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Full Length Research Paper

Demonstration and participatory evaluation of Triticale (X-*Triticosecale Wittmack*) technologies in Diga district of East Wollega zone

Berhanu Soboka[1]

Bako Agricultural Research Center, Department of Socio-economics, Agricultural Extension and Gender, POBOX. 03,

Author's email: Tel. +251911904655; Email: bfiraol8@gmail.com

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ABSTRACT

This activity was undertaken in Diga district of East Wollega, Oromia with the objectives of popularizing improved triticale varieties with their full package. Two kebeles were selected and three farmers per kebele were used for the activity. Two recently released triticale varieties "Moti and Abdissa" along with local check were planted on 10m*10m adjacent plots with a spacing of 20cm between rows, and 100kg DAP applied during planting. Urea was top dressed at early stage of the plant growth at the rate 50kg ha^{-1}. The fields were managed well and periodically supervised. At maturity the experimenting farmers, neighboring farmers, Development Agents, and researchers jointly evaluated the varieties. Grain yield, seed Color, disease tolerance, tolerance of moisture stress, tillering capacity and ear/spike length were the farmers' important criteria against which the varieties were evaluated. Based on the criteria set by the farmers, Abdissa variety was ranked first in majority of the traits considered, while Moti was ranked second. The mean grain yield performance of the varieties was 14.87qt/ha^{-1} and 19.39 qt/ha^{-1} for Moti and Abdissa varieties, respectively. The technology gap and technology index were 31.63 and 68.02 and 33.61 and 63.7 for Moti and Abdissa varieties, respectively. Though the varieties underperformed their potential due to marginality of the soil and early withdrawal of precipitation, both showed yield advantage over the local check. The yield advantage of the new varieties over the local check was 48.7% and 94% for Moti and Abdissa varieties, respectively. Based on the preference, yield advantage and being the best alternative to wheat, the two varieties were recommended for further scaling up.

Keywords: Demonstration, Diga, participatory evaluation, Triticale, Varieties

INTRODUCTION

Triticale (× Triticosecale, Wittmack), the first successful human-made hybrid cereal grain, was deliberately produced by crossing wheat (Triticum) as female and rye (Secale) as a pollen source. The crossing of two crops is to obtain the best characteristics of the two crops. Wheat yields and grain quality are better than rye, but rye has greater disease resistance and better tolerance to environmental stress. Triticale combines yield potential and grain quality of wheat with the disease and environmental tolerance including adaptability to difficult soils, drought tolerance, cold hardiness, disease resistance and low-input requirements of rye (Food and Agriculture Organization (FAO, 2004).

The ability to provide higher grain yield even under adverse growing conditions such as drought, pests and diseases, frost, hail, acidic soil or heavy competition by weeds is the unique characteristics of triticale that farmers might choose to grow, (Ashenafi, 2008). According to Ashenafi (2008), triticale is known to reduce soil erosion and captures excess soil nitrogen often lost from other crops because of its strong root structure. As research reports, (Hede, 2000) evidenced triticale requires approximately 30% less water to produce the same amount of biomass as wheat, sorghum, oats or rye. According to Hede (2000) acidic soils with highly soluble aluminum content which is toxic to other cereals, recent triticale varieties yield at least 30% more than wheat or barley. Similarly, experiments on sandy soils (low nutrient) from North Africa show that triticale out yields wheat and barley by about 33%.

Modern triticale cultivars perform as well as the best common wheat cultivars wherever scientific research has been sustained. Furthermore, in certain types of marginal soils, triticale cultivars out yield the best wheat cultivars. For instance, research results in the drought-prone regions of North Africa have shown that triticale can be an excellent alternative crop to wheat and barley. In cold, wet environments, the highly productive winter-type triticale cultivars developed primarily in Poland are continuously expanding into most cereals-based systems in Northern Europe (FAO, 2004). The first group of triticale was tried in Ethiopia in 1970, when the first international triticale screening nursery (ITSN), received from CIMMYT was grown at Holeta. The wider adaptation and surprisingly higher yields compared with the well established wheat varieties left no doubt about the production potential of the crop in Ethiopia. Along with adaptation trials, small scale test were initiated to determine the suitability of triticale as human food where experienced house wives were employed to test it for traditional recipes and modified as necessary (Pinto, 1974). Despite the high productivity of triticale, global production is increasing slowly, and the crop has not yet become well established in local or world markets. The main reason for the lower-than-expected production is that triticale, a good source of protein and energy (Hill, 1991), is used mainly for animal feed but very little for human consumption. Triticale could become a major crop if, in addition to its use as a feed grain, it were cultivated on a large commercial scale for human consumption.

