Pre-extension Demonstration of Improved Tomato Varieties at Koga Irrigation Scheme, Northwestern Ethiopia

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Abstract

Adoption of agricultural innovations is important in improving the livelihoods of smallholder farmers in Ethiopia. Adoption could be more efficient by presenting basket of technological choices with full participation of farmers. Demonstration of tomato varieties with their improved production packages was performed in Mecha district, Koga irrigation scheme, under irrigation growing condition. The objective of this research was to demonstrate improved tomato varieties with their production packages and to collect farmers and extension workers' feedback to be used by the biological researchers and for further scaling up. In addition to the actual fruit yield data, gender disaggregated farmers varietal preference was collected and analyzed with pair wise ranking technique. The result showed that one of the improved variety, Miya, has gave 36 ton/ha marketable fruit yield with 24% yield advantage on the check variety Kochero. Both the female and male farmers' group ranked the local variety, Kochero, first followed by Miya. This might be due to the fact that farmers are more experienced in cultivating and consuming Kochero variety for longer period of time or the need of developing new variety that fulfill their determined selection criteria. However, In terms of disease resistance, marketable fruit yield, and financial analysis, variety Miya was better than Kochero. Thus, adopting the improved tomato variety, Miya, could increase the profitability of the farmers and neutralize the market shock through high fruit yield and longer maturity period.

Key words: Demonstration, Gender, pairwise ranking, Selection criteria, Tomato

Introduction

Agriculture continues the most important sector contributing to the national economy, the main stay and source of livelihood for more than 85% of the population in Ethiopia. However, the sector is under developed characterized by very low productivity and impotent to meet the food security of the ever increasing population of the country. The Federal and regional governments of Ethiopia have thus started various interventions towards achieving food security and surplus production for export as well. Clearly, interv

China is the leading tomato growing country contributing nearly 30% of the world production followed by India and the United states. Egypt is found to be the only country in Africa ranking fifth in the world in terms of production. The crop is known in generating considerable income to both small and large scale farmers and provides employment opportunity to many individuals involved from production through processing.

In Ethiopia, the total area under rain-fed tomato production was 7,100 hectares with 50,150 tons of fruits (FAO, 2016). In Ethiopia, however, tomato is mainly cultivated under irrigation culture and the area under tomato and its production is expected to be higher than the aforementioned value. An increasing local culture of consumption increased the demand of tomato in the country which in turn makes tomato production more profitable and sustainable. The high demand for tomato is associated with its wide consumption in a variety of forms including row, cooked, or processed products more than any other vegetable (CSA, 2018). Strategically, it is an important cash generating crop to smallholder farmers in Ethiopia and Amhara region due to its multiple productions per season and provides employment opportunities across the value chain. Such diverse uses make tomato an important vegetable in irrigated agriculture of the country (Getahun 2015).

Even though various crop improvement research activities have been carried out in the country (Desalegn, 2002), limitation of improved tomato varieties and its production techniques in Amhara region in general and Koga irrigation command area in particular is found to be apparent (Getu, 2018; Sora 2018). As a result, adaptation of tomato varieties was carried out during the 2016 irrigation season (November to April). As a result, two varieties, Melka-sholla and Miya, were recommended based on their high yielding capacity. Hence, demonstration of these varieties with their improved production packages was imperative for smallholder farmers under irrigation. This research activity was, therefore, conducted (i) to demonstrate improved tomato varieties with their production packages, (ii) to collect farmers and extension workers' feedback to be used by the biological researchers and for further scaling up.

Materials and Methods

Description of the study area

These demonstration was implemented at Koga irrigation scheme in Mecha district. Mecha is located in West Gojam zone of Amhara region. Koga irrigation scheme is situated ----- N and ----- E longitude, 28 Km away from the regional capital, Bahir Dar city, along the main road to Addis Ababa. The dam was designed to irrigate around 7500 hectares of land. The command area was known for finger millet, maize, and eucalyptus tree plantation in earlier times under rain fed growing condition. However, currently due to the expansion of the irrigation scheme and the increased awareness on the profitability of irrigable crops, new plantation of eucalyptus tree is declining. In addition, farmers have been removing existing eucalyptus plantations permanently and shifting to irrigable crops.

