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Demonstration of improved bread and durum wheat varieties in South Tigray, Ethiopia

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Abstract
This study was planned to demonstrate promising durum and bread wheat varieties to farmers, extension workers and other stakeholders; and to analyze farmers' perception towards these varieties. Four improved wheat varieties, two from each, were demonstrated in Ofla and Emba-Alaje districts in ten voluntary farmers in total. Data was analyzed using simple descriptive statistics. The average yields for mangudo and mukiye (durum wheat varieties) were 56.64 and 54.3 Qt/ha in Emba-Alaje, Ayba kebele while they were 23.36 and 24.16 Qt/ha in Ofla, Awlie-gara kebele. There was no reasonable yield difference between the varieties in the same locations but there was a huge yield difference within varieties across location. Participatory varietal evaluation was also taken at the maturity stage where evaluation criteria were set by the farmers themselves. Mangudo was ranked first in Ofla, Awliew-gara kebele, in its early maturity and spike length while Mukuye was ranked first in Emba-Alaje, Ayba kebele in its head size and number of tillers. 100% of the farmers laid their response between good and excellent for each given crop attribute. Both varieties were preferred by farmers in Emba-Alaje, Ayba kebele even they are late matured and low yielder varieties than bread wheat varieties. Bread wheat (Mekelle-4 and Besha-2) varieties also had the same trend to durum wheat varieties in both locations. The only difference that has been observed was that the yield difference within the varieties in the same location was quite different. Mekelle-4 had 17.6% and 23.8% yield advantage over Besha-2 in Awlie-gara and Ayba respectively. Farmers do not preferred both varieties in Emba-Alaje, Ayba kebele as these varieties were highly affected by septorea blotches especially Besha-2 was totally discarded.
Keywords: demonstration, durum wheat, bread wheat, yield, farmers' perception

1. Background and Justification

Wheat (Triticum spp.) cultivation reaches far back into history. It was one of the primary domesticated food crops and for 8000 years, it has been the basic staple food of the major civilizations of Europe, west Asia and North Africa. Today, the crop is grown on a huge land area than any other commercial crop and remains to be the most important food grain source for humans. Its production became prior to all crops, including rice, maize and potatoes (Curtis, et al, 2002).

Although wheat is the major crop of temperate regions, presently it is one of the most important cereal crops grown on a large scale in the tropical and sub-tropical regions of the world (Onwueme and Sinha, 1999). It is the fifth most important cereal in Ethiopia both in terms of area and production after teff, maize, barley and sorghum (Kassahun, 1996). In sub-Saharan Africa, Ethiopia is ranked second to South Africa in terms of total wheat area and production. It is mainly grown in the highland areas of the country and constitutes approximately 10% of the annual cereal production and plays a significant role in supplying the population with carbohydrates, protein, and minerals (Schulthess et al., 1997). The crop is grown at an altitude ranging from 1500 to 3000 meters above sea level (m.a.s.l), between 6-16^{0}N latitude and 35-42^{0}E longitudes. The most suitable agro-ecological zones, however, fall between 1,900 and 2,700 m.a.s.l (Bekele et al., 2000).

In spite of cultivating wheat in most parts of Ethiopia, the country is not self-sufficient in production and consequently a large quantity of bread wheat is imported every year. The domestic average yield of the crop in the country, which is 1379 kg ha$^{-1,}$ is 24% below the average of African yields and 48% below that of the world's (FAO, 1994). Food production and eventually human survival depends on land, soil and water and on the methods used to exploit these resources in a sustainable manner. The regions of highest food production have been those with favorable climatic conditions, relatively fertile soils and an adequate supply of water, among others (Getachew F., 2004).

In Tigray region, the livelihood of the vast majority of the population are highly dependent on agriculture and the highlands of Southern Zone of Tigray (E/ Alaje, E/mehoni, and ofla) districts are the potentials and major wheat growing areas. Since 2005, AARC has been working on several wheat varieties that fit area specialization and market-oriented production system at research station level. So, this research out puts must be introduced and evaluated at farmers' level by farmers in their farming practice and management. Therefore, AARC has taken the initiation to improve farmers' livelihood through on farm durum and bread wheat demonstration in southern zone of Tigray in two districts.