Despite the fact that triticale improvement work was started about five decades back in Ethiopia, the crop is less known, if any, in western part of the country where the current study was conducted. Further, despite the efforts made by Bako agricultural research center release improved triticale varieties to areas under its mandates, no effort was made so far to demonstrate these varieties on farmers' fields. Consequently, farmers in the western part of the country are still not beneficiaries of these new varieties. Most importantly farmers in the specific kebeles who failed to grow bread wheat due to highly acidic nature of soil condition are more disadvantaged. This activity was, thus conducted with the primary objective of demonstrating and collectively evaluating performance of these varieties under farmers' condition.

METHODOLOGY

Description of the study area

The study was conducted in Diga district, one of the eighteen districts of East Wollega Zone, Oromia, Ethiopia. Geographically, the district is located in the western part of the Zone extending between 8056'40"-9018'15"N longitude and 36007'50" - 36032'50"E Latitude. The district has 21 rural kebeles and is situated at 345 km away from Addis Ababa to the west, immediately after Nekemte, the capital city of East Wollega zone. Administratively, Diga district is bordered in the South by Guto Gida, in the West by Gimbi, in the Northwest by Sasiga, and in the East by Guto Gida, and in the south by Leka Dulecha district. It covers an area of 1,704.73sq.km with a population density of 103.5 persons per sq.km and is randomly populated with average family size of seven in rural, three in urban and five total averages in the district. According to the data obtained from the Woreda BoFED, 2018 the district has 21 rural kebeles and two rural towns with a total of about 30,146 households (Diga BoFED, 2018 unpublished). Figure 1.

The district, (according to the district Bureau of Finance an Economic Development, 2018 unpublished data) has different physical settings ranging from mountainous and plain areas to lowland areas. Although there is no accurate data, it is estimated that the mountainous and plain areas cover large parts of the district. The altitude ranges from 800-2400m above sea level. This altitudinal variation makes the district to have two traditional ago-ecological zones namely: 'mid-altitude', constituting 48.6% and 'lowland that accounts for 51.4%. Rain fall is uni-modal in nature which sets in at late April and withdraws at early October. The annual rainfall of the district ranges from 891-1900 mm. The mean temperature varies from one agro-ecology to the other, but generally ranges from 12-30 Degree Celsius.

The district is characterized by mixed crop- livestock production system where crop production and livestock rearing are the main economic activities of the farming community. The district is predominantly a food crop growing area, and the major crops grown in the district in