Experimental sites and trial management

The demonstrations were conducted both on experimental station for verification and on farmers' plots outside the experimental station. The on-farm demonstration was conducted at two Kebeles namely "Kudmi" and "Kolela" using one host farmer at each Kebele. The target Kebeles were selected purposively based on irrigation water availability and suitability of the soil for tomato cultivation. The host farmers were also selected purposively mainly based on willingness and capacity to manage the demonstration trial. Two improved tomato varieties, Melka-shola and Miya with Kochero as a local check were used in the demonstration. Seedlings of each variety were transplanted in a 10m x 10m plot area in rows. Transplanting was performed on ridges using 100 cm and 30 cm spacing between rows and plants respectively. Fertilizers following the recommendations for tomato, 46 Kg/ha DAP and 114.6 Kg/ha Urea were applied. The whole DAP and half of the Urea were applied at transplanting. The remaining half Urea was applied immediately after the first weeding, 33 days at Kudmi and 28 days at Kolela from transplanting. The irrigation frequency was kept

at 7 days interval throughout. Pest prevention was implemented by applying chemicals such as Diazinon and Dimethoate with the rate of 0.3 ml per 0.01 m^2 and 0.1 ml per 0.01 m^2 for Bollworm and whitefly respectively. Detailed trial managements followed are presented in table 1 below. Researcher led participatory technology demonstration approach was used where seed and fertilizer were supplied by the research center while all management activities were done by the host farmers.

Table 1. Agronomic practices used during the demonstration

Activities	Kebeles	
	Kudmi	Kolela
Retranslating	After 6 days of transplanting	After 6 days of transplanting
First weeding	After 33days of transplanting	After 28 days of transplanting
Second weeding	60 days after transplanting	54 days after transplanting
1st chemical spray	One day after second weeding	7 days after 2nd weeding
2nd chemical spray	9 days after first application	9 days after 1st spray
3rd chemical spray	13 days after 2nd spray	13 days after 2nd spray
Soil type	Nitosol	Nitosol
Previous crop	Maize	Maize

Data collection

Monitoring and evaluation were carried out. Field day was organized to raise awareness and to assess farmers and extension workers reactions. The field day was organized with the help of Mecha district agricultural offices. During the field day pair wise ranking were used to weight the criteria. At the maturity stage farmers evaluation criteria for tomato variety were identified and prioritized in order of their importance (weight =1 the best criterion) for each Kebele independently. With these criteria, farmers were informed to evaluate the varieties and individual score was given to each variety. Male and female farmers were grouped

separately during the evaluation and scoring process. The result from each criterion by different farmers were added together and then ranked in ascending order (the lowest sum is the best). The sum of the preference values (scores x weight) of each variety across all criteria was used to determine the final acceptable rank of the variety (Table 2 and 3). During field evaluation 37 farmers (22 male and 15 female) in Kolela kebele and 26 farmers (20 male and 6 female) in Kudmi Kebele were participated in the variety selection process.

Table 2. Farmers' tomato selection criteria at Kudmi Kebele

No.	Male farmers		Female farmers	
	Criteria	Weighted rank	Criteria	Weighted rank
1	Lodging resistant	4th	Medium fruit size	7th
2	Circular fruit shape	8th	Disease resistance	1st
3	Resistance to disease	1st	Branching capacity	7th
4	Resistance to pests	3rd	Less amount of water/fruit	3rd
5	Shelf life	2nd	Fruit quality	4th
6	Number of fruits/plant	6th	Taste	2nd
7	Early maturity	7th	Number of fruits/plant	5th
8	Large fruit size	5th	Market preferences	2nd
9			Early maturity	6th
10			Oval fruit shape	6th
11			Shelf life	2nd

In addition, primary data was collected from host farmers who planted the demonstration using open ended questions and informal interviews to reflect what they observed during the demonstration process and presented as cases. Quantitative data such as grain yield, pod number, cost of labor, seed, and fertilizer were collected. Gender disaggregated data in terms of perceptions and preferences of farmers were also collected.

