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Research Article

Pre-extension demonstration of bread wheat (*Triticum aestivum*. L) varieties at midlands of Guji zone, Southern Oromia, Ethiopia

Dembi Korji* Basha Kebede* and Tekle Bobo

Oromia Agricultural Research Institute, Bore Agricultural Research Center, PO Box 21, Bore, Ethiopia

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***Corresponding authors**: Basha Kebede, Oromia Agricultural Research Institute, Bore Agricultural Research Center, PO Box 21, Bore, Ethiopia,
E-mail: bsshkbd@gmail.com

Dembi Korji, Oromia Agricultural Research Institute, Bore Agricultural Research Center, PO Box 21, Bore, Ethiopia.

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Abstract

In Ethiopia, wheat is a strategic crop to solve food insecurity. However, there is a lack of improved variety which can increase surplus production. Thus, demonstration and use of improved and new variety are important for producers. This demonstration aimed to evaluate the yield performance and profitability of the Adola 1 bread wheat variety. Adola 1 and the local variety were demonstrated on 10 m x 10 m during the 2021 production year in the midland districts of the Guji zone. Farmers were trained in wheat production. Interviews and measurements were taken to collect the data. The collected data were analyzed by descriptive, net income, and narrations. The result of the demonstration showed that Adola 1 variety gave a higher yield (36.41 qt/ha) than the local variety (23.21 qt/ha) in the Wadera district. The result of net income showed that Adola 1 variety gave more Net income (73266.79 ETB/ha) than the local variety (26830.71 ETB/ha). Production of the Adola 1 variety was more profitable than locally used varieties at Midland. The color of Adola 1 was preferred by farmers for market and household consumption purposes. Adola 1 was an early matured variety so it was preferred by farmers. Adola 1 was more easily threshed than the local variety in the Wadera district. Despite being affected by birds the early maturity of the Adola 1 variety was likened by experimental farmers. Farmers should use Adola 1 variety in their bread wheat production. For further promotion, the pre-scaling up of the Adola 1 variety should be conducted in the midland districts of the Guji zone.

Introduction

Africa spends 85 billion USD annually on food imports, of which 15% is for wheat imports alone. Wheat imports are particularly high for countries in Northern Africa, which are responsible for 59% of Africa's wheat import bill, followed by countries in Western (19%) and Eastern Africa (14%) [1]. Moreover, Africa's wheat import bill has been increasing over the past two decades at a rate of 9% per year due to population growth, urbanization, and less consumption of coarse grains [2-4]. Thus, wheat imports have been necessary to fill the widening gap between wheat consumption and wheat production in the continent. However, reliance on imported wheat is becoming a serious challenge considering recent anthropogenic and natural crises disrupting production and trade systems worldwide. Short and medium-term strategies [5] are needed to prevent over-reliance on wheat imports, which could jeopardize food and national security. Because of trade-disruptive events, increasing attention has been directed towards countries' self-sufficiency [6] which refers to the capacity of a country to produce food domestically to cover their own needs [7]. Supporting domestic wheat production through better practices and proper technology transfer is indispensable to ensure affordable wheat prices for consumers [8]. Domestic wheat production can be increased in Africa by allocating resources and setting proper policies that support a Research and Development (R&D) agenda addressing the major bottlenecks affecting current regional wheat production. Many African countries have similar environmental and socio-economic constraints to wheat production. Wheat production

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and productivity are constrained by diseases, pests, and climate variation [9], limited access to information, technical knowledge, and agricultural technologies [10]. Coordinated efforts towards wheat self-sufficiency in the region are possible, particularly on transboundary constraints (e.g., wheat rusts) and the exchange of germplasm. An extension is needed to narrow the yield gap by demonstrating improved seed and scaling-up technologies [11]. Such strategies would help reduce wheat import dependency in many African countries, which should re-consider the value of wheat self-sufficiency as a strategic investment for national economies [8].

The innovation of Asia and Latin American countries in the Green Revolution had taught many developing countries in increasing their production and productivity. This mission persisted in the hearts of many African countries to out from poverty and malnutrition. There is also a possibility to get more yields from wheat in potential areas of the continent. That is why many African leaders drive different policies on wheat production for their nations.