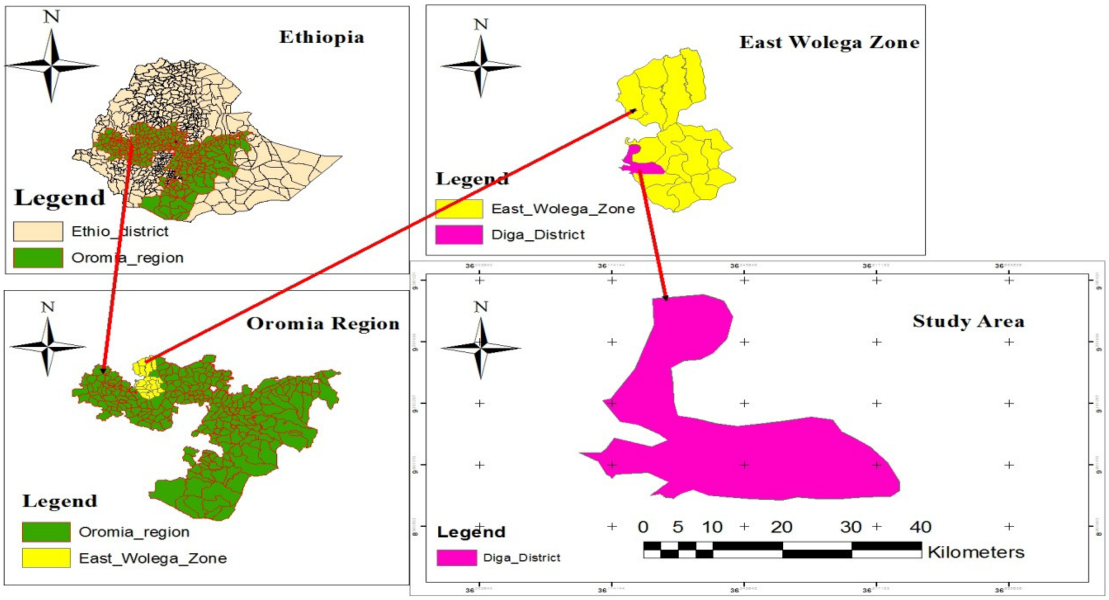

Figure 1. Map of Diga District

their order of importance, according the district (BoFED, 2017) are Maize, sorghum, finger millet and ground nut. It was reported that some kebeles in the district produce vegetables, fruits and coffee in addition to the major crops mentioned above. According to the data obtained from the district bureau of Agriculture and natural resource, in the 2017/2018 production year, an estimated 31,491 hectare of land was covered with different cash and food crops including vegetables, fruits and coffee. The most common species of livestock kept by the farming community in the district are cattle, sheep, goats, equines (donkey, mule and horse) and poultry.

Site selection and planting the varieties

Diga district was purposively selected for this activity due to acidity nature of the soil that makes production of bread wheat very difficult. Triticale is a special kind of crop that best fits to acidic soil condition making it suitable for the acidic condition of Diga district. From the district two farmers' associations were purposively selected on the basis of accessibility for supervision and potentiality. From each Farmers Association, three farmers were purposively selected based on willingness to host the demonstration, vicinity to main roads, possession of land that can accommodate the trials, willingness to allocate part of the land, past experience and loyalty in handling experimental plots and transparency to explain the technologies to other farmers. Cognizant of the importance of training to narrow the knowledge and skill gap, the experimenting farmers were trained on both practical and theoretical aspects of triticale production. Three triticale varieties, Moti Abdissa and local check were planted on 10mx10m adjacent plots with a spacing of 20cm between rows. DAP was applied at the rate of 100kg ha^{-1} at planting and 50kg ha-^{1} urea was top dressed at the early stage of the plant growth. The fields were supervised at monthly interval and at any time when the need arises. The plots were hand-weeded twice: a month after planting and a month after the first weeding.

Participatory variety evaluation

According to Banzger et al. (2000), farmers possess broader knowledge based on their environment; crop and cropping system built up over many years; and experiment on their own and generate innovations though they lacked controlled treatments and statistical tools for comparison and test of hypothesis. Beneficiaries of agricultural technologies, based on built experience, develop a strong affinity towards the varieties that can answer their questions about certain economically important varietal traits. This knowledge calls for consulting end users for their traits of interest before directly embarking on any breeding activity/ program which in turn saves resources and hastens adoption (Dan, 2012). With this in mind, at maturity the experimenting farmers, neighboring farmers, Development Agents (DAs) and researchers from the extension research team came together and evaluated the varieties on the basis of the farmers' evaluation

Table 1. Comparison of the varieties for different traits

Parameters	Abdissa (Rank)	Moti (Rank)	Local (Rank)
Yield	1	2	3
See color	1	2	3
Disease resistance	2	3	1
Drought tolerance	2	3	1
Pest resistance/tolerance	1	2	3
Tillering capacity	1	2	3
Ear size	1	2	3

Source: Own result of the evaluation process

Table 2. Summary of the ranks on the basis of the evaluation criteria

Variety	Rank	Reasons
Abdissa	1	High yielder, relatively good seed color, good disease tolerance, good tolerance to moisture stress, higher pest tolerance, better tillering, larger ear size,
Moti	2	Moderate yielder, better seed color, good disease tolerance, good tolerance to moisture stress, moderately tolerant to pests, moderate tillering, relatively large ear size
Local	3	Lower yield**,** poor seed color, better disease tolerance, better tolerance to moisture stress, lower pest tolerance, poor tillering and small ear size

Own result

criteria. At first the farmers' criteria were kept at random after which they were ordered using pair-wise technique. The farmers' evaluation criteria were Yield, Seed Color, disease tolerance, Tolerance of moisture stress, Tillering capacity and Ear/spike size.