Table 3. Farmers' tomato variety selection criteria at Kolela Kebele

No.	Male farmers		Female farmers	
	Criteria	Rank	Criteria	Rank
1	Large fruit size	6th	Large fruit size	7th
2	Not perishable (Shelf life)	2nd	Yield	4th
3	Diseases and pest resistance	1st	Market preferences	2nd
4	Hard fruit coat	3rd	Taste	3rd
5	Circular fruit shape	5th	Circular fruit shape	6th
6	Early maturity	4th	More Fleshy	3rd
7	Number of fruits per plant	7th	Disease resistance	1st
8	Plant height	8th	Early maturity	5th
9	Fruit color (red)	9th	Not perishable (Shelf life)	3rd

Data analysis

Data was analyzed by employing thematic analysis technique. Simple descriptive statistics and CIMMYT partial budget and sensitivity analysis were performed. During the partial budget analysis, fruit yield was adjusted downwards by 10%. Pair wise farmers' preference ranking and Spearman's rank correlation coefficient was conducted. **S**election priorities between the two locations and groups of farmers were narrated to provide a meaningful recommendation both for biological researchers as a feedback and future interventions.

Results and Discussion

Fruit yield performance of the varieties

In terms of marketable fruit yield, variety Miya was found to be the highest with 36 ton/ha followed by Kochero with marketable fruit yield of 29 ton/ha. Whereas, variety Melka-shola was the list yielding variety at Kolela Kebele (Figure 1). In Kudmi Kebele, however, Melka-shola was the second high fruit yielder than Kochero with a fruit yield advantage of 8.8%. Kochero was found to be the list marketable fruit yielder with 25 ton/ha. The observed unmarketable fruit yield was generally higher, ranging from 3.5 to 4.6 ton/ha, at Kudmi than what was seen at Kolela that ranged from 2.5 to 3.0 ton/ha. On average, the fruit yield loss which is usually called unmarketable due to several factors ranged from 3.0 to 3.8 ton/ha.

