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Participatory Demonstration and Evaluation of Bread Wheat and Teff Technologies: The Case of Urban Agriculture at Akaki Kaliti Sub-City in Addis Ababa, Ethiopia

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Abstract: The agriculture sector plays a significant role as the primary source of food and income for the farmers in Ethiopia. This study was conducted in three districts of the Akaki Kaliti sub-city of Addis Ababa city in the 2021/22 production year. Urban agriculture is the agricultural production in cities and the areas near cities for food and other purposes. In this demonstration activity, a total of 61 (47 male and 14 female) headed farmers benefited and a total of 14 hectares of bread wheat and 30 hectares of land were covered by teff. From the demonstrated technologies average grain yield of 56.66 qt/ha of bread wheat was produced and mean grain yield of 22.16 qt/ha was obtained from teff which is higher than the national average. Hence, to boost agricultural production the dissemination and adoption of improved crop varieties with full production packages requires the attention of stakeholders engaged in the agricultural sectors to use cluster farming to elevate poverty and ensure food security.

Keywords: Demonstration, Urban agriculture, Bread wheat, Teff, Akaki Kaliti, Technologies.

Research Paper

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1. INTRODUCTION

In Ethiopia, the agriculture sector plays an important role as the primary source of food and income for the farmers and is dominated by smallholder farmers who produce more than 95% of the country's agricultural production (Gebeyanesh *et al*., 2021). The agriculture sector contributes 98% of the total calorie supply and 70% of industrial raw material supplies (Janko, 2014). The sector remains largely dominated by rain-fed subsistence farming by smallholder farmers (Amsalu, 2015). Agricultural intensification occurs when the total amount of agricultural production increases due to higher productivity of inputs, or agricultural production is maintained while certain inputs are reduced. Agricultural intensification is conceived as obtaining more output per unit area of land allocated for cultivations (Börjeson and Warf, 2010). Urban agriculture can be defined as "agricultural production in cities and the areas near cities for food and other purposes uses, related transport, agricultural processing and marketing products and non-agricultural services provided by urban farmers (de Zeeuw, 2004).

Smallholder farmers in Ethiopia are characterized by subsistence agriculture with a low level of productivity in part due to the traditional production system, lack of improved farming practices, and limited supply or use of improved technologies. Urban agriculture is at a high level versatile; it can take different forms such as community gardens, home gardens, roof gardens, urban spaces, guerilla gardens, backyard horticulture, poultry and breeding and aquaculture farms (Lin *et al.*, 2015). Urban agriculture recently gets the attention of researchers, policymakers, and practitioners as a possible measure to solve the problem of the food needs of the growing urban population and to combat some of the negative effects environmental and economic effects of urbanization (Orsini *et al*., 2013). However, the sector is still characterized by low production and productivity and thus is not able to provide adequate food for the growing population as well as raw materials for emerging agro-processing industries.

Sustainable agricultural intensification practices can reduce yield differences in the smallholder sector (Wilkus *et al.,* 2021). For the sector inadequate extension advisory services; low level of adoption of improved agricultural technologies; lack of credit and mechanization services for resource-poor farmers,

inadequate supply of inputs, and poor output market linkages are among the key challenges. The Ethiopian Institute of Agricultural Research (EIAR) is one of the institutions that contribute to the development of technologies and innovations, and still working towards addressing the increasing technology demand of beneficiery. Despite the efforts made so far in generating and transferring agricultural technologies, the rate of adoption of these technologies remained low, primarily because of limited location-specific recommendations, inadequate capacity to multiply source technologies, and low demonstration.

Therefore, creating a favorable condition for wider application of proven agricultural technologies to have production and productivity is one of the priority investment areas. The rural-urban link focuses on the mutual benefit of urban and rural communities. The presenter supported the mutual exchange of goods and services, which creates positive economic growth (Christiaensen *et al.,* 2013). Despite all these widespread technology dissemination efforts, yields of major crops are still very low and the adoption rate of the technologies is minimal. The country has not fully tapped the benefits of investment made in agricultural technology generation. This is attributed to the weakness in the approaches used to disseminate the research outputs have not been visible to create excitement among the wider community and best address the different agro-ecologies, production systems, and regions of the country.