Bread wheat is the most important input/ raw material used for powder factories. Most of the crop used by these factories and fast foods processors is imported from abroad and other wheat producing regions of the country to fill the demand for flour processing purpose.

Durum wheat is another wheat variety that is used for Pasta and Macaroni making. It is tetraploid wheat species and traditionally grown on heavy black clay soils (Vertisols) of the high lands between 1800-2800 meters above sea level. It has very narrow adaptation and lower yield potential as compared to bread wheat. However, the data on the released durum wheat varieties in most of the durum wheat growing areas of the country is low compared to bread wheat varieties.

2. Objectives

To demonstrate the improved bread and durum wheat varieties to farmers, extension workers and stakeholders
To analyze farmers' opinion on the performance and quality of the improved varieties compare to previously introduced varieties

To popularize and disseminate the best performed bread and durum wheat varieties to a number of farmers in the study areas.

Activity1. Demonstration of Bread wheat varieties

1.3. Methodology

The study was conducted in Emba-Aalje and Ofla districts of the Southern Zone of Tigray region. One representative kebele was purposely selected from each district. Six voluntary farmers were randomly selected based on their willingness and interest to participate and allotted their land for the demonstration activity in both kebeles. Intensive orientation was given to update the farmers' knowledge and skills related to agronomic practice, protection, weed management and post-harvest management. Two improved bread wheat variety demonstration trials, Mekelle-4 and Besha-2 were demonstrated in 10m*10m land area for each variety on the farmers' field. All agronomic practices were applied uniformly to all plots as per standard recommendations for the crop. Farmers' field day was organized and held to promote and collect opinion of farmers on each variety. Participatory varietal evaluation was also carried out at both demonstration sites and famers have evaluated and ranked the best performance bread and durum wheat variety based on their evaluation criterion. Varietal evaluation attributes were set by the farmers from their own previous agronomic experience. Seed size, plant height, early maturity, disease and rust resistance capacity, frost resistivity, water lodging resistivity, lodging, number of tillers per plant, spike length, plant uniformity and emergency were the parameters used in this varietal evaluation task.

1.4. Data collected

Both primary and secondary data were collected and analyzed in this particular investigation. Secondary data were used from different literatures and primary data was collected at the field level. All research on station agronomic data, Yield data and farmers' perception at the maturity stage were collected and analyzed.

1.5. Data Analysis

Simple descriptive statistics was used to analyze the yield and farmers' perception data through frequency and tabular forms. Yield data and farmers' perception at the maturity stage were used in this analysis.

1.6. Result and Discussion

Mekelle-4 was the best performed variety than Besha-2. The average yield for Mekelle-4 was 50.86 Qt/ha in Alaje whiles it was 38.76 Qt/ha for Besha-2 which is lower than the previously introduced bread wheat varieties in the area. On the other hand, the average yield for Mekelle-4 in Ofla was 19.08 Qt/ha whiles it was 15.72 Qt/ha for Besha-2 which was highly affected by septorea disease. Mekelle-4 has 23.8% yield advantage over Besha-2 in Emba-Alaje, Ayba kebele. Comparing the yield performance of both varieties in both locations, Mekelle-4 and Besha-2 had better performance in E/Alaje district, Aybe kebele than those of in Ofla, Awlie-gara kebele. The average yield for Mekelle-4 in Ofla, Alie-gara, was 19.08 Qt/ha where as it was 15.72 Qt/ha for Besha-2. There is a reasonable yield difference between Mekelle-4 and Besha-2 in the same location in Ofla, Awlie-gara, which accounts for about 3.37 Qt/ha (17.66%). The yield difference within the same varieties across location is also significant which accounts for about 62.4% for Mekelle-4 and 59.4% for Besha-2.

