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Pre Extension Demonstration and Evaluation of Improved Maize Varieties in Meskan District,Gurage Zone, Ethiopia

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Abstract
The largest producer of maize in Africa is Ethiopia. Increased accessibility and utilization of modern inputs (such as hybrid seeds and artificial fertilizers), more effective agricultural extension, and rising consumer demands are all significant contributors to the increasing productivity in the country. Technology demonstration and evaluation played an important role in expanding fertilizers and improved seeds (recently released variety) and basic agronomic packages. Several maize varieties are released by many research centers, but those varieties does not fully reach to farmers because of the weak relationships between researchers, extension agents, and farmers. Demonstrating technology on farmers' fields is the best technique to link farmers, extension agents and researchers finally improve technology adoption and increase the production and productivity of maize. Three improved maize varieties:- BH-546, BH-549, and Shone which BH-546 as a commercial check were included in the full technological packages of maize used for on-farm demonstration. Training and consultative meetings were conducted to capacitate farmers and experts.Both quantitative and qualitative data were collected. Finally data from different sources were triangulated to get reliable information. The maximum yield (74 kg/ha) was obtained from BH-549 variety, whereas the minimum grain yield was obtained from shone hybrids. The results, in general show existence of Yield difference among varieties. Accordingly; BH 549 had yield advantage of 3.65% and 24% over BH 545 and Shone; respectively. Application of full package and organizing via clusters has great advantage for farmers to improve productivity and share resources. Overall the varieties are well accepted and suggested to widely promote and make farmers beneficial through the concerned office of Agriculture.
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1. Introduction

The second most common crop grown worldwide is maize. Maize area coverage in Africa (SSA) increased by around 66% between 2007 and 2020. Maize grain yields have doubled in recent years, rising from 1.6 t/ha in 1990 to 4 t/ha, the highest level in sub-Saharan Africa after South Africa (FAOSTAT, 2021). In SSA nations, maize frequently occupies more than 50% of the land utilized for growing grains (Masuka *et'al*., 2017). Maize is a crucial crop in order to guarantee the financial and food security of hundreds of millions of households in SSA (Fisher *etal*., 2015). Maize makes up 45% of the calories and 43% of the total protein in grains in eastern and southern Africa, respectively (Shiferaw *et'al*.2011). In Ethiopia, maize is the most produced crop, with more than 10.5 million tons produced overall, and the highest grain yield (4.18 t/ha). Yet, it is second in terms of area covered (more than 2.5 million hectares) (CSA, 2021). The largest producer of maize in Africa was Ethiopia. Increased accessibility and utilization of modern inputs (such as hybrid seeds and artificial fertilizers), more effective agricultural extension, and rising consumer demands are all significant contributors to the increasing productivity (Tesdeke Abate *et'al*., 2015).

In other words, the impact on productivity has not been as expected mainly because the extension system has largely focused on facilitating the distribution of modern inputs and less on disseminating new knowledge due to its poor links with research centers. Because of this Ethiopia's national average maize grain yield is still quite low compared to the crop's potential and the average worldwide (Legesse *et'al*., 2020.) The average maize yield in the nation is higher than the average for Africa (2.21 t/ha), but it is lower than the average worldwide (5.80 t/ha) (FAO, 2020).Thus extension has played an important role in expanding fertilizers and improved seeds (recently released) and basic agronomic knowledge.

When demonstrations are held by farmers on their farms, they are an effective way to spread new technologies and reach many farmers (Bekele *et'al*., 2022). To reach many farmers and spread new technologies to end users, pre-extension of enhanced technology utilizing lead farmers ways would be effective. It would be conceivable for farmers to teach their peers about the new technologies once they have received training and are well-oriented (Bekele *et'al*., 2017).

Several maize varieties are released by many research centers, but the technology does not reach farmers because of the weak relationships between researchers, extension agents, and farmers, and because farmers are wary of introducing new technology out of afar of it failing. Showing the greatest technology on farmers' fields is the best technique to improve adoption and finally to increase the production and productivity of farmers.

On the other hand, despite the recent expansion of the maize seed industry, varietal replacement is still a gradual process in many Sub-Saharan African nations, including Ethiopia. Farmers run the risk of developing new diseases and pests, as well as climate change if they continue to utilize old, out-of-date varieties (Chivasa,*et'al*.,2022). In order to apply genetic improvements to agricultural productivity and support farmers' adaptation to climate change, varietal replacement is therefore necessary. This is only achieved by intensive and continuous demonstration of new and high-yielding maize varieties to replace the old and low-yielding ones. This pre-extension demonstration trial's goal was to evaluate the profitability and economic viability of the improved maize technologies in the fields of Meskan district farmers and thereby provide a great opportunity for the selection of an appropriate variety for the continued dissemination of maize technologies to multiple farmers.