From recent experience, it has become evident that participatory scaling-up approaches involving regional research institutes, universities, and extension departments are vital in bringing impact. To this effect, a cluster-based large-scale package technology demonstration approach is adopted by the research system, particularly for major crops to create demand. Thus, this activity is intended to demonstrate proven agricultural technologies and practices of bread wheat and teff in the Akaki Kality sub-city using full package technology and large-scale clustered farm approach and thereby, contribute to improved agricultural production and productivity that would finally lead to enhanced food security and to draw an important lesson for the future agricultural technology dissemination.

2. RESEARCH METHODOLOGY

2.1. Descriptions of the Study Areas

The study areas Akaki Kality is located in Addis Ababa capital of Ethiopia and has an altitude of 2,125 meters asl. The sub-cities borders are conducive for cerial crops production out of the rest ten sub-cities (Desybel, 2020 cited in Duguma and Tebarek, 2022). Akaki Kality is located at the 8°53′40″ north latitude; Longitude 38°46′23″E. The total areas of the sub-city were 11,808 km^2 and bordered by the sub-city of Nifas Silk-Lafto and Bole to the south and north, respectively. Further to the East it's boardered by the highway at Tulu Deemtu/ Galan town (Emebet, 2018). The CSA report indicated that the sub-city have a total population of 238,355 in 2019 (Desybel, 2020 cited in Duguma and Tebarek, 2022).

2.2. Sample Size and Participants Selection

This research activity comprises two commodities which include bread wheat and teff. The total amount of seed distributed, the area covered and farmers directly benefited from these technologies conducted for the year 2021/22 were indicated in Graphs 1 and 2. The target districts and host farmers were selected purposively farmers who are willing to organize themselves in cluster farms. The site and farmer selection were done by the participation of woreda agricultural experts and kebele DAs focusing on the growing potential of bread wheat and teff. The farm operation activities like land preparation using oxen plow, planting, first and second-hand weeding, harvesting, and threshing were held by the host farmers. Holeta Agricultural Research Center supplied the recommended quantities of seeds. In this activity, a total of 61 farmers were involved out of which 47(77%) were male-headed and 14(23%) were female-headed farmers.

2.3. Types and Methods of Data Collection

The data required for this study were collected focusing on the participants in the production of bread wheat and teff on a large scale. The primary data and secondary data were considered and both qualitative and quantitative data were considered. The data were collected using an open questionnaire and focus group discussions from the large-scale farming participant farmers and published secondary data sources were also used in the study.

2.4. Methods of Data Analysis

Both quantitative and qualitative data were collected from agricultural technology beneficiary farmers. The collected quantitative data were analyzed using SPSS software version 23 (mean, yield advantage, and % yield increase) while qualitative data collected using group evaluation and field observation were analyzed using descriptive statistics tools and presented by Tables and Graphs. The yield advantage improved bread wheat and teff technologies over the national average yield per hectare were estimated using the following formula:

Yield advantage
= Average yield of demonstrated technology
− Mean National yield obtained.

3. RESULT AND DISCUSSIONS

3.1. The Demonstration Approaches of Bread wheat and Teff Technologies

The bread wheat and teff technologies were promoted to host and follow farmers using different extension techniques including training, field visits and observation, and field days. In the 2021/22 production year, training on bread wheat and teff crop cultivation

and management practices was provided for farmers, development agents, and experts at the Akaki Kaliti sub-city in three woredas (9, 11, and 12).