The yield difference across location may came from difference in rainfall patterns and due to soil nature of the study areas as the varieties in some fields in Ofla had highly affected by waterlogging. Actually, both Mekelle-4 and Besha-2 were affected by septorea disease especially in Emba-Alaje, Ayba. But, the yield difference between varieties in Alaje is due to the fact that Mekelle-4 was affected by septorea after heading while Besha-2 was affected before heading at the vegetative stage which leads to give a lower yield. Farmers in Ayba totally discarded this variety due to its poor disease resistance capacity. In general, both varieties in Ofla district Awlie-gara kebele had low performance due to sever water lodging problems and higher rainfall patterns in the rain season.

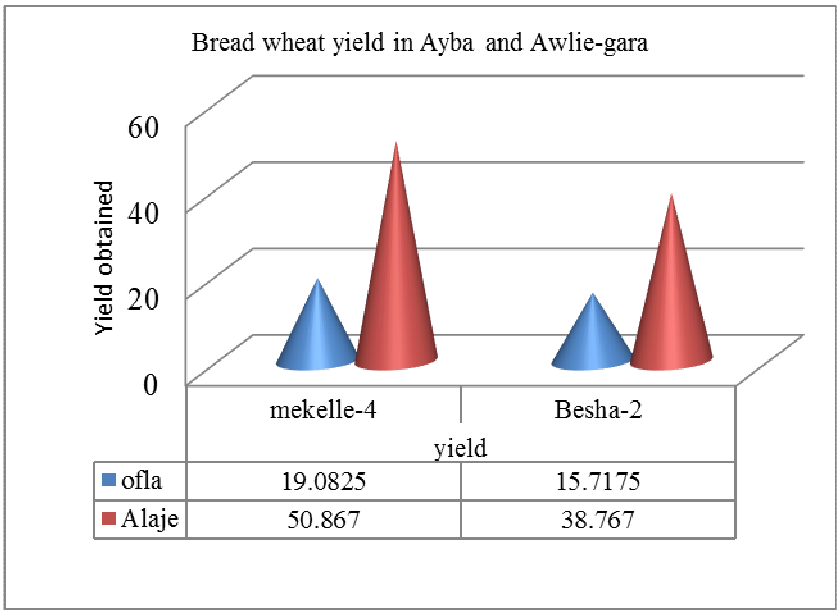

Figure1. Yield of Mekelle-4 and Besha-2 in Ayba and Awlie-gara

1.6.1. Participatory varietal evaluation

Farmers in both study areas have set out their own crop attribute measures/characteristics from their experience on how they select a best variety from lists of given varieties practiced at their field. Therefore, number of tiller, head size/heading, disease and rust resistance, seed size, frost resistance, early maturity, resistance to waterlogging, lodging capacity and plant height were the major crop attributes identified and used to evaluate the varieties by the farmers. Hence, mekelle-4 was ranked as first and Besha-2 second. Even though Besha-2 was ranked as second, it was negatively perceived by farmers based on the crop attributes used in their evaluation criterion. Farmers in Emba-Alaje had negatively perceived for Besha-2 that they do not want to see this variety in their field once again.

Table1. Varietal evaluation and ranking given by farmers

Crop attributes	Location of demonstration					
	Ofla, Awlie-gara			E/Alaje, Ayba		
	Mekelle-4	Besha-2	Rank	Mekelle-4	Besha-2	Rank
Number of tillers	1	2	1st = Mekelle-4	1	2	1st=Mekelle-4
Head size	1	2		1	2	
Disease and rust resistance	1	2		1	2	
Seed size	1	2		1	2	
Frost resistance	2	1	2nd= Besha-2	2	1	2nd=Besha-2
Early maturity	1	2		1	2	
Water lodging resistance	1	2		1	2	
Lodging capacity	1	2		1	2	
Plant height	1	2		1	2	

Source: farmers' evaluation result

1.6.2. Farmer's perception

Post-harvest perception was not ye collected and analyzed in both locations but farmers evaluate these varieties at maturity stage. Even though post-harvest quality of both varieties were not collected and analyzed, farmers in the both study areas totally discarded Besha-2 variety that they don't want to see it again on their fields especially in Emba-Alaje, Ayba kebelle. Mekelle-4 was ranked first in both study areas where its grain and biomass yield was better than that of Besha-2 which indicates that Besha-2 is more susceptible to septorea than Mekelle-4. Farmers in both area preferred Mekelle-4 due its lodging, plant height, plant population (tillers) and spike length. But it is susceptible to septorea disease which results in declined in yield. Besha-2 on the other hand, was ranked second due to its poor disease resistivity, poor plant population and height, short spike length and late maturity.