RESULTS

The result of variety evaluation on the basis farmer preferred traits is depicted in (Table 1). Based on preferred traits the farmers ranked the varieties of their preference. Accordingly Abdissa was ranked first for grain yield, disease tolerance, pest resistance tillering capacity and ear size. Moti, on the other hand, was ranked second excelled by Abdissa in most of the traits, and beating Abdissa in only one trait (seed color). On the other hand, the local variety was better in disease tolerance and tolerance to moisture stress compared to both of the improved varieties. With regard to the rest five traits it was found to be inferior both to Moti and Abdissa, and selected the least. Table 2.

At the end of the evaluation process, results were displayed to the evaluators and thorough discussion was held with participants about future plans

Yield performance of the varieties

The overall mean grain yield performance of Moti was 14.87 ± 5.04qt ha^{-1} with a range of 10qt ha^{-1} to 20.5qt ha^{-1}. On the other hand, the mean grain yield per hectare for Abdissa ranged between 20- 22qt ha^{-1}, with a mean of 19.39±3.67qt ha^{-1}. The two varieties performed differently at both of the study sites. At Firomsa site, for instance, the grain yield performance of Moti ranged from 10 qt ha-^{1} to 16.7qt ha-^{1} with a mean yield of 12.9qt. The grain yield performance of the same variety at Jirata ranged from 10 qt ha^{-1} to 22.5qt ha^{-1} with a mean grain yield of 16.83±6.33qt ha-^{1}.

On the other hand, the grain yield performance of Abdissa at Firomsa ranged from 14 to 20qt ha-^{1} with a mean of 16.67qt ha-^{1}. The yield performance of the same variety at Jirata ranged from 20 to 23qt ha^{-1} with a mean grain yield of 22qt ha^{-1}±1.73. It can be noted from the trial that there is no statistically significant mean difference between the two locations for Moti, while the difference for Abdissa is statistically (p=.06) different for the two locations. The mean grain yield performance of the local variety at Firomsa was 11± 3.12qt ha^{-1} while it was 10 ± 2.64qt ha^{-1} at Jirata. The overall grain yield performance of the local variety was 10 ± 2.64qt ha^{-1}, ranging between 7.5qt ha^{-1} to 13.50qt ha^{-1}. The difference in productivity between the two sites was non-significant (Table 3).

Analysis of productivity gaps

The values of yield advantage, technology gap and technology index is depicted in Table 4.

Table 3. Overall Mean grain yield and site specific performance of the varieties

	Kebele	N	Mean	Std. Deviation	p-value	Pooled mean	Pooled Std. Deviation
Y-Moti	Jirata	3	16.83	6.33	0.398(NS)	14.87	5.04
	Firomsa	3	12.90	3.44			
Y-Abdissa	Jirata	3	22.00	1.73	0.058*	19.33	3.67
	Firomsa	3	16.67	3.05			
Y-local	Jirata	3	11.00	3.12	0.694	10.5	2.64
	Firomsa	3	10.00	2.64			

*= significant at less than 10%; GY-Moti= yield of Moti; Y-Abdissa= yield from Abdissa; Y-local= yield of local

Table 4. Technology gap, yield advantage and technology index of the demonstrated varieties

Variety	Potential yield (qt ha^{-1})	Demo yield (qt ha^{-1})	Yield of check (qt ha^{-1})	Yield advantage (%)	Technology gap (Qt)	Technology index
Moti	46.5	14.87	10	48.7	31.63	68.02
Abdissa	53	19.39	10	93.9	33.61	63.4

Source: own data

Different parameters as suggested by Yadav et al. (2004) were used for calculating gap analysis. The detail of different parameters is as follows:

Yield advantage = (yield of the new variety-yield of check/yield of check)* 100

Technology gap= (Potential yield–Demonstration yield)

