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On-farm Demonstration and Evaluation of Quality Protein Maize (*Zea mays L.*) in Central Zone of Tigray, Northern Ethiopia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Maize is one of the crops which play a significant role in improving food and nutritional (protein) security of resource poor households. The study was conducted to familiarize farmers with improved maize production technologies and assess farmers' perception on improved maize variety. The project was implemented at Merebleke, Adwa, Ahforom and Tahtay Maychew districts of Central zone, Tigray during 2019/ 2020 production year. A total of sixty beneficiary farmers were participated in this demonstration. Melkasa 6Q and one local check were demonstrated on 0.125 to 0.25 hectare depending on the availability of land. The result of the non-parametric test: (1-tailed) Wilcoxon Signed Ranks Test showed statistically significant grain yield difference between Melkasa-6Q and local cultivar. The perception data also showed the yield attributes of the improved

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variety such as cob size, number of ears per plant, earliness to maturity, seed uniformity, tolerance to moisture stress and grain yield was better for Melkasa 6Q than the local cultivar. Therefore, the new variety should be further promoted to large number of farmers under wider areas of similar agro ecologies.

Keywords: Demonstration; evaluation; grain yield; maize; QPM.

1. INTRODUCTION

Maize (*Zea mays*) is of paramount importance serving as source of food and industrial raw material for industries such as brewery and confectionary [1,2,3] of many African populations. Nearly one-half a millennium later, maize has made a distinct imprint across African landscapes with nearly 95% of harvests used for human consumption due to easy to process, low cost than other cereals [4]. After its introduction from New World explorers in the 16th century, maize quickly rooted itself as a main ingredient in local cuisine due to its relatively high grain yield, low labor requirements, livestock feed, flour mills, productivity and favorable storage characteristics.

Maize is the dominant staple food crop in much of Eastern Africa. In Ethiopia maize is first in terms of total production and second in area converges of all cereal crops produced. Most people in the Ethiopian maize belt rely on maize as the highest percentage of energy in the diet. It is also becoming a major staple food as the price of tef, wheat and barley is rising beyond the means of resource-poor consumers and the production of these staple crops fall short of household needs.

Despite its poor nutritional value particularly low in the limiting amino acids: tryptophan and lysine [5,6], maize is a prominent staple food especially in Eastern and Southern Africa. To overcome these shortcomings, maize should be consumed with protein enriched foods such as meat, milk and beans which are relatively expensive. This drove scientists to search alternative ways to increase protein balance [7] for those who daily and regularly produce and consume maize, aiming to tackle malnutrition and improve growth and health, particularly in young children [8]. According to [9] identification of Opaque-2 mutant gene as the most amenable genotype for use in breeding program for Quality protein maize (QPM) had changed the opinion of people about nutritive quality of maize. Vasal [10] also reported as efforts by breeders at the international maize and wheat improvement center (CIMMYT) finally yielded varieties with high lysine and tryptophan contents and proved to have positive results towards malnutrition. The resulting maize is thus known as quality protein maize (QPM) which has twice the lysine and tryptopham, making its protein quality comparable to that of milk and has much lower ratio of leucine to isoleucine than normal maize. QPM is of enormous advantage over normal maize [11]. It is a common phenomenon that many African babies are being fed with maize-base diets as substitution foods. Normal maize feeding infants are vulnerable to disease and malnutrition [12]. This probably imply the need to replace normal maize with QPM. Thus, it is important promoting new varieties of maize rich in protein, much more nutritious than local varieties. Recent research outputs shows that quality protein maize (QPM) has potential to augment healthy growth and protein metabolism in the rural poor who consume maize on a daily basis.

Quality Protein Maize is a cheap source of protein, given that farmers can grow, manage, harvest and consume it in the same way they do in conventional maize varieties [13]. The variety has higher concentration of lysine and tryptophan than conventional maize, making its protein quality comparable to that of milk. QPM therefore has a tremendous potential to improve nutrition and health. Quality protein maize varieties are nowadays acknowledged as a protein source to enhance the protein deposition and provide an improved amino acid profile compared to common maize types. Therefore, the aim of this study was to demonstrate, evaluate, create awareness and asses farmers perception on quality protein maize variety to meet protein needs of the resource-poor farming families through demonstration of Melkasa-6Q variety in IFAD-PASSIDEP (International Fund for agricultural Development/Participatory Small Scale Irrigation Development) constructed irrigation schemes.

2. MATERIALS AND METHODS

2.1 Description of the Study Areas

The demonstration of quality protein maize was implemented in four Districts of Central Zone of Tigray, namely, Mai-harmazPeasant Association (PA) from Mereb leke District, Wuhdet from

Tahtay maichew District, Mytium from Adwa District and Hoya-medebkebele from Ahferom District (Fig. 1) of IFAD irrigation schemes.

2.2 Beneficiary Farmer Selection and Field Activities

Beneficiary farmers were selected in collaboration with respective district office of agriculture, development agents and local administrative bodies of the selected kebelles. A total of 60 beneficiary farmers were selected based on interest for QPM maize production, gender consideration, having adjacent farm land and poor or disadvantaged households but can work and believed to improve their livelihood. From the total beneficiary farmers, 30% were female- headed households.

