. Maize is preferred for its high productivity and adaptability; it can be expected to feed the world population for the indefinite future through the improvement of genetic and agronomic practices. From 1995 to 2030, global and sub-Saharan Africa maize consumption is projected to increase by 50% and 93%, respectively. Helping farm families grow more is the smartest way to fight hunger and poverty.

The sub-humid agroecology of mid-altitude ranging from 1500 m to 2000 m above sea level and receives a fairly reliable average annual rainfall ranging from 1000-1500 mm is considered to be the major maize growing Zone in Ethiopia [3].

Maize is one of the most important cereal crops in Ethiopia, ranking second in area coverage after teff and first in total production [4]. Approximately 88 % of maize produced in Ethiopia is consumed as food, both as green and dry grain [5]. The higher nutritional value of maize grain is due to its high starch content, which is 72%; it also contains 10% protein, 8% fiber, 4% oil, 3% sugar, and 1% ash. In addition to being used as food for humans, maize is also used as animal feed at various growth stages in the form of silage at young stages. In areas where there are not enough fuel woods, its stalk and cobs are also crucial for fuel purposes [6].

The major maize-producing regions in Ethiopia are Oromia, Amhara, and Southern Nations Nationalities and Peoples' Regional States. The 2020/21 Meher season post-harvest crop production survey indicated that at the national level, about 2,526,212.36 hectares of the land area was covered by maize, and production of grain was about 105,570.935.92Qt ha^{-1}. Even though maize has multiple purposes and high yield potential, the national average yield is 29 Qt ha^{-1} [7]. This shows the productivity of maize in Ethiopia has remained low as compared to the world average yield of 51 Qt ha^{-1} [8].

Similarly in Southern Ethiopia, where 0.31 million ha of land was produced, 1.2 million tons of maize were harvested [8]. Maize covered an area of about 57,797.17 ha^{-1}; production of grain was 2,299,412.75Qt ha^{-1} with an average grain yield of 39.78 Qt ha^{-1} in the Gamo Gofa Zone are low as compared to developed countries' average yield which is about 6.2 t·ha^{-1} [9].

The low productivity of maize is attributed to many factors such as poor agronomic practices, poor soil fertility, drought, insects, diseases, and weeds, farmers' limited access to fertilizers, and low access to seeds of improved maize varieties [10-12]. To tackle the problem a year before, Arba Minch Agricultural Research Center did adaptation and pre-extension demonstration on BH-140, BH-540, BH-546, BH-660 improved midland maize varieties in potential areas of Gamo and Gofa Zones of Southern Ethiopia, and BH546 variety were given good yield which is about 4562 Kg ha^{-1} and recommended to demonstrate and popularize in a wider farmers' field. Therefore, this activity was designed to popularize improved midland maize variety (BH-546) widely to the potential areas of Gofa and Gamo Zones, particularly, in Melo-Koza, Geressie, and Boreda districts with the following objectives.

2. Objectives

(1) To increase awareness among farmers, Development agents, and other stakeholders about midland maize technology with recommended packages.
(2) To improve the productivity of maize through improved production practices in the study areas.
(3) To investigate the farmer's perception toward improved midland maize technology in the study area.

3. Materials and Methods

3.1 Descriptions of the Study Area

The activity was implemented in Melokoza district of Gofa Zone and Geressie and Boreda districts of the Gamo Zone among potential maize-producing districts of Southern Ethiopia in the 2022/23 cropping season.

Melo-Koza district is located at an altitude of 900 m; longitude 036°28'07''N and latitude 06°25'03' E. It has three agro ecologies Dega (21.73%) Woyna, Dega (52.43%) and Kola (25.84%). The soil of the district is mainly clay-loam (50%), sand-loam (35%), and clay (15%). The district has two rain-seasons, 'Meher' season (from July to Oct) and 'Belg' season (from last week of Jan to April). altitude ranges from 1900-2900 meters above sea level The maximum rainfall is 600 mm, minimum 400 mm, and average annual rainfall is 500 mm. The maximum temperature is 27.5°C and the minimum temperature is 15.1 °C.