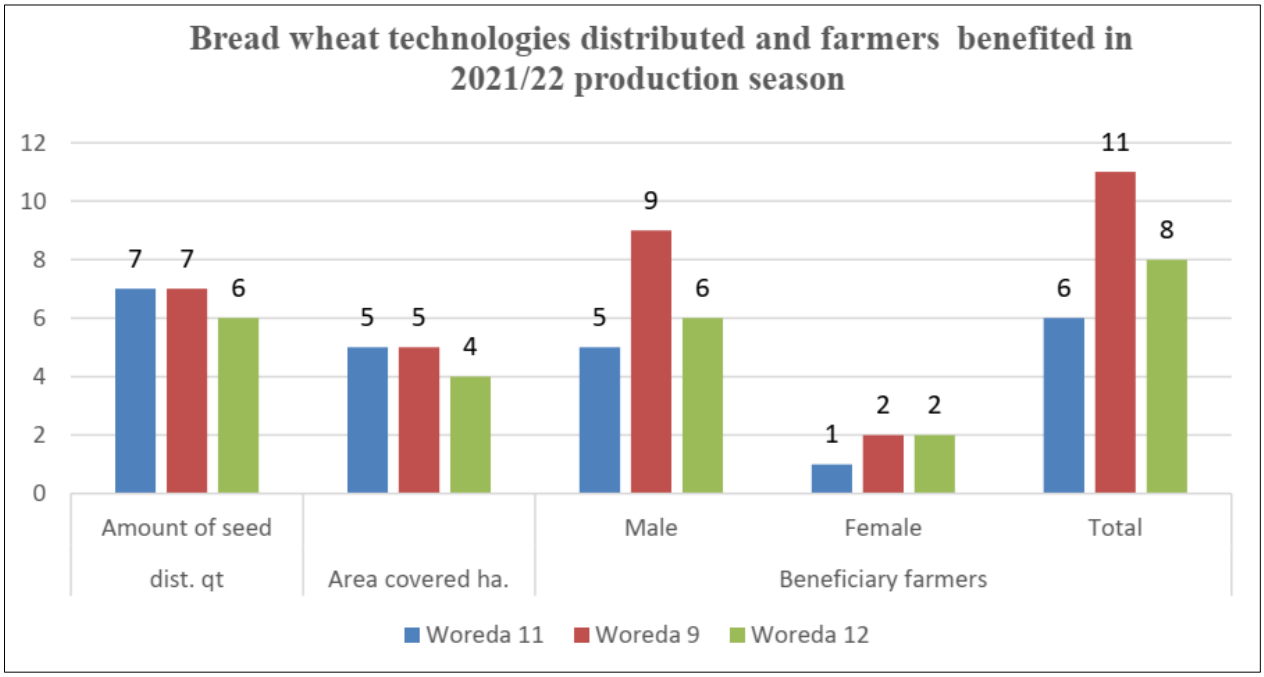
Training is one of the instruments used in extension to create awareness and improve the knowledge, skill, and attitude of farmers, DAs, and agricultural experts. The training activities that increase the need for additional agricultural production information and the important services offered to farmers were crucial (Raidimi and Kabiti, 2019). The farmers, development agents, and agricultural experts selected from Akaki Kaliti districts were trained on bread wheat and teff crop production and management practices, field clustering approaches, field follow-up, data collection, and post-harvest handling. In the training provided a total of 269 participants (186 male and 86 female) participated and out of the training participants, 87 percepts were farm households (Table 1).

Table 1: Training participants on technology adoption and production in 2021/222

Participants category	No. of training participants	
	Male	Female
Farmers	159	75
Agricultural experts	21	5
Development agents	6	3
Total	**186**	**83**