This demonstration activity was carried out using QPM maize variety Melkasa 6Q and one local cultivar as a local check. The two varieties were planted side by side and applied similar agronomic practices as per recommendation to the crop. Each hosting farmer allocated 0.125 to 0.25 hectare plot of land for each variety and spaced 40 cm and 70 cm between plants and rows, respectively. Planting was done by manual drilling along the rows on the basis of 25 kg ha^{-1}. All recommended rate of NPSB and one third of urea was applied at planting and the remaining amount of urea was applied just after second thinning (35-40 days after planting). The other agronomic practices were applied equally to each variety as per the recommendation of the crop.

2.3 Input Distribution

IFAD/PASSIDP-II Supported Melkasa 6Q variety required for the demonstration to the respective kebelles (DAs and local administrations) were secured from Ethiopian Institute of Agricultural Research through Aksum Agricultural Research Center. Seeds were provided to selected beneficiary farmers after providing training by Aksum Agricultural Research center researchers. Farmers also agreed to return back the seed in kind after harvest which can be used for the next season.

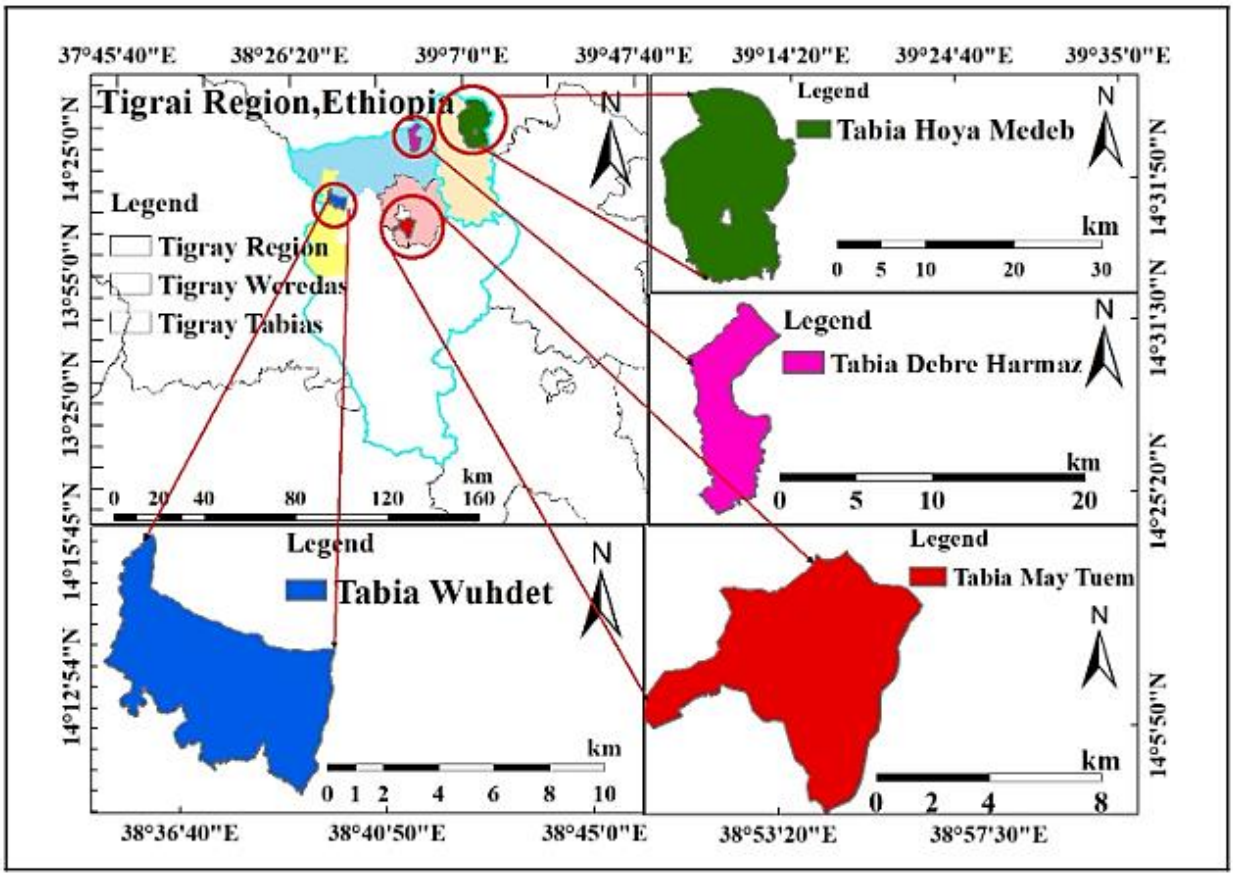

Fig. 1. Location Map of study areas

Table 1. Number of participants attending the field day and experience sharing visit at Adwa

Field day participants										
Districts	**Farmers**		**Experts**		**Researchers**		**Administrative bodies**		**Total**	
	F	**M**	**F**	**M**	**F**	**M**	**F**	**M**	F	**M**
Mereb leke	7	31	6	3	3	10	1	3	17	47
Adwa	5	21	-	2	-		2	5	7	28
Ahferom	4	25	1	2	-	-	-	2	5	29
Tahtay maychew	6	25	2	3		-	-	2	8	30
Total	22	102	9	10	3	10	3	12	37	134

2.4 Field day and Experience Sharing

Field days was organized at Adwa (Table1). The performance of the technologies was evaluated and communicated to different stakeholders such as farmers, experts, seed multipliers as well as district administrators. The demonstration created an opportunity for a large number of farmers to visit the demonstration and experiences were shared among farmers of many districts. Finally broadcast using mass Medias (Radio, Television and website) to reach a large community.

