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Participatory On-Farm Evaluation of Improved Bread Wheat Technologies in Some Districts of Southern Ethiopia

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Abstract
Six released varieties of bread wheat (Triticum aestivum L) were evaluated on 27 framers fields in Lemu, Angacha and Mareka districts of Southern Ethiopia in 2010/2011. The objectives were to test the adaptability and acceptance of bread wheat technologies and create awareness to the farmers. The pooled analysis of variance showed mean square due to varieties were highly significant ($P \leq 0.01$) for Plant height, spike length, number of seeds/spike and number of days to mature; and significant ($P \leq 0.05$) for yield (t/ha). The interaction of treatments and location was highly significant ($P \leq 0.01$) for these characteristics implying that the traits were highly influenced by the environments. The mean from combined grain yield of varieties (1.78t/ha) was lower than that of Mareka (2.02t/ha) and higher from Lemu (1.69t/ha) and Angacha (1.74t/ha). Farmers of all districts ranked variety Digalu first. Tay took the second place in Mareka and Lemu; and the fifth in Angacha.
Keywords: Bread wheat, released varieties, evaluation, adaptation

1. Introduction

Wheat is an important crop commodity in Ethiopia, which could contribute a major part in achieving the millennium goal of the country, food grain self-sufficiency. In sub-Saharan Africa, Ethiopia ranks second next to South Africa in terms of total production and area coverage of bread wheat. The total annual production in Ethiopia was estimated at about 1.400,000 metric tons from an area of about 1,000,000 ha (Aquino, 1996).

Utilization wise, wheat is used for the manufacture of flour for different purposes. Bread, biscuits and pasta products such as macaroni, spaghetti and noodles are some of the industrial products. Bread wheat is known to be a major source of energy and protein. Traditionally the crop is used for making "dabo", "dabokolo","ganfo", "kinche" and other types of foods. The straw is good source for animal feed and is also used for thatching roofs. The potential use of bread wheat will be that it will enter the export market if production is expanded and productivity is increased. This will save the foreign currency used to import bread wheat.

Since some years back, there is a slight increase of bread wheat in both area and total grain yield (Bekele Geleta and D.G. Tanner, 1995; Adanech, 1991). An increase in production is attributed to not only through areal enlargement, but also due to adoption of improved and better adapted varieties in a few bread wheat growing localities of the country. Currently, the national bread wheat requirement is estimated to be 2.2 million tones, thus indicating the need to increase the current national bread wheat yield level up to 2.2 tones/ha (CSA 2003 and CSA 2006). Therefore, there is a need to further enlarge bread wheat production and productivity in order to meet the country's full demand.

The crop is largely grown in the mid and highland areas of Ethiopia at altitudes ranging from 1500 to 3000 m.a.s.l; however, the most suitable agro-ecological zones for bread wheat production fall between 1900 and 2700 m.a.s.l (Hailu Gebremariam, 1991).

The Southern Nation, Nationality and People Regional State (SNNPRS) is an ideal place for bread wheat production in Ethiopia. In the region, among the total land size of 859,340.71 hectares planted by all cereals, bread wheat covered 131,162.87 hectares, which is 15.26 % of production area covered by all cereals grown in the region. It is the third major crop in the region next to maize and tef. According to the report of CSA (2010), in the year 2009/10 in SNNPR, regional productivity (q/ha) of bread wheat was 18.65 which is too low and even less than half of the potential productivity of bread wheat which could be obtained through using improved bread wheat varieties.

The survey report which was conducted at regional level in 2008, also confirmed that the yield obtained from the local cultivars is too low. And in many parts of the region, lack of improved crops varieties and associated improved management practices are some of the major constraints in the crop production systems i.e. farmers in many remote areas of SNNPR even do not know the existence of the new bread wheat varieties.

Moreover, it is a recent event that almost all bread wheat farms in SNNPRs were seriously attacked by yellow rust out breaks which occurred in 2010. Even improved bread wheat varieties like Kubsa and Galema, which have been well adopted by farmers in some parts of the region, have been found to be victims of the epidemics.

In order to solve those problems, continual identification of the best and suitable bread wheat production technologies appeared to be essential. Participatory on farm evaluation of available bread wheat technologies with farmers is a good approach to identify the most adaptive and suitable technologies in different agro-ecologies of the region. Dissemination of preferred technologies should also be undertaken as it has a tremendous impact on total bread wheat production and productivity, and this also fosters supply of alternative seed sources to the farmers. Therefore, this study was designed to create awareness to farmers on bread wheat production technologies and evaluate the yield performance of the varieties for further scaling up program.