Bread wheat (*Triticum aestivum*. L) is the most common cultivated wheat species-taking up to 95% of the wheat and staple food for consumers worldwide [12]. In the World among 125 wheat-producing countries, Ethiopian wheat area coverage and productivity are ranked 25th (1.7 million hectares) and 63rd (28,126 kg/ha), respectively. Its productivity is by far lower compared to wheat-producing countries such as Ireland (101,746 kg/ha), New Zealand (98,633 kg/ha), and the Netherlands (90,936 kg/ha) [13]. Empirical studies on the assessment of wheat yield indicate that other African countries such as Egypt, South Africa, and Kenya obtained 67, 35, and 30 quintals per hectare, respectively more than Ethiopia (28qt/ha) [9-10,14]. In the Guji zone wheat productivity was 32.24 qt/ha [15]. Wheat is the most important grain crop for food security and is used as a source of income for developing countries [16-17]. In Ethiopia, wheat is the most important cereal crop in terms of both production and use. Wheat grain is used for the preparation of different traditional food staffs, such as "Injera", bread (Dabo), Local beer (tella), "dabo kolo", "marqa" and "kinche". Besides, wheat straw is commonly used as roof thatching materials and as feed for animals [18-19].

Ethiopia has huge potential and suitable agroecology for growing wheat. In spite of the presence of wide agroecologies wheat production is left behind by 25 to 30% of its demand because of increased demand for wheat due to population growth, urbanization, and expansion of agro-industries [20]. To feed the world's growing population, the global demand for wheat yield should increase by 50% in 2050 [21]. The demand for wheat for household consumption is achieved by popularizing and multiplying released wheat varieties on farmers' land [15]. Ethiopia is still importing about 1.6 million tons of wheat which are estimated to be 25% in deficit to fulfill domestic wheat demand by foreign currency [22]. Hence, the Ministry of Agriculture and Natural Resource plans to increase wheat productivity from 2.7 metric tons/ha in 2019 to 4 metric tons/ha by 2023 and reduce wheat import from 1.7 million metric tons in 2019 to zero by 2023 [23].

For surplus production, the government of Ethiopia focused on wheat production both rainfed and irrigation aimed to bring household food security and income generating. However, the productivity of the crop is low mainly due to rust and a lack of improved varieties. Breeders intended to balance the wheat demand by releasing new bread wheat varieties suitable for different agroecologies. Bore Agricultural Research Center released a new bread wheat variety for the midland Guji zone. In line with the government on wheat production demonstrating new variety is very important as an entry point for surplus production and fulfilling the demand for bread wheat for household consumption and export for income generation. In contrast to previous top-down extension approaches where technology users' preferences were not intensively studied this paper focused on farmers' preference for variety released and intensively studied under farmers' conditions.

Objectives

1. To evaluate the yield performance of the Adola 1 wheat variety under farmers' conditions.
2. To estimate the profitability of Adola 1 wheat variety production.
3. To assess farmers' feedback on Adola 1 bread wheat variety.

Materials and methods

Description of the study areas

Adola Rede District The district is located in the Southern part of Oromia, Ethiopia, at a distance of 468 km from Finfine, the capital city of Ethiopia. Astronomically, the district is located between 5°44'10"- 6°12'38" latitudes and 38°45'10"-39°12'37" longitudes. In terms of the agricultural calendar, the rainfall pattern of the district is bimodal for lowlands and midland areas and mono-modal for highland parts an annual mean of 1000 mm of rainfall and an annual average of 28 C° of temperature. The dry arid agro-climatic zones are attributed to little rainfall while the humid agro-climatic zones receive extremely high rainfall. Rain-fed agriculture is a common practice for many farm households in this district. However, a semi-nomadic economic activity is also practiced as a means of livelihood by some of its dwellers. The farmers of this district produce both in the autumn and spring seasons. They produce cereals such as teff, wheat, barley, and maize, pulses such as haricot bean, and others such as fruits and vegetables. Overall, haricot bean, maize, and teff are the major crops cultivated by the farmers in these study areas. They also engaged in the production of coffee as means of livelihood.

Wadera district is situated at a distance of 535 km from Finfinne and 60 km from the zonal capital town, Negele. Astronomically, the district is located between 5° 39'5"-6° 2'28" northing latitudes and 39° 5'30"-39°27'52" easting longitudes. It is an area where mixed farming and economic activities take place, which is the major livelihood of the people. The district is characterized by two types of typical climatic zones, namely, an arid (60%) and semi-arid (40%) climate with mean annual

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temperature ranges from 12 ºC -34 ºC and it has a bimodal rainfall pattern. The annual rainfall ranges between 915 mm and up to 1,900 mm. The long rainy season starts from mid-March to May (45-60) days while the short rainy season starts from mid-September to October (30 - 40 days) in years. The district is drained by Genale, and Sokora Rivers, similarly, Banti Streams are the major rivers and streams of the district. The soil of the district is good for crop production. Generally, teff, maize, haricot bean, wheat, and barley are the major crops produced in the district [24]. Adola Rede and Wadera district has mainly two seasons (Bona and Gana). Maize is produced during the Gana season. Tef, barley, haricot bean, and wheat can be produced in both seasons.