Activity2. Demonstration of improved durum wheat varieties

2.3. Methodology

The study was conducted in two districts of the highlands of southern zone of Tigray region particularly in Ofla, Awlie-gara and Emba-Alaje, Ayba, kebeles of the two districts.

Two candidate durum wheat varieties called mangudo and mukiye were used as demonstration trials in both areas. A total of 10 voluntary farmers, 5 from each kebels were selected based on their willingness and interest to participate and allotted their land for the demonstration activity. The number of beneficiary farmers was limited to 10 based on the resource availability and transportation facilities of the center as well as the core process. All agronomic practices were applied uniformly to all plots as per standard recommendations for the crop. The land size used was 10*10 m per variety in all the participant farmers. Recommended seed and fertilizer rates were used in addition to row planting. A continuous follow up and supervision was held for better management and farmers' field day was organized to promote the varieties and collect opinion of farmers on each variety. Participatory varietal evaluation was carried out at the maturity stage of the varieties and farmers had ranked the variety based on their own evaluation criterion. The methodology used for selection was: first, farmers had set out their evaluation criteria second; farmers were grouped in to four to five groups with a maximum of 5 farmers within a group. Four groups with five individuals within a group were used in Ofla while five groups which comprised of five individuals within a group were used in E/Alaje. Finally farmers evaluated the varieties based on the crop attributes they set out themselves. Yield and perception data on the maturity stage were collected and analyzed.

2.4. Result and discussion

The average yield for mangudo and Mukiye in Emba-Alaje, Awlie-gara, were 56.64 and 54.31 Qt/ha respectively as shown below in (
). But, these varieties yielded about 23.69 and 23.02 Qt/ha for mangudo and mukiye in Ofla, Awlie-gara kebele respectively. Average yields for Manngudo and Mukiye in Emba-Alaje, Ayba were much more higher than that of in Ofla, Awlie-gara which accounts for about 58.76% and 55.5% yield increment. But, there is no reasonable yield difference (3.31%, 4.11%) between varieties in the same location in both Aliew-gara and Ayba respectively. This indicates that both varieties have almost the same performance at Awlie-gara.

Table 2. Yield obtained from each varieties

	Location			
	E/Alaje (Ayba)		Ofla (A/gara)	
	varieties		varieties	
	Mangudo	Mukiye	Mangudo	Mukiye
	Mean	Mean	Mean	Mean
Yield (Qt/ha)	56.64	54.31	23.02	23.69

2.4.1. Farmers' perception and varietal evaluation

Farmers have positively perceived to Mangudo Variety and ranked it first in Ofla, Awlie-gara in its number of tillers, spike length, maturity, water lodging resistance and plant height. But, farmers in Ayba preferred Mukiye and they ranked it first and is best in its head size, water lodging resistance and number of tillers with expected better yield.

Table 3. Ranking of varieties based on scores for each crop attributes

Crop attribute	Ayba, Ayba			Ofla, Awlie-gara		
	Mangudo	Mukiye	Ranking	Mangudo	Mukiye	R
Spike length	9.5	10		9.5	9	1=Mangudo
Maturity	9	10	1=Mukiye	9	9	
Plant height	10	10		10	9.5	
Disease resistance	10	10		10	10	
Lodging	10	9		9.5	9	
Water lodging cap.	9.5	10	2=Mangudo	9.5	9	2=Mukiye
Seed size	10	9.5		9.5	9.5	
Number of tillers	9.5	9.75		9.5	9	
Heading	9.5	9.75		10	9	
Average score (%)	**96.7**	**97.8**		**96.1**	**94.4**	

The varieties with the highest average score values in percent are preferred by farmers in the study areas. Therefore, Mukiye scored about 97.8% in Ayba whrere Mangudo scored about 96.7% based on farmers'

evaluation. Moreover, mangudo scored about 96.1% in Awlie-gara while the average percentage score for mangudo is 94.4%.