2. Methodology

Description of the study area

The experimental site at Meskan is found at 08° 05' 33″ N latitude and 38° 26' 75″ E longitude with an altitude of 1,841 masl. The experimental site is mostly categorized under a semiarid climate with a long-term average annual rainfall of 987 mm, of which 84% falls during the growing season (April to October) and an annual mean temperature of 20.4°C. The soil types for the field trial were Chernozem , according to the WRB soil classification system (IUSS Working Group, 2015).

Materials Used

Three improved maize varieties—BH-546, BH-549, and Shone—as well as BH-546 as a commercial check were included in the full technological packages of maize used for on-farm demonstration. Selection of the variety was made based on agro-ecological adaptations, grain yield potentials, and their tolerance to major diseases. Each host farmer in the districts received the recommended fertilizer and seed rates.

Site and farmer selection

Training

Capacity building and consultative meetings were conducted for farmers and experts respectively. The issues concerned on the event were extension approaches, cluster farming, stakeholder's collaboration and practical training about weed and disease management and agronomic practice on the maize production packages. At Meskan district, 52 farmers, 6 development agents and 4 officials were invited on the training.

Method of data collection and analysis

Both quantitative and qualitative data were collected. The collected quantitative data were Subjected to analysis using SPSS software version 20 (frequency, mean, standard deviation and range) while qualitative data collected using group discussion, key informant interviews, field observation and focus group discussion were analyzed using narrative explanation and argument. Finally data from different sources were triangulated to get reliable information.

3. Result and discussions

3.1. Yield evaluation

Table-1: descriptive analysis result (qt/ha)

	N	Minimum	maximum	Mean	St.deviation
BH-549	8	55	74	63.8750	6.42401
BH-546	8	50	72	61.6250	7.04957
Shone	8	39	68	51.5000	9.71008

The combined mean analysis result of on farm yield performance of the varieties demonstrated is summarized in (table 1) on average, sample farmers obtained 63.87, 61.62 and 51.5 qt/ha of maize from BH-549, BH546 and shone respectively. The maximum yield (74 kg/ha) was obtained from BH-549 variety, where us the minimum grain yield was obtained from shone hybrids. The results, in general show existence of yield difference among the varieties.

$\boldsymbol{Table-2}$: Yield advantage of newly released maize varity over the standard check.

Varity	Yield	Yield advantage over the standard checks (BH 546 and Shano) in%
BH 549	63.87	3.65%
BH 546	61.62	24%
Shone	51.5	

On the other hand calculating yield advantage of the varieties helps: to show the extra benefit in percentage that the farmers' obtained from producing improved variety. Besides; to recommend based on the relative yield advantage over other varieties. Accordingly; BH 549 had yield advantage of 3.65% and 24% over BH 545 and Shone; respectively and could be calculated using the underlying formula.

Yield advantage $= \frac{yeild\ of\ new\ varity - yeld\ of\ standerd\ check}{yeild\ standerd\ chech} * 100$

Yield advantage of BH 549 over BH546=3.65%, Yield advantage of BH 549 over Shone=24%

$\boldsymbol{Table-3: independent\ sample\ t-test\ analysis\ result}$

$t-test$	$BH-549\ to\ BH-546$	$BH-549\ to\ shone$	$BH-546\ to\ shone$
$Yield\ difference\ (qt/ha)$	2.25	12.375	10.125
$Standard\ error$	2.25000	4.11633	4.24238
DF	14	14	14
$t-value$	0.667	3.006	2.387
$Significance\ level$	0.515	0.009	0.032

Further, mean yield comparison (t-test) result summarized and presented in (table 3) above also verified that as there is significant difference on mean yield performances between the varieties demonstrated; BH-549, BH-546 and Shone. Overall, the results indicated that BH 549 was the best hybrid for production due to its high genetic potential and newly released variety, which is in line with the concept that genetic advancements in grain yield can only lead to increased farmer productivity if improved varieties are quickly disseminated and old ones are replaced (Veettil et al., 2018). Frequent varietal replacement boosts productivity, reduces yield losses from devasting pests and diseases (Witcombe et al., 2016; Prasanna et al., 2020, 2021b), and climate change (Ray et al., 2012) and safeguards seed companies from losing market share. Fast varietal replacement enhances national food security and helps farmers, seed corporations, and the environment, particularly as climatic change picks up accelerates.