Sites and experimental farmers' selection

The study was conducted at two midlands of Guji Zone during the 2021 production year. Adola Rede and Wadara districts were purposively selected based on their wheat production. Two kebeles from each district were selected based on their wheat production and were accessible for monitoring. At each kebele, one farmer research group was established. In one farmer's research group, there were 15 members. Out of one farmer's research group, there were three-four experimental farmers. With the collaboration of the district agricultural office, seven experimental farmers were selected from each district. Totally, the demonstration was conducted on 14 experimental farmers.

Research designs and implementations

Adola 1 variety and local variety were demonstrated during the Gana season (April to June) on 14 experimental farmers and the activity was again repeated on 21 experimental farmers during the Bona season (starting early September) though it was not given a good result due to lack of rainfall after the milking stage. Hence, the result of data during the Bona season was excluded from data analysis. There is no local variety used in the Adola Rede district since the area was not producing wheat during the demonstration. A seed rate of 150 kg/ha was used on a 10m x 10m area. 20 cm between rows and the seed was drilled in the line of rows. Inorganic fertilizers (NPS 121 kg/ha and 50 kg/ha of UREA) were used during a demonstration as recommended technology. Weed was controlled by hand and herbicide application (2-4-D). Harvesting was done by hand and threshing was done by manual. The training was given on the spot. The activity was monitored by researchers and Development Agents assigned at each kebele.

Methods of data collection

Yield data was collected by measurement from 10x10m areas and then converted to hectares for analysis. In addition, the cost of production of wheat was collected by interview method. Group discussion was used to exploit farmers' preference for demonstrated wheat variety.

Methods of data analysis

The collected data were analyzed by descriptive statistics and narrations of farmers' feedback. Net income was used to estimate the profitability of demonstrated wheat in the area. Variable costs and fixed cost was collected. Total revenue (TR) was calculated as:

$$TR=Y*P \quad (1)$$

Y= yield obtained (qt/ha) and P farm gate price in birr

Net income (NI):

$$NI=TR-TVC-FC \quad (2)$$

Where TR= Total Revenue, TVC= total variable cost and FC= fixed cost

Results and discussions

Enhancement of farmers' knowledge and skills

One of the extension methods used in technology transfer is training. It was used to enhance the knowledge and skills of farmers on aspects of technology demonstrated. Knowledge and skill-based training were given on wheat production both during the bona and gana seasons. 60 farmers, 8 Development agents (DAs) and 4 Subject Matter Specialists (SMSs) were trained during the bona season. The training was given on demonstration sites. During monitoring of the performance of the trial at each experimental farmers were supervised and corrective measures (comments) which can enhance farmers' knowledge and skills were given by agricultural extension researchers.

Yield performance demonstrated varieties

The new bread wheat Adola 1 variety is well performed under farmers' conditions. The result of the demonstration showed that Adola 1 variety gave a higher yield (36.41 qt/ha) in the Wadera district than in the Adola Rede district (Table 1). Since farmers were not producing wheat in the Adola district there is no local variety used as a check. However, with the initiative on irrigation, the production of wheat by irrigation was started at some irrigation schemes. As this demonstration was done by rain-fed the result was not compared with irrigation production. The result of the Adola 1 demonstration was (35.06 qt/ha) higher than during its releasing time (27.3 qt/ha) [25] and a national yield of 30.46 qt/ha [26]. This indicated that the midlands of the Guji zone had the potential for wheat production.

Profitability analysis

The farm gate price Adola 1 variety was 28 birr/kg while it was 23 ETB/kg for the local variety. The estimated seed cost of Adola 1 was 4000 ETB and the mean cost of the local variety in the Wadera district was 2500 ETB. Total Revenue (TR) was

Table 1: Yield performance of demonstrated varieties (qt/ha).