The geographical coordinates of Geressie district were located in latitude of 5° 55' 0" North, and longitude of 37° 18' 0" East. The district is classified into two agro-climatic zones, Dega 60% and Woyna Dega 40% agro climatic conditions. The average maximum temperature is 22.5 °C, which occurs in the months of December to January. The lowest minimum temperature is 10.1 °C which occurs in the months of June to August. The rainfall of the study area is bi-modal. The district receives a mean annual rain fall it varies from 2200mm-3500mm and its altitude ranges from 1340m3568m m.a.s.l. The major crops grown include: teff, wheat, barley, maize, sorghum, and millet), pulses, faba bean, chickpea, haricot bean, field pea, oilseeds, and noug.

Geographically, Boreda district located at 6° 24'00''to 6° 39'00'' latitudinal and 37° 33'00'' to 37^0 49'00'' longitudinal. The district has three distinct agro-climatic Zones, Kolla (75%), Weynadega (15%), which was the dominant agro-climatic zone, and Dega (10%). altitude ranges from 1900-2900 meters above sea level. The mean annual temperature of the district is between 32 °C -38 °C and the mean annual rainfall is 900-1100 mm. It also has a bimodal rainfall distribution such as "Belg", which is a short rain season that extends from April to June, and "Kermit" season, which is a long rainy season that lasts between June and October. Crops produce in the area such as maize, insets, sweet potato, tats, teff, barely wheat, and yams [3].

3.2 Site and Farmers Selection

The study was conducted in the Gamo and Gofa Zones of Southern Ethiopia. Melo-Koza district from Gofa and Geressie and Boreda district from Gamo Zone were purposively selected based on the potential for maize production. 2 Kbeles from Melo Koza namely, Fira Shuma and Pircha Kebele, and 23 farmers were selected. Similarly, Zaga Kebele from Geressie and Kodo-Awusata Manuka Kebele from Boreda district were selected purposively based on the availability of sufficient farmland, willingness to participate, and potential of the area for maize production (Table 1). The farmers were selected in collaboration with the Kebele Development Agents of the respective districts. These 41 farmers were grouped into 4 clusters.

Table 1. Indicate area Covered by Large Scale Demonstration (LSD) on maize technologies

Region	Zone	District	No. of selected farmers		Varieties	No clusters	Hectares
			Male	Female			
Southern Ethiopia	Gofa	Melokoza	16	7	BH-546	2	10
	Gamo	Geressie	8	-	BH-546	1	5
	Gamo	Boreda	9	1	BH-546	1	5
	Total		33	8			

3.3 Mode of Implementation

After reaching an agreement with the farmers on the implementation of the activities, training was provided for 72 farmers, 13 Development Agents, and 17 administrative bodies (Table 2). The training was focused on their characteristics, type, and amount of fertilizers used along with the time of application, crop management practices, and postharvest activities. The training materials were printed and dispersed to the agricultural experts and development agents.

Table 2. Trainings given by the research center to farmers and development agents

S. No.	Participants	Districts						Total
		Melo-Koza		Geressie		Boreda		
		Male	Female	Male	Female	Male	Female	
1	Farmers	23	7	17	1	19	5	72
2	Development Agents	2	1	5	1	3	1	13
3	Administrative and Others	4	-	7	-	5	1	17
Total		**29**	**8**	**29**	**2**	**27**	**7**	**102**

3.4 Responsibility of Stake Holders During the Demonstration

The stake holders involved and their responsibility in the demonstration was shown here under (Figure 1).