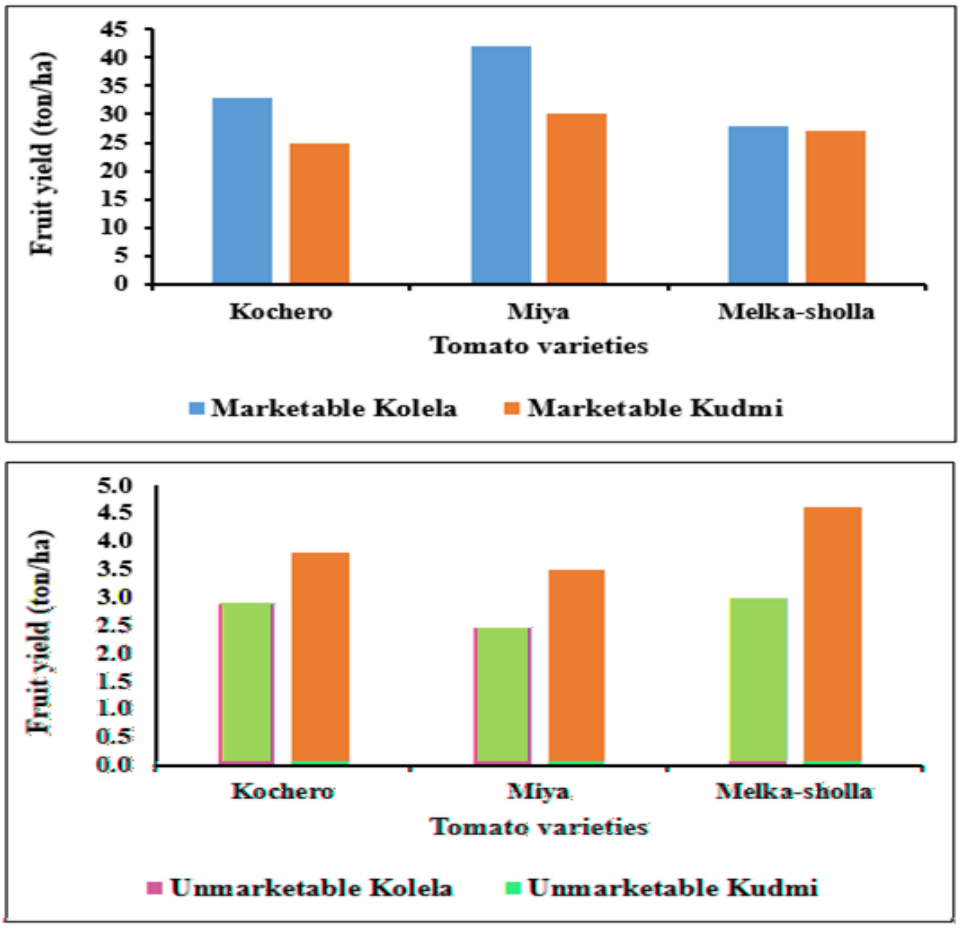

Figure 1. Marketable and unmarketable fruit yield of tomato varieties by demonstration site (Kolela and Kudmi Kebele)

Selection criteria and varietal ranking

Disease resistance was considered the top priority selection criteria of improved tomato variety at both demonstration sites unanimously by female and male farmers (Table 2 and 3). Whereas, shelf life was the second most important selection criteria both by female and male groups. Taste was the second and third most important preference only by female farmers' group at Kudmi and Kolela Kebele respectively. Whereas, the male farmers' group did not consider the taste as a selection criterion at all indicating a considerable variation in setting the section criteria by the two groups. Thus, gender disaggregation was the wright approach in selecting good tomato variety at Koga irrigation scheme. Unlike the male farmers' group, less water and high flesh content of the fruit were also considered as a selection criterion in female farmers' group.

The male farmers' group in Kudmi Kebele ranked the local variety (Kochero) as the best while Miya and Melka-shola ranked subsequently as the second and third. Kochero was more preferred than the other varieties for most of their criteria but was worst for lodging and maturity (Table 4). Miya was the best lodging resistant variety according to the male group. Whereas, Melka-shola was the best for early maturity and quantity of fruits per plant. Melka-shola was the list preferred in terms of fruit size than Kochero and Miya at Kudmi demonstration site. In addition, Miya was the second preferred variety in terms of fruit shape next to Kochero (Table 4).

Table 4. Male farmers ranking of tomato varieties based on selection criteria (Kudmi)

Criteria	Variety		
	Kochero	Miya	Melka-shola
No Lodging	3	1	2
Circular shape	1	2	3
Resistance to disease	1	2	3
Pest resistance	1	2	3

Shelf life (not perishable)	1	2	3
Number of fruits per plant	2	3	1
Early maturity	3	2	1
Fruit size	1	2	3
Total	13	16	19
Rank	1st	2nd	3rd

In a similar selection procedure, the women group in Kudmi ranked Kochero as the best variety overall and their rank overlapped for the other two tomato varieties (Table 5). The female farmers' group also ranked Miya as the best in terms of overall fruit quality such as roughness and taste at Kudmi demonstration site. Melka-shola was found to be the most preferred variety in terms of shelf life followed by Miya while Kochero showed the lost rank for shelf life by the evaluation of the female farmer's group at Kudmi (Table 5). Like the male farmers' group, Miya was ranked the best in terms of disease resistance by the female farmers' group. Whereas, Kochero was found to be the list disease resistant variety. Generally, for female farmers, Miya was the top preferred variety in terms of diseases resistance and fruit quality. Whereas, Melka-shola was more preferable for its relatively longer shelf life (low perishability), oval shape and short maturity period. Comparing Melka-shola variety with the first and second ranked varieties, market preferences with its taste prevailed as the most dominant characters by female farmers' group.