2. Materials and Methods

2.1. Field evaluation

Six improved bread wheat varieties (Table 3) were planted on nine farmers' fields in each of three districts (Mareka, Angacha and Lemu) of Dauro, KembataTembaro and Hadya zones of Southern Ethiopia which represent major bread wheat (Triticum aestivum L.) production environments in the region (Bekele Geleta and D.G. Tanner, 1995; Adanech, 1991). A variety, HAR-604, the so called Galema which is an improved bread wheat variety, is well adopted in all districts. Thus, there was no need to include extra local cultivars in all districts. The plot size was 10m x 10m and the distance between plots was 1.0m and the experimental plots were fertilized 100 kg DAP/ha and 25 kg Urea/ha at planting, and Urea top dressing three weeks after planting as the source of the reminder N. In all other pre and post stand establishment, cultural practices in the experimental plots were managed by the farmers themselves under close supervision of researchers and respective development agents from agricultural offices of each district. The plots of nine experimental farmers' fields in each district were used for data collection and analysis. Assessments were made on all agronomic and phonological characters recorded immediately after germination it included plant population and development (vegetative and flowering), Uniformity, plant height(cm), Spike length(cm), number of seeds/spike, yield kg/ha and number of days to mature at optimum plant harvesting stage and insect and disease incidence one-five scale considered as a whole. The analysis of yield and other quantitative traits were performed using SAS computer software packages (SAS, 2001) considering individual farmers fields as replications or blocks with the overall experiment, thereby, tested as a randomized complete block design with nine replications.

2.2. Farmers' assessment

In this study, individual and group discussions, field visits and questionnaire was used for evaluation and data collection with farmers. Through recurrent discussions, we reiterated our engagement to ground the research on farmers' knowledge and preferences. Our relationship with the farmers and key informants developed into a sort of contract based on mutual benefit. Such contracts with farmers appear as pre-requisites for joint learning and platform generation and form the frames on which the research trial and activities are developed.

Through focus group and individual discussions with farmers and key informants in three districts; a total of 15 different criteria were identified to farmer's selection and preference. These criteria were submitted to the group of farmers for further evaluation in each district. Selection of individual farmer was made on meeting with key informants familiar about the crops to determine the adaptability and the growth performance of all bread wheat technologies through the entire growing period. The interviews are later extended to group participatory discussions with selected farmers in two clusters from each district. Group discussions were conducted to carefully build on and critically examine derived information from individual farmers of different households. It was also intended to clear conflicting ideas on issue like adaptability, the yield potential and growth performance of those of improved bread wheat varieties. The group discussions critically focused on: i) Preference and selection of the varieties ii) Yield potential iii) Growth performance and adaptability of the varieties iv) Marketing value and seed color v) Resistant to frost, disease and insect pests and vi) Seed size as a whole. Focus group interviews and key informants were used to understand the underlying factors influencing farmers' decisions to conserve and sustainable utilization of improved technologies on farmers' field. Information obtained from the interviews (individual households and group discussion) and from the key informants was used to obtain a broad understanding on sustainable utilization of those technologies in the areas. After harvested the crop, tested farmers from each district was evaluated and gave its ranking of selected varieties based on their evaluation criteria.

The pair-wise ranking (Russell, 1997) method was used to analyze the position of each of variety in tested areas by farmers evaluation criteria. A matrix table of varieties in each district was constructed. Farmers were asked to compare each variety to the other ones with regards to the values (Yield, plant height, spike length, number of seeds/ spike, backing quality, market value, seed color and size, etc.) and the priority each farmer gives to the variety. Each variety was compared in turn with each of the other varieties. The process was repeated for all varieties until all possible comparisons had been made. The number of times each variety was found to be more important was counted for each individual farmer. This value represents the individual score for each variety. An aggregation was then realized on the scores for each variety over the farmers participating in the exercise. This aggregated score represents the district score. The ranking of these scores provides the position of the varieties in the local economy. The same process was applied to criteria farmers consider for variety choice in the three districts.

3. Workforce Sizing Plan (WOZIP)

3. Results and Discussions

3.1. Farmers field experiment

The combined analysis of variance over locations (Table 1) indicates that out of the 5 traits studied mean square due to varieties showed very highly significant variation ($P \leq 0.01$) for 4 of the 5 traits and significant variation ($P \leq 0.05$) for yield t/ha. Statistically significant location effect on all traits, except yield t/ha, shows that these traits were highly influenced by change in the environment. The significance of location effect was expected as all of Mareka, Lemo and Angacha vary for their soil type, average annual rainfall, average temperature and etc. Like to all tested locations, the variability in total yield (t/ha) was significant for combined analysis. The variability of treatments in tested locations for yield indicates that varieties containing high yield can be developed if desired. The interaction of treatments and location was highly significant ($P \leq 0.01$) for plant height (cm), spike length (cm), number of seeds/spike; number of days to mature and total yield (t/ha) (Table 1).

The mean combined data over locations (Table 2) indicated the yield performance of treatment (1.78t/ha) was lower than that of Mareka (2.02t/ha) and higher from Lemo (1.69t/ha) and Angacha (1.74t/ha). Variability in all traits over locations was varying ranged from 0.46 to 12.4t/ha, 25.5-70.2, 3.9-9.95 cm, 72.8-120.6 cm and 83-167 for total grain yield, number of seeds/spike, spike length, plant height and number of days to mature respectively (Table 2). This shows that there exists sufficient variability to develop high yielding bread wheat variety for production in these areas.