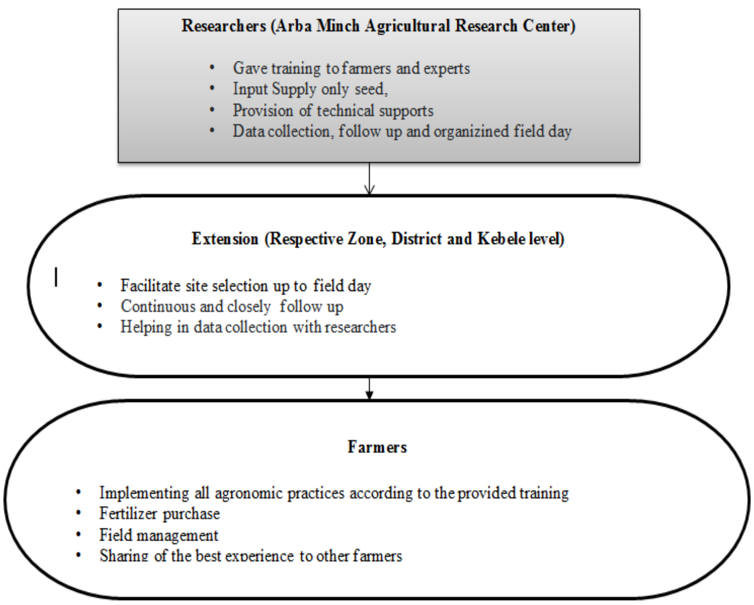


Figure 1. Responsibility of the stakeholders in the demonstration.

3.5 Implementation Design

The seeds were supplied by the Arba Minch Agricultural Research Center in collaboration with the district experts and Development Agents of the respective Keeble's. Ploughing, weeding, and other agronomic management practices were applied by farmers according to the recommendations (Table 3).

Table 3. Agronomic recommendations used for maize production

No	Practices	Recommendations/ technologies
1	Type of variety used	BH546
2	Land size (ha)	Melo-Koza (10), Geressie (5) and Boreda (5)
3	Number of clusters	Melo-Koza (2), Geressie (1) and Boreda (1)
4	Land preparation	3-4 times ploughing with maresha
5	Sowing time	Beginning of March
6	Seed rate (Kg ha^{-1})	25
7	Planting depth(cm)	5, 1-2 seed/hole through drilling
8	Spacing(cm)	75 cm between rows, 25 cm between plants)
9	Fertilizer rate (Kg ha^{-1})	NPS: 100, UREA: 150 (1/3 at planting and 2/3 at knee height)
10	Weed Management	Twice hand weeding at 25-30 days and 55- 60 days
11	Disease and pest control	Pre-sowing treatment with chemical
12	Harvesting	3-4th months

3.6 Evaluation and Monitoring

Evaluations were conducted with farmers and interested organizations at every stage of development. Farmers and other stakeholders had the opportunity to see the varieties and assess them through observation, particularly during the germination, flowering, and harvesting periods. farmers sow the seeds on their farms according to the provided training and follow-ups and essential advice from respective researchers and extension agents was given and on-farm knowledge-sharing sessions were undertaken.

3.7 Method of Data Collection

The grain yield data was taken from an area of 2m x 2m in the form of quadrat estimation (from the highest, medium, and lowest performed crops per field) from fields of 20 randomly selected farmers. Farmers' feedback on the demonstrated technology (likes and dislikes, which form the basis for the plant breeding process) and farmers' perceptions toward the technology were also collected using check lists through interviews and discussions.