Table 5. Female farmers ranking of tomato varieties based on selection criteria (Kudmi)

Criteria	Variety		
	Kochero	Miya	Melka-shola
Medium fruit size	1	2	3
Disease resistance	3	1	2
Branching capacity	1	3	2
Less amount of water per fruit	1	2	3
Fruit quality	2	1	3
Taste	1	2	3
Amount of fruits per plant	2	3	1
Market preferences	1	2	3

Early maturity	3	2	1
Oval shape	2	3	1
Not perishable (Shelf life)	3	2	1
Total	20	23	23
Rank	1st	2nd	2nd

In Kolela Kebele, although it was ranked the worst for disease and pest resistance among the varieties demonstrated. The male farmers' group ranked Kochero as the best tomato variety (Table 6). Melka-shola was the best variety for disease resistance with short maturity period. Overall, the local variety Kochero was preferred for its yield and marketability as well as low perishability. Clearly, farmers (both male and female) had better understand in identifying the criteria to select their best tomato varieties. They unanimously emphasize on disease resistance and quality traits that attract market preferences such as taste and fruit size. Similarly, the female farmers' group in Kolela ranked the local variety Kochero as the best while it ranked worst for yield and maturity period that are also important factors for adoption (Table 7). Melka shola gave the highest yield and was preferred for short maturation period and diseases resistance. Miya variety ranked medium in all of the criteria listed by female farmers.

Table 6. Male farmers ranking of tomato varieties based on selection criteria (Kolela)

Criteria	Variety		
	Kochero	Miya	Melka shola
Large fruit size	1	2	3
Not perishable	1	2	3
Diseases and pest resistances	3	2	1
Hard coat	1	2	3
Circular shape	1	2	3
Early maturity	3	2	1
Amount of fruits per plant	1	2	3
Height	2	1	3
Red color	1	2	3
Total	14	17	23

Rank	1st	2nd	3rd

The final preference result of the two groups of farmers was similar except the female group in Kudmi. There was even difference in trait preference among women in different Kebeles (e.g., fruit size). Overall, Kochero variety was selected as the best variety for several of its traits. In addition to fruit size, late maturity in Miya is the basic problem for non-selection as to the farmers. However, in order to spread over the harvesting and marketing of tomato that has high volatile market price, late maturity should be one option to maximize the benefit from delayed harvesting.

Table 7. Female farmers ranking of tomato varieties based on selection criteria (Kolela)

Criteria	Variety		
	Kochero	Miya	Melka shola
Large seed size	1	2	3
Yield	3	2	1
Market preferences	1	2	3
Taste	1	2	3
Circular shape	1	2	3
More Fleshy	1	2	3
Disease resistances	2	2	1
Early maturity	3	2	1
Not perishable	1	2	3
Total	15	18	19
Rank	1	2	3

ranking versus actual yield

Participatory technology demonstration is considered as one of the fastest and cost-effective way of delivering the technologies. The physical measurement result and farmers preference for the two varieties differed due to market preference, which is crucial in this product. Large fruit size was important for farmers as they were dictated by the market preference. If yield

alone was considered, farmers' preference would have been unacceptable (Table 8). Melka-shola was preferred as diseases resistant.

Table 8. Farmers' varietal preference ranking and ranking based on actual fruit yield

Variety	Marketable (ton/ha)			Unmarketable (Qt/ha)		
	Kollela	Kudmi	Average	Kollela	Kudmi	Average yield
Kochero	33.0	25.0	29.0	2.9	3.8	3.4
Miya	42.1	30.0	36.1	2.5	3.5	3.0
Melka-sholla	27.9	27.2	27.6	3.0	4.6	3.8
Total yield and farmers rank						
	Actual yield (tons)	Yield at (-10%) sensitivity	Actual yield rank	Farmers' rank		
Kochero	32.4	29.1	2	1		
Miya	39.0	35.1	1	2		
Melka-shola	31.4	28.2	3	3		

A case study

Ato Semagnegn is a 38 years old farmer living in Addis Alem Village of Kolela Kebele, Mecha district. He properly managed the tomato demonstration. He has intensively inspected the tomato and managed better by constructing bed. He harvested 9 times before he left the rest due to awfully low market price. He indicated that to produce better quality tomato, avoiding fruit rotting should be the top focus of the farmers which in turn needs construction of beds. The production was good but due to the decrease of market price from 3 to 0.5 Birr/Kg he was discouraged from harvesting and taking to the market as the transaction cost was high. Now I do have no interest to harvest except for household consumption. He also noticed that working on market linkage is important in the future by indicating Kudmi Kebele was better in marketing than Kolela due to previous marketing experience and have better linkage with the market.