3.2. Yield, extension and technology gap analysis

Yield gap analysis was generally done to quantify the additional yield that could be produced with the given level of resources & improved technologies. Yield gap arises due to the difference in efficiency and management practices of farmers. The gap analysis was conducted as per the formula adopted by (Samui *et'al*. 2000) as given below:

Technology Gap (TG) = Potential yield – Average demonstration plot yield

Extension Gap (EG) = Average demonstration plot yield – Average farmer's plot yield

Technology Index = $\frac{(P_i - D_i)}{P_i}\ x\ 100\%$

Where Pi is the potential yield of soybean crop and Di is the average demonstration plot yield.

Percent of yield increase over farmer's practice =

$$\frac{\boldsymbol{Average\ demo\ plot\ yield\ - Farmer's\ average\ plot\ yield}}{\boldsymbol{Farmer's\ average\ plot\ yield}}\ \boldsymbol{x\ 100}$$

Table-4: yield, technology and extension gap analysis

Variety	Average productivity (qt/ha) Potential Yield	PED Yield	FP	Extension gap (qt/ha)	Technology gap (qt/ha)	Index (%)
BH-549	**120**	**63.87**	**56**	**7.87**	**56.13**	**66.775**
BH-546	**80**	**62.6**	**58**	**4.6**	**17.4**	**1.75**
Shone	**70**	**51.5**	**53**	**-1.5**	**18.5**	**-3.57**

The results of the demonstration showed that the highest (63.87 qt ha^{-1}) mean grain yield recorded from BH549 variety followed BH 546 (62.6 qt ha^{-1}). The overall findings of the experiment revealed that BH 549 variety is highly promising both in terms of its great yield advantage and farmers' preference.

The technology gap (TG) observed from BH549 variety 56.13 qt ha^{-1}. The technology gap analysis indicates that 17.4kg ha^{-1} recorded from BH546 followed by BH549 variety. Shone variety showed a negative technology index in the district. The findings of the demonstration revealed that the extension gap (EG) is low than the technology gap (TG) in the district. The maximum extension gap (EG) observed from BH549 variety in the district. Although the highest extension gap recorded from BH 549 variety, all the demonstrated varieties showed great technology gap in all experimental sites. The great extension gap and the higher technology index indicate that the productivity of farmers' practice was extremely low. Use of local variety seeds, low level of fertilizer rate application and limited applications of other recommended production packages might be the possible reasons of obtaining the great extension gap.

3.3. Preference analysis

Farmers were interested to prioritize the main criteria's to consider in choice of maize varieties according to their environment. The preference parameters included such as: yield, disease resistance, drought tolerance, early maturity and residual biomass. From these traits yield and drought tolerance were given high attention by majority of farmers. In good rainy season, BH-546 can relatively provide higher yield than the other two varieties (BH-549 and shone), while BH-549 and Shone are highly preferable, respectively due to both drought resistant and early maturity.

As compared to the local breed, however, BH-549 and BH-546 can highly withstands the moisture stress season that provides reasonable yield to ensure the food security of the households. Finally, BH-549 and BH-546 were selected as the first and second maize variety on average by different criteria (Table 3). Though the market demands were not yet evaluated the higher yield and resistant to moisture stress could be an indication to improve the income of the community as compared to the shone locally recycled variety.

Table-3: farmers' feedback on maize variety traits

Varity	Maize variety traits					Total score	Rank
	Yield	Disease resistance	Drought tolerance	Early maturity	Residual biomass		
BH-549	5	4	5	4	5	23	1st
BH-546	4	5	5	5	3	22	2nd
Shone	5	3	3	2	2	15	3rd

4. Conclusion and recommendations

This large scale demonstration was conducted to promote improved maize varieties through cluster farming and to compare yield and yield component traits. Application of full package and organizing via clusters has great advantage for farmers to improve productivity and share resources. Therefore, center has disseminated and popularized the selected varieties to the target farmers for the last two years. The varieties were well appreciated by farmers in the areas. Moreover, farmers said "using these varieties is alleviating the existed problems on production and productivity in the areas. Maize not only for grain yield but also they used the stalk for animal feed, fire wood/fuel. Overall the varieties are well accepted and suggested to widely promote and make farmers beneficial through the Office of Agriculture. This can achieved through applying appropriate extension approach like giving training to DAs and farmers, experience sharing, field day organizing and collaborative work with stakeholders', private producers, and NGOs that with close supervision of research center.

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