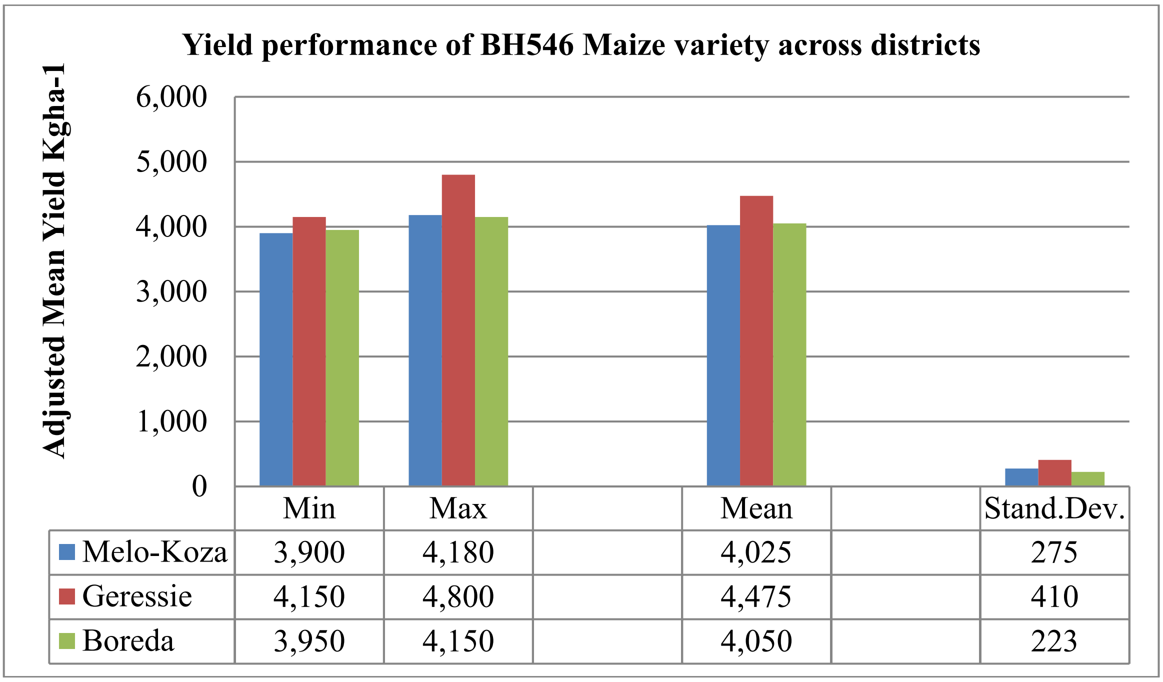
3.8 Method of Data Analysis

The collected grain yield data was entered into SPSS (Version 27) and analyzed using mean, minimum, maximum, percentages standard deviation and presented using tables and graphs. Farmers' perception was analyzed using Likert scale using a mean score. The farmer's feedback was analyzed and interpreted qualitatively.

4. Results and Discussion

4.1 Grain Yield Performance of BH546 Maize Variety

The adjusted mean grain yield recorded in the areas were 4,025, 4,475, and 4,050 Kg ha^{-1} from Melo-Koza, Geressie, and Boreda respectively (Figure 2 and Figure 3). The variety has a good yield with the Ethiopian national average yield of maize of 41.79 Qt ha^{-1} [14]. The result is lower than the study conducted in the Gurage and Yem Zones of Central Ethiopia [15]. These yields are also below the global average of 5.1 tons per hectare [16]. In spite of the inevitable variability in performance between and even within districts, the yield performance of the BH546 variety was promising.



	Min	Max	Mean	Stand.Dev.
Melo-Koza	3,900	4,180	4,025	275
Geressie	4,150	4,800	4,475	410
Boreda	3,950	4,150	4,050	223

Figure 2. Adjusted mean yield performance of BH546 Maize variety across districts (n = 20).

Figure 3. Sample showing field level performance of BH-546 Maize variety at Geressie district.

4.2 Farmers Perception Toward Maize Technology in Cluster Approach

6 positive and 3 negative questions with Likert scale values were prepared. Farmers were asked to give a **score:**

*For positive perception values were agree = 1, disagree = -1, do not know = 0.

**For negative perception values were agree = -1, disagree= 1, do not know = 0.

In terms of farmers' perceptions collected in the form of interview, on average, all farmers positively perceive on the variety has good germination performance, high yield as compared to former varieties, high yield as compared to former varieties and seed uniformity (Table 4).