Technology index = (Potential yield -Demonstration yield / Potential yield)* 100

Yield potential (Yp), according to (Evans, 1993; Evans and Fisher, 1999; van Ittersum and Rabbinge, 1997) is the yield of a crop cultivar when grown in an environment to which it is adapted, with non-limiting water and nutrient supplies, and with pests, weeds, and diseases effectively controlled. In these optimal conditions, crop growth is determined by solar radiation, temperature, atmospheric CO2 concentration, and management practices which influence crop cycle duration and light interception, such as sowing date, cultivar maturity, and plant density. In rain-fed systems where water supply from stored soil water at sowing and in-season rainfall is not enough to meet crop water requirement, water-limited yield potential (Yw) is determined by water supply amount and its distribution during the growing season, and by soil properties influencing the crop water balance, such as rootable soil depth, available-water holding capacity, and terrain slope (van Ittersum and Rabbinge, 1997).

The yield of the front demonstration trials and potential yields of the crops were compared to estimate the yield gaps which were further categorized into technology index. Accordingly, the technology gap for Moti variety was (46.5Qt/ha-^{1}–14.87Qt/ha-^{1}) =31.63Qt. For the same variety, technology index, referring to feasibility of the technology to the farmers, was (46.5- 14. 87)/46.5)* 100=68.02. The value of technology gap for Abdissa variety was (53-19.39) =33.61 quintal. For the same variety, the technology index was (55qt-19.39qt/55)*100 = 63.4.

Though the result of technology gap and technology index for the two varieties was significantly higher than expected, both of the varieties showed encouraging yield advantage over the local check. The yield advantage of Moti variety over the local check was 48.7% while it was 93.9% for Abdissa variety. Table 4.

DISCUSSION

The mean grain yield performance of Moti variety was markedly lower than that reported for the same variety (29.83qt $ha^{-1)}$ by Aemiro et al. (2019) at Wag-last marginal highlands of Ethiopia. Similarly, the mean grain yield performance of Abdissa variety in the current study was by far lower than that reported by Aemiro et al. (2019) for the same variety. The authors reported the mean grain yield performance of Abdissa to be 24.48qt ha^{-1} in Wag-last marginal highlands of Ethiopia. The result of technology gap analysis for Abdissa variety reveals that there was a very large gap (31qt) between the on-station performance (potential yield) and demonstration yield (14.87qt) of the variety under consideration. The result of analysis for both technology gap and technology index was markedly higher than the result reported by Rakesh (2014) for improved chickpea variety trial in India. It is also extremely higher than that reported by Dhaka et al. (2010) in his demonstration of improved maize technologies in South-eastern Rajasthan, India.

In both of the sites the current yield performance of the varieties was by far below their potential. This wider gap might have stemmed from the fact that these varieties were tested on very potential areas like Horro district where soil acidity problem is very minimal, if any. The yield recorded from such sites might have heightened the average yield of the crops during the breeding stage. Diga site, on the contrary, is known for its acidic problem on which wheat production is impractical. This difference in fertility is a potential factor for a wider disparity in performance of the varieties. Moreover the erratic nature and early withdrawal of precipitation during the demonstration year might have exerted much impact on the on-farm performance of the varieties under consideration.

CONCLUSION AND RECOMMENDATIONS

Both of the improved varieties under consideration had showed better yield advantage over the local variety. In both of the trial sites considered, however, the improved varieties underperformed their potential. Among other factors that might contribute to these huge yield gaps, early withdrawal of rain shower during the trial year can be cited as an important factor. Other factors might be the difference in soil condition of Horro district where the varieties were tested and that of Diga where the technology was demonstrated. The demonstration was deliberately conducted at Diga because highly productive wheat varieties cannot tolerate the acidic soil condition of Diga, making triticale a better alternative to opt for. In both of the trial sites (Jirata and Firomsa), Abdissa variety was ranked first and was selected as the best variety, on the basis of grain yield, disease and pest tolerance, tillering capacity and ear length. Moti was selected as the second alternative, being bitten by Abdissa in many of the traits considered. Though the improved varieties underperformed their potential on both of the demonstration sites, it is advisable to go for pre-scaling up of the two varieties as they are the best alternative to bread wheat that cannot tolerate the edaphic condition of the district.

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