District	Varieties	N	Mean	Standard deviation
Adola Rede	Adola 1	7	33.71	1.729
Wadera	Adola 1	7	36.41	1.284
	Local	7	23.21	1.955
Total	Adola 1	14	35.06	2.025
	Local	7	23.21	1.955

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obtained by multiplying yield by farm gate price Total Variable Costs (TVCs) included for cost-benefit analysis include costs of seed, fertilizer, land preparation, sowing, weeding, harvesting, and threshing. The cost of fertilizer used for one hectare (121kg/ha) of NPS was 2500 ETB and 50kg/ha of UREA was 1300 ETB at Adola Rede district while NPS was 2600 ETB and UREA was 1375 ETB in Wadera district. Fertilizers were purchased at the mean of 3887.5 ETB in both districts. Net income was calculated as TR-TVCs-TFCs. It was observed that Adola 1 variety gave more Net income (73266.79 ETB/ha) than the local variety (26830.71 ETB/ha) (Table 2). Production of the Adola 1 variety was more profitable than locally used varieties at Midland. Therefore, farmers should use Adola 1 variety for their wheat production in midland areas of the Guji Zone.

Farmers' preference for demonstrated varieties

The newly released Adola 1 variety gave a higher yield than the local variety. Adola 1 variety production was preferred during the Gana season though there is a possibility during the Bona season based on the availability of rainfall. The color of Adola 1 was preferred by farmers for both market and household consumption purposes. Adola 1 was an early matured variety so it was preferred by farmers. Adola 1 was more easily threshed than the local variety in the Wadera district. However, it was slightly affected by birds in both districts. Despite being affected by birds the early maturity of the variety was likened by experimental farmers since there was a shortage of rainfall in the study areas (Table 3).

Conclusions and recommendations

Higher yield with higher profit and farmers' preference can determine the production of bread wheat variety production.

Table 2: Net income of demonstrated varieties.

Parameters	N	Mean	Std. Deviation
Yield of Adola 1 variety (quintal/ha)	14	35.06	2.03
Yield of local variety (quintal/ha)	7	23.21	1.96
Price of Adola 1 variety (ETB/ha)	14	2900.00	103.78
Price of local variety (ETB/ha)	7	2300	0.00
Seed cost of Adola 1 variety (ETB/ha)	14	4000.00	.000
Cost of local seed variety (ETB/ha)	7	2528.57	75.59
Fertilizer cost (ETB/ha)	14	3887.50	90.80
Land preparation (ETB/ha)	14	3052.14	135.54
Sowing cost (ETB/ha)	14	1682.14	89.03
Weeding cost (ETB/ha)	14	1369.29	54.03
Harvesting cost (ETB/ha)	14	2502.86	94.66
Threshing cost (ETB/ha)	14	2560.71	81.28
TR of Adola 1 variety (ETB/ha)	14	101821.43	8773.40
TR of local (ETB /ha)	7	53392.86	4496.15
TVCs of Adola 1 variety (ETB/ha)	14	19054.64	225.67
TFC (cost of land) ETB/ha	14	9500	518.875
TVCs of local variety (ETB/ha)	7	17533.57	174.68
Net income of Adola 1 variety (ETB/ha)	14	73266.79	9229.895
Net income of local variety (ETB/ha)	7	26830.71	4409.977

Table 3: Farmers' preference on demonstrated varieties (N = 7).

	Rank	Preferred wheat traits	Rank	
Adola 1 Variety	1st	Higher Yield	2nd	Local Variety
	1st	Early maturity	2nd	
	1st	Marketability	2nd	
	1st	Disease tolerant	2nd	
	1st	Easiness for threshing	2nd	
	1st	Bird attack	2nd	
	1st	Overall rank of variety	2nd	

Demonstration of the Adola 1 variety was conducted in midland districts of the Guji Zone. The result of the demonstration showed that Adola 1 variety was a higher yield than the local variety and with the application of recommended packages the Adola 1 variety could improve further bread wheat production in midland areas. This ensures that Adola 1 variety had the potential to solve wheat demand in the study areas. The result of Net income revealed that production of the Adola 1 variety was profitable in midland areas of the Guji zone. Experimental farmers preferred Adola 1 over the local based on its disease tolerance, early maturity, good marketability, and easiness for threshing. One problem regarding Adola 1 variety production during the demonstration was its attack by birds. This was due to its earliness to mature. Despite it being affected by birds farmers preferred to produce Adola 1 variety since there was a shortage of rainfall in the midland areas of the Guji zone. The production of Adola 1 was preferred during the Gana season over the Bona season. For further promotion, the pre-scaling up of the Adola 1 variety should be conducted in the midland areas Guji zone. Farmers of the midland area should use Adola 1 variety in their bread wheat production since it gave higher yields and returns.

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