Table 4. Farmers' perception based on some crop attributes

Crop attributes	Perception	location for demonstration trials			
		Ofla, Awlie-gara		E/Alaje, Ayba	
		Durum wheat variety trials		Durum wheat variety trials	
		Column N %	Column N %	Column N %	Column N %
Number of tillers	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	18.2%	9.1%
	Very good	66.7%	33.3%	45.5%	27.3%
	Excellent	33.3%	66.7%	36.4%	63.6%
Head size	Very poor	.0%	16.7%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	16.7%	9.1%	.0%
	Very good	83.3%	16.7%	27.3%	36.4%
	Excellent	16.7%	50.0%	63.6%	63.6%
Disease and rust resistance capacity	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	9.1%
	Very good	50.0%	.0%	27.3%	36.4%
	Excellent	50.0%	100.0%	72.7%	54.5%
Seed size	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	.0%	.0%
	Very good	33.3%	16.7%	36.4%	9.1%
	Excellent	66.7%	83.3%	63.6%	90.9%
Frost resistance	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	10.0%	.0%
	Very good	25.0%	.0%	10.0%	.0%
	Excellent	75.0%	100.0%	80.0%	100.0%
Early maturity	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	9.1%	.0%
	Very good	66.7%	16.7%	27.3%	9.1%
	Excellent	33.3%	83.3%	63.6%	90.9%
Water lodging tolerance	Very poor	0.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	.0%	.0%
	Very poor	50%	25.0%	27.3%	.0%
	Excellent	50.0%	75.0%	72.7%	100.0%
Lodging capacity	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	.0%	.0%
	Very good	100.0%	16.7%	9.1%	27.3%
	Excellent	.0%	83.3%	90.9%	72.7%
	Not applicable	.0%	.0%	.0%	.0%
Plant height	Very poor	.0%	.0%	.0%	.0%
	Poor	.0%	.0%	.0%	.0%
	Good	.0%	.0%	.0%	9.1%
	Very good	66.7%	20.0%	36.4%	18.2%
	Excellent	33.3%	80.0%	63.6%	72.7%

2.5. Conclusion and Recommendation

2.5.1. Conclusion

- Bread wheat varieties in both Ayba and Awlie-gara have poor yield performance comparing to previously introduced candidate varieties where they are highly susceptible to septorea and other related diseases.
- However, the yield for Mekelle-4 is still quite good in Ayba where the average yield for Besha-2 is much lower than the previously introduced improved bread wheat varieties in both areas.

- Both mangudo and mukiye had well performed in E/Alaje, Ayba kebele and had better economic importance to producers as the market price for these varieties is assumed to be higher than the local and bread wheat varieties being cultivated in the area.
- Agro-processors will have the access for good quality durum wheat varieties nearby their area if these varieties are disseminated to a large number of producers in the area which will reduce the import exchange currency of the country.
- Promoting farmers with promising yield and quality durum wheat varieties enable to adopt cultivation of economic value crops and market oriented produces which will enhance their economic wellbeing and ensure food security as well.
- Therefore, Mekelle-4, Mangudo and Mukie have to be scaled out to a large number of farmers in Emba-Alaje and other areas with the same agro-ecology and soil types in the highlands of southern zone, Tigray region.

2.5.2. Recommendation

- Office of Agriculture, research centers and other stakeholders should work cooperatively to scale-out the high yielding and economically valuable bread and durum wheat varieties to a large number of growers in Emba-Alaje.
- A market linkage among producers and agro-processors is also a mandatory task to popularize and better scaling-out of the varieties to a large of growers in the area.

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