3.2. Farmers' Evaluation and preferences

In all tested areas, farmers maintain their desires in satisfying different bread wheat varieties for foods, income generation and socio-cultural value that farmers preserve. In this study, some farmers prefer more early-maturing varieties instead of late-maturing varieties to solve their seasonal food shortage. However, farmers express some contrary needs and make different choices as economic or market importance. In most of tested farmers appreciate late-maturing varieties for which the harvesting coincided with the period of increasing bread wheat market price in all tested areas. This strategy of synchronizing the harvesting time with the high market price enables farmers to avoid investing supplementary storage costs. So the agronomic performance of cultivated varieties, their suitability to satisfy the household or community needs the market demand form the basis of farmers' preferences. On the market, price premium is given to crops with different characteristics. On bread wheat, seed color, seed size, shape and free from disease and insect pests are important characteristics to consumers. Faye (2002) reported similar results on cowpea in Senegal and found that buyers are willing to pay a premium for grain size and white skin color but discount price for other color and number of bruchid holes on the grain. Coulibaly (2002) revealed that seed color and seed size are important characters for farmers needs.

The pair-wise comparison of varieties by farmers in Mareka, Angacha and Lemo districts showed that Variety (Tay) took the second place after variety (Digalu) in Mareka and Lemo districts and the fifth in Angacha (Table 3). The farmer's logic behind this result is that even if the supply of different varieties in bread wheat enables farmers to have their needs gradually satisfied over different years, there is periods improved bread wheat seeds scarcity. Moreover, in all districts, variety Digalu was selected at the first rank by its the following merits; had high yielder, easily adapted to different environment, resistant to disease and frost, had good stands and resistance to lodging, high tillering capacity, quality of grain for bread or "injera", high dough quality and had high market value due to its good seed size and color. Nevertheless, variety HAR-604 (Galema) had not selected by farmers in all tested areas due its poor performance and highly susceptible to diseases and insect pests particularly yellow rust and frost.

Variety Millennium was also selected at the third place by Mareka and Angacha farmers; it has good tillering capacity, had good seed size and color.

Based on farmers' field and evaluation concluded that variety Digalu is the most vigorous, persistent and highly adapted variety in all tested environments, and thus can be safely recommended for the all tested districts. Besides, the growth performance of variety Tay is also good at Marko and Lemo; therefore, it is recommended for those areas. However, the performance of HAR-604 is poor in all areas this is probably resulting from unfavorable climatic conditions; as a results, it is not recommended in all tested areas.

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Table 1. The Combined analysis of variance, coefficient of variation, and coefficient of determination (R^2) for five traits assessed in six bread wheat varieties grown at Mareka, Lemo and Angecha districts of southern region.

Source of Variation	Mean square					
	DF.	Plant height (cm)	Spike length(cm)	Number of seeds/spike	Number of days to mature	Yield t/ha
Replication	8	120.45	59.98	10.67	950.95	0.06
Treatments	5	220.9***	17.52***	202.2***	393.06***	0.24*
Location	2	428.7***	368.63***	389.77***	22441.5 ***	1.68***
Treat x Loc	10	113.8***	18.67***	157.53***	347.7***	0.24***
Error	133	30.84	6.21	45.22	53.5	0.10
C.V(%)		5.930	29.99	14.30	5.51	17.92
R^2		0.57	0.62	0.47	0.90	0.44

Note: ***, **, * = significant at 0.1%, 1% and 5% respectively

Table 2. The combined mean and range values of five traits assessed in six bread wheat varieties grown at Mareka, Lemo and Angecha districts of southern region.

Traits	**Mareka**		**Lemo**		**Angacha**		**Combined**	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Plant height(cm)	97.27	75.5-109.2	97.15	80.3-120.6	91.4	72.8-114.1	93.54	72.8-120.6
Spike length(cm)	5.7	3.9-8.1	10.89	5.6-27.3	8.45	5.6-12.8	8.30	3.9-9.95
Number of seeds/spike	43.39	25.5-57.9	47.48	33.8-63	49.27	32.6-70.2	47.01	25.5-70.2
No of days to mature	143.83	135-152	107.06	83-141	147.11	133-167	132.53	83-167
Yield(t/ha)	2.02	1.41-3.01	1.69	1.05-2.46	1.74	0.46-12.4	1.78	0.46-12.4
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Table 3. Varieties and their rankings on the basis of pair-wise comparisons by nine farmers each from Mareka, Angacha and Lemo districts of southern Ethiopia.

Varieties	**Districts**		
	Mareka	**Angacha**	**Lemo**
Millennium	3rd	3 rd	5th
Digalu	1st	1st	1st
Guasay	5th	4th	3 rd
Alidoro	4th	2nd	4th
Tay	2nd	5th	2nd
HAR-604	6th	6th	6th