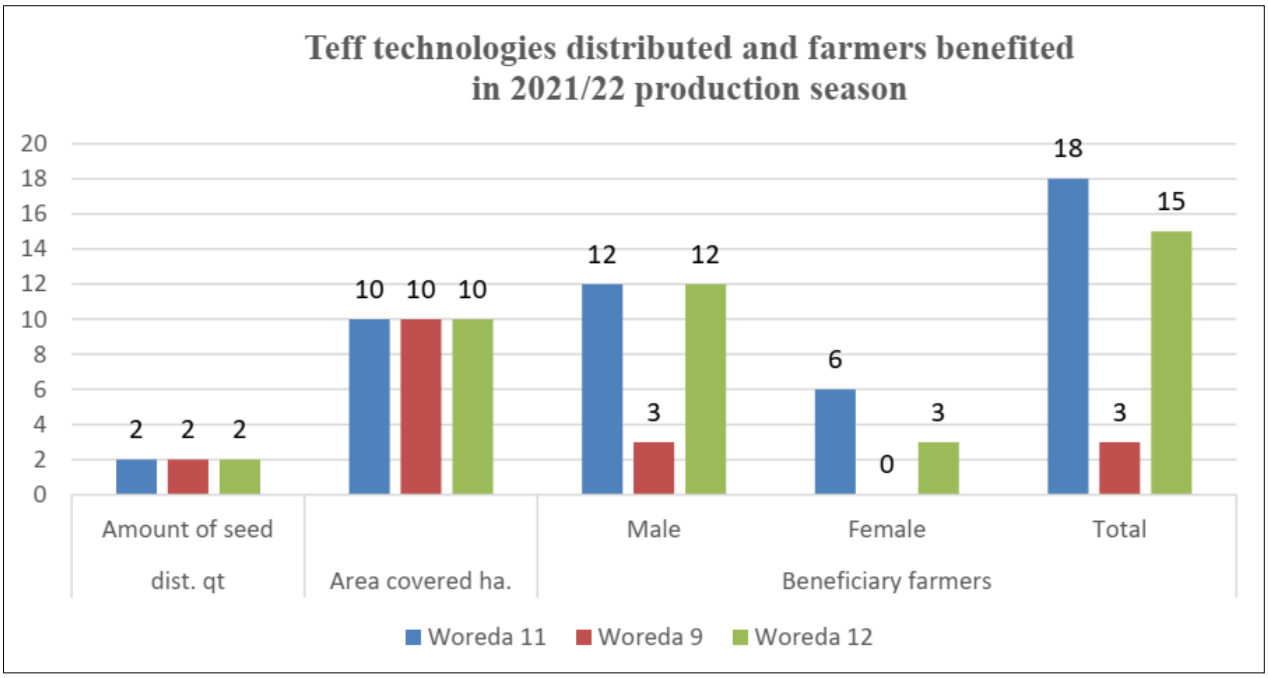
3.2. Technoligies Dessiminated to the Farmers

In this study, the improved bread wheat variety of Tay and improved teff varieties of Kora were used. As indicated in Graph 1 the total amount of Tay seed distributed was 20 quintals and 14 hectares of land covered by bread wheat. In the large-scale farming of bread wheat, a total of 25 farm households (20 male and 5 female) farmers were benefited in the three districts of the sub-city.



Graph 1: Tay bread wheat varieties demonstrated to the farmers in 2021/22

Concerning the demonstration of teff technologies on a large scale a total of 6 quintals of Kora varieties were distributed and a total of 30 hectares of land are covered. From the cultivations of teff, a total of 36 households (27 male and 9 female) farmers benefited (Graph 2).



Graph 2: Kora teff varieties demonstrated to the farmers in 2021/22

3.3. Yield Advantages of the Demonstrated Technologies

The results from the activities revealed that the mean grain yield, yield advantage and percent yield increase of the improved bread wheat and teff technologies across locations are illustrated in Table 2 and Table 3, respectively. The yield data showed that the highest average yield 58 qt/ha was obtained from the variety at Akaki Kality sub-city woreda 11 (Table 2). From this technology demonstration activity, it's revealed that increasing the bread wheat and teff output per unit area of land allocated was achieved.

The bread wheat production grand mean grain yield of the Tay variety across all locations showed that improved bread wheat technology gave a mean grain yield of 56.66 qt/ha which is higher than 31.11 qt/ha the national average (ESS, 2021/22). The yield data also revealed that there was a mean yield advantage and percent yield increment of 25.55 qt/ha and 45.07% over the national mean yield, respectively.

Table 2: Grain yield and yield advantages of promoted bread wheat technology in 2021/222

District	Average grain yield Qt/ha		Yield advantage Qt/ha	% yield increase
	From demonstrated	CSA data		
		National	National	National
Woreda 11	58	31.11	26.89	46.36
Woreda 9	57		25.89	45.42
Woreda 12	55		23.89	43.44
Average	56.66	31.11	25.55	45.07

With regards to teff cultivations the average grain yield recorded for the teff Kuncho variety showed that there is a yield advantage and increased percent yield obtained in the study areas as compared to the national average grain yield (Table 3). In the 2021/22 production year, the yield data showed that the highest mean grain yield of 23.0 qt/ha was recorded at Akaki Kality woreda 11 and the lowest mean grain of 21.5 qt/ha was obtained from woreda 9 due to poor soil fertility and poor crop management practices. When we compare the actual overall average yield with the national average yield, the average grain yield of improved variety obtained at the demonstrated districts was to the same extent better than the national average grain yield recorded during the cropping season. The data from the central statistical agency revealed that the average national teff yield obtained was 19.14 qt/ha which is lower than the demonstrated (ESS, 2021/22).