He also clearly noticed that Kochero variety could have stayed for 3-4 days after harvesting while Melka-shola degraded within a day coupled with its less preference in the market causes huge income loss. Melka-shola matures early, and has higher number of fruits per plant. Miya was late maturing but it would mature fairly early after the first harvest (in a week time).

Financial analysis

The net benefit from Miya was higher than Kochero while the benefit from the other varieties was approximately equal. The financial analysis was weak due to lack of time series data on costs and benefits to an overall production season. Based on the analysis Miya was the recommended variety for adoption.

Table 9. Cost benefit analysis (considering it as a market crop)

Category	Variety		
	Kochero	Miya	Melka-shola
Yield (ton/ha)*	26.1	32.45	24.80
Gross benefit (ETB)	52200	64890	49590

Loss (ton/ha)**	1.68	1.49	1.90
Value of loss (ETB)	3350	2976	3800
Price of consumed (ETB)	3350	2976	3800
Transaction cost (ETB)	6525	8111.25	6198.75
Labor and input cost (ETB)$^{\$}$	7254	7254	7254
Pesticide cost (ETB)	1020	1020	1020
Irrigation water cost (ETB)	-	-	-
Total cost (ETB)	18149	19361.25	18272.75
Net benefit (ETB)	34051	45528.75	31317.25
MRR (%)	1.87	2.35	1.71

Note: ** considers only marketable yield, ** 50% of the unmarketable yield was used for household consumption, $^{\$}$ includes labor for weeding, irrigating and harvesting. Labor cost mostly is an estimation. Net benefit excluding benefit to home consumption.*

Conclusion and Recommendations

The delivery of technology options is crucial to enhance the efficiency and sustainability of Koga irrigation scheme. The use of different groups of farmers creates an atmosphere of confidence during selection, avoids bias/blanket selection, helps to target different aspects of the technology, and hence improves overall adoption and farmers' profitability. Even if the improved varieties were ranked second as the best performing variety by the farmers, we recommend especially Miya variety to be pre-scaled up as a market price neutralization option since supply could be managed by late maturity. Farmers' preferred variety disagreed with the actual fruit yield and their predetermined selection criteria was somehow different between Kebeles (locations) and gender. Such differences remind the researcher to consider the criteria in the future research programs on one hand and participatory technology evaluation activities could better be done through gender disaggregated groups on the other hand. In addition, the selection result indicated that there must be a more elaborative effort to provide a much better yielder and market preferred tomato variety to the farmers of Koga irrigation scheme. Financial analysis on the opportunity cost of precursor and following crops needs to be done to widely recommend this production technologies in the scheme.

Reference

AARC (Adet Agricultural Research Center) (2003) Horticultural Crops Production and Associated Constraints in North-Western Ethiopia (Initial result of informal survey) Unpublished.

Aklile Masho, Alemayehu Melkamu and Alemayehu Getachew (2016) Performance evaluation of tomato varaieties for irrigation production system in Mecha District of west Gojiam Zone, Amhara Region, Ethiopia.

CSA (Central Statistical Agency) (2018) Agricultural Sample Survey for 2017/18 (2010 E.C.). Report On Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Volume I. Addis Abeba, Ethiopia.

Dessalegn, Lemma (2002) Tomatoes. Research Experience and Production Prospects. Research Report # 43, Ethiopia Agricultural Research Organization, EARO.

Getahun Dessie (2015) Open Field Performance of Tomato (*Lycopersiconesculentum*Mill.) Cultivars in the Rainy Season at Woreta, South Gondar, Ethiopia. International Journal of Scientific Research in Agricultural Sciences 2(5): 117-125. http://dx.doi.org/10.12983/ijsras-2015-p0117-0125.

Getu Kassa (2018). Tomato Value Chain Analysis in North Mecha, Bahir Dar Zuria, Fogera and Dera Woredas of Amhara National Regional State. A report submitted to program for Agribusiness Induced Growth in the Amhara region (AgroBIG), August, 2028.

Sora SA (2018) Review on Productivity of Released Tomato *(SolanumLycopersicum Mill.)*Varieties in Different Parts of Ethiopia. J Hortic Sci, 1:102.