2.5 Data Collection and Analysis

Both agronomic and social data were collected. Agronomic data were collected from randomly selected beneficiary farmers from a $4m^2$ randomly delineated quadrants of the two varieties. Yield data collected from 4 m^2 area was converted to hectare. The collected data were analyzed and presented in the form of frequency, mean and percentage. In addition to the agronomic data, the social data, perception on some attributes of the commodities was collected from both primary and secondary sources. Primary data were collected randomly from hosting farmers using semi-structured questionnaire. The secondary data were gathered from various sources such as respective District office of agriculture, Axum Agricultural Research Center, and official reports. The social data were analyzed using simple descriptive statistics such as mean, frequency, percentage and range.

3. RESULTS AND DISCUSSION

3.1 Yield Performance of Melkasa 6Q

The yield performance of Melkasa 6Q is presented in (Table 2). The non-parametric test: (1- tailed) Wilcoxon Signed Ranks Test showed statistically significant grain yield difference between Melkasa 6Q and the local cultivar. The result showed that the average grain yield performance of Melkasa 6Q was 3306.9 kg ha^{-1} which was higher than the local cultivar. This difference might be attributed due to the agronomic parameters such as good plant stand, number of ear per plant, cob size, and earliness to flower and mature, tolerance to disease and pests and others. The overall performance of the improved variety showed higher yield advantage over the local check variety. Based on the combined mean value of varieties over years across environments similar result was reported from the variety Melkasa-6Q (3284 kg ha^{-1}) by [14]. In contrary lower yield was reported by [15] for Melkasa 6Q tested at different sites which was 1726 kg ha^{-1} at Adada, 2471 kg ha^{-1} at Kile, 2100 kg ha^{-1} at Dujuma and 23.47kg ha^{-1} at Wahil.

3.2 Farmers' Perception

Farmers selected the best performing variety based on fourteen pre and post-harvest features of the crop (Table 3.). The criteria used to select best variety were earliness, cob size, grain yield, stover yield, seed color, seed uniformity, easiness for threshing, tolerance to pests and diseases, tolerance to moisture stress and market preference by consumers.

Based on the above perception data, beneficiary farmers selected the improved variety over the local variety. Large majority of the beneficiaries responded that they are satisfied with overall performance of the new variety and showed interest to re-plant their fields in the next production season. Melkasa 6Q variety is also recommended for people who are with severe malnutrition problem. Unlike the improved maize variety, more than 75% of the sample users had given negative response towards the local variety. The local variety was found weak with respect to most of the parameters such as cob size, seed size, grain yield, earliness to mature and others.

Table 2. Average grain yield (kg/ha) of QPM Melkasa-6 variety

Parameter	N	Mean	Std. Deviation
Grain yield (kg ha^{-1})	30	3306.90	207.064

Table 3: Farmers' level perception on pre and post-harvest attributes on Melkasa-6Q maize variety in 2019/2020 irrigation production season

Slno.	Technology attributes	Perception level (%)			
		Poor	No change	Good	Very good
1	Earliness to mature	0	0	50	50
2	Comb size	0	22	56	22
3	Grain yield	0	0	100	0
4	Stover yield	44	33	22	0
5	Easiness to thresh	0	10	70	20
6	Tolerance to pest and disease	0	20	60	20
7	Resistance to moisture stress	0	20	60	20
8	Grain quality	0	20	70	10
9	Market preference	0	10	60	30
10	Seed uniformity	10	10	90	0
11	Seed colour	0	10	90	0
12	Test roasted (at green)	0	20	60	20
13	Porridge taste	0	20	50	30
14	Pancake taste	0	15	55	30

4. CONCLUSION AND RECOMMENDATIONS

According to grain yield performance and farmers perception, Melkasa 6Q variety showed better yield performance over the local cultivars in the entire tested districts. Farmers also identified grain yield, seed uniformity, seed colour, easiness to thresh, earliness to mature, cob size, porridge taste, pancake taste, and tolerance to disease and pests as the best selection criteria of maize. Finally, Melkasa 6Q variety was found to be promising in most of the attributed considered. The variety also got good acceptance to further multiply and disseminate seeds to other maize producing farmers. Therefore, bureau of agriculture and other local and international developmental organizations would better devote their effort to promoting the variety at a wider scale to similar agro ecologies. In addition, it is also important to work with seed producing cooperatives, unions and seed enterprise for sustainable supply and availability of quality seed production. Besides, it also helps in providing nutritional security to the children as well as old age peoples in the rural areas.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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