Table 3: Mean grain yield and yield advantage of teff technology in 2021/22

District	Average grain yield Qt/ha		Yield advantage Qt/ha	% yield increase
	From demonstrated	CSA data		
		National	National	National
Woreda 11	23.0	19.14	3.86	16.78
Woreda 9	21.5		2.36	10.98
Woreda 12	22.0		2.86	13.00

3.4. Technology Observation and Evaluation Approaches

The promoted technologies of bread wheat and teff technologies at Akaki Kaliti sub-city were evaluated by farmers using field days and observation and by mean grain yield achieved. A team of researchers from extension, teff, and wheat breeding, protection, technology multiplication, and seed research, farmers, and other stakeholders (office of Agriculture and Kebele DAs) actively participated in evaluating the performance of the technologies at the field level. The opinion of farmers and agricultural experts on varietal performance was collected during field evaluation and field days and the select Tay varieties of bread wheat and Kuncho varieties of teff over the local varities sown in side plots non-adopter farmers.

Table 4: Demonstration and evaluation field day participant at Akaki kaliti

Field day participants category	No. of participants	
	Male	Female
Farmers	225	75
Addis Ababa city admin.	1	1
Akaki Kaliti sub-city admin.	153	45
District Admin.	80	40
Researchers	35	5
Total	**494**	**166**

The Tay of bread wheat and Kuncho of teff varieties demonstrated through large scale was appreciated by farmers because of the better yield performance over the previously known varieties in the study areas. Technology showing field days were organized in the study areas at different locations to evaluate the overall successes, challenges, and performance of the technology demonstration, to share experiences, to strengthen linkages among partners, and to gather feedback from the participants. During this event guests i.e. higher officials, district office heads and experts, researchers, kebele DAs, and farmers a total of 660 participants (494 male and 166 female) participated (Table 4).

The major lessons learned from urban agricultural activity and the technology demonstration of improved bread wheat and teff production was it proved that crop cultivation is feasible in urban areas to enhance the production of cereal crops and for food security. This is one of the advantages of the city's contribution of agriculture to food security and nutrition (Poulsen *et al.*, 2015; Warren *et al.*, 2015). The farmers gain practical knowledge of clustering approaches, agronomic practices, field management, post-harvest handling, and market linkage of bread wheat and teff production. The improved variety of promoted bread wheat and teff varieties yields a higher average production than the national average in the year 2021/22 cropping season and this was a great achievement and lesson.

4. CONCLUSIONS AND RECOMMENDATIONS

In Ethiopia, the agriculture sector plays an important role as the primary source of food and income for the farmers. The smallholder farmers in Ethiopia are characterized by subsistence agriculture with a low level of productivity in part due to the traditional production system. Urban agriculture is the agricultural production in cities and the areas near cities for food and other purposes. In this study before the dissemination of technologies technical training was provided to a total of 269 participants (186 male and 86 female) in the field in the 2021/22 production year. In the urban agriculture demonstration of bread wheat and teff, a total of 14 and 30 hectares of land were covered, respectively.

The bread wheat production of the grand mean grain yield of the improved bread wheat Tay variety showed a mean grain yield of 56.66 qt/ha which is higher than 31.11 qt/ha the national average yield. The teff production showed that the highest mean grain yield 23.0 qt/ha and the lowest mean grain 21.5 qt/ha was obtained better than the national average yield. In general, the result of the study showed that an improved variety of bread wheat and teff cultivation with improved management gave a higher yield than the mean yield recorded at the national levels. Therefore, improved varieties with recommended production packages should be demonstrated in unaddressed areas using cluster farm approaches to ensure food security.

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