Table 4. Farmers Perception on CBLSD of maize technologies at Melo-Koza, Geressie and Boreda Districts (n = 20)

No.	Perception	Agree	Disagree	Do not know
	Positive perception*			
1	The variety has good germination performance	1		
2	More number of cobs per plant		-1	
3	High yield as compared to former varieties	1		
4	Seed uniformity	1		
5	Resistance to wind damage	-1		
6	Good ability to grow in residual moisture	1		
	Negative perception**			
1	Its taste is not that much good as others			0
2	Difficult to thresh		1	
3	Easily attacked by pest		-1	

4.3 Field Days and Farmers Feedback

To raise farmer's awareness on the performance of the maize technology, field day was organized. Among these farmers Development Agents, researchers and other experts, administratives and other special guests were others invited. A total of 91,54 and 60 participants from Melo-Koza, Geressie and Boreda respectively were attend the field events (Table 5). The technology was promoted through brochures, leaflets, Facebook, South TV and radio to those who couldn't participated in the program directly. Farmers appreciated the variety demonstrated, its Agronomic practices and approaches compared to their former cultivars and agronomic practices. A Farmer-extension-researcher linkage creates opportunity for jointly participation in problem identification, planning, implementation and finding solution to the society using down to top extension approaches.

Table 5. Number of participants for the field day events

S No	Training Participants	Districts					
		Melo-Koza		Geressie		Boreda	
		Male	Female	Male	Female	Male	Female
1	Farmers	45	12	32	6	30	11
2	Development agents	2	2	3	-	3	1
3	Other experts including researchers	9	1	7	-	5	-
4	Invited guests including administrative bodies	15	1	5	1	8	2
	Total	71	16	47	7	46	14

4.4 Challenges Faced Measures Taken During the Demonstration

The common challenges faced during the demonstration and the measures taken by the researchers and stake holders was here under (Table 6).

Table 6. Challenges faced and measures taken during the demonstration

No	Challenges encountered	Measures taken
1	In the beginning, some farmers were resistance to accepting the idea, because they feared the risk	Convincing and creating awareness
2	Farmers & DAs have no experience in sorghum technology demonstration	Give training and consultancy service
3	Inflation in the price of inputs (NPS and UREA)	Respective district stake holders facilitated credit
3	Shortage of rainfall	Farmers consulted to do different soil and water conservation techniques on their farm
4	'Partinium' weed infestation	Manual weeding and firing by using all able bodies of the household

4.5 Lessons Learned

- Multi-stakeholders participation in cluster based approach reduces the time of adoption of the technology in the community because of the multiple interaction of stakeholders through direct and indirect meetings.
- Cluster-based activities can create opportunities for farmers or concerned bodies to collaborate, share knowledge, and build networks.
- It needs time to convince farmers and understand existing practices, and socio-economic aspects of them before delivering the technology.
- It helps to reach more farmers simultaneously and can lead to improved productivity, efficiency, and innovation in the agricultural sector.

5. Conclusion and Recommendations

Improved maize variety with its full packages was demonstrated at the Melo-Koza district of Gofa Zone and Geressie and Boreda districts of Gamo Zone on a total of 41 farmer's fields and 20 ha^{-1} of land in clustering approach in the 2022/23 cropping season. Training was provided to farmers, development agents and other experts on agronomic practices of the commodity to increase awareness and skill of stake holders which is the main objective of the demonstration. When crop reaches to its maturity stage, field day was organized and farmers, Development Agents, District and Zone office of Agriculture and researchers were attended the field days in order to facilitate the diffusion of technologies. The mean grain yield of 4,025, 4,475, and 4,050 $Kgha^{-1}$ was obtained from Melo-Koza, Geressie and Boreda respectively which is relatively good compared to national maize productivity. Therefore, the district and Zonal office of Agriculture should expand and address the technology with its full packages to wide areas of community through different means of extension system for further production.

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