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Evaluation of Improved Wheat Varieties under Different Management Practices in Eastern Wallaga Highlands, Ethiopia

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Abstracts: Crop management practices enhance wheat yields to be maintained at fairly high levels. Considering this in view a trial was conducted from 1997-1999 cropping season at two locations. Four wheat varieties and one local were used in factorial combination with two management levels (research and farmers'). Different wheat varieties showed significant yielding potential across two locations. Improved and local varieties performed better under research management practices. Higher grain yield of wheat was observed from improved management practices compared to farmers' practices. Improved management practices gave higher marginal rate of return 57.51% of wheat. Local variety with farmers' management practices gave higher mean grain yield. Improved management practices gave yield advantage of 17.45, 0.8 and 7.25% at Shambo, Arjo and combined over location compared to farmers' production practices. The use of improved varieties with research management practices is essential to maximize wheat grain yield. Maximum grain yield and higher net return were realized from improved packages for wheat production. HAR-1685 variety gave better yield with research management practices and recommended for both locations. More importantly, the use of improved management techniques targeted at increasing yield of wheat allowed wheat producers to greatly increasing economic returns. Thus, extension agents should consider this recommendation for wheat production in Shambo and Arjo areas.

Key words: Variety, management levels, wheat

INTRODUCTION

The introduction of new crop varieties on soils with improved management packages has increased food production in some smallholder farmers. The trend however, has been opposite in most smallholder farming system with crop production declining from time to time due poor soil fertility and crop management[1]. The rising cost of commercial fertilizers limited smallholder farmers can afford reasonable quantities that can increase crop yield to their potential yield. In smallholder farming system of Africa nutrient outputs exceeds nutrient inputs[2]. Management options to increase yield and ameliorate productivity of crops are urgently needed for wheat production.

Wheat grain yield potential has significantly increased due to release of improved high yielding varieties[3]. Generally high yielding crop varieties require high agronomic management practices to express their potential yield. Amsal *et al.*[4] recently released cultivars of wheat are highly responsive to improved management systems and require high rates of nutrient application[5]. This further stated that the productivity of improved variety of wheat is more sensitive to management levels compared to local variety. The adoption of high yielding improved varieties without improved management practices should not boost the productivity of wheat. To date however, wheat production with improved management practices is limited due to high price and inaccessibility of fertilizers and overlapping farming activities to smallholder farmers. In addition the current market price of wheat does not profit producers in the area. Furthermore, improved varieties have failed to adequately meet the needs and requirement of marginal environments. Hardon[6] plant breeding stems mainly directed at increasing yield in more favorable environments. Looking for broad adaptability to different environments with alternative management practices for sustainable production of wheat is urgently needed. Giving values to wheat varieties through their alternative management and profitable products will automatically lead to sustainable production. Therefore the objectives

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of this study were to estimate the extent of cultivars vs. management level interaction and thereby identify cultivars that suits to alternate management levels and to identify stable cultivars that could better perform under both low and high management levels.

MATERIALS AND METHODS

The experiment was conducted during the 1997-1999 cropping seasons on farmers field of eastern Wallaga highlands. Shambo lies between 9°34′N latitude and 37°06′E longitude at an altitude of 2400 meter above sea level and 311 km west of Finfinne (Addis Ababa). It receives, the mean annual rainfall of 1695 mm[7]. It has a cool humid climate with the mean minimum, mean maximum and average air temperatures of 8.15, 15.72 and 11.94°C, respectively. Arjo lies between 8°45′N latitude and 36°40′E longitude at an altitude of 2400 m above sea level. It receives, the mean annual rainfall of 1330 mm[7]. It has a cool humid climate with the mean minimum, mean maximum and average air temperatures of 9.33, 17.85 and 13.59°C, respectively. The experiment was laid out in a Randomized Complete Block Design in split plot arrangement with variety as main plots and management levels as sub-plots. The main plots are wheat varieties HAR-710, HAR-1685, HAR-1709, ET-13 and Local variety. The sub-plots are management practices: farmers' management and research management practices for wheat production.

The improved cultural practices were research recommendation for wheat production (150 kg ha^{-1} seed rate and two times hand weeding) The local cultural practices were local farmers cultural practices' for wheat production in that area (160 kg ha^{-1} seed rate and one times hand weeding). The plot size used was 4x4 m. Sowing dates followed farmers' practices, which are undertaken between mid June to early July. For the plots receiving fertilizers, the recommended fertilizer rates of 100 kg ha^{-1} DAP and 100 kg ha^{-1} Urea was applied at planting. For the improved cultural practices, once weeding 25 days after planting and 45-50 days after planting and for the farmer's cultural practices, once hand weeding 25 days after planting. The data were analyzed using MSTATC statistical package[8]. Mean separation was done using Least Significance Difference (LSD) at 5% probability level.

For economic evaluation, partial budget, Values to Cost Ratio (VCR) and marginal analyses were used. To estimate economic parameters, wheat grain yield was valued at an average open market price of EB 143.00 100 kg^{-1} for the last five years. The yield was down adjusted by 10% to reflect actual production environments[9]. The seed cost of wheat was EB 2.40 kg^{-1} for improved variety and EB 1.43 kg^{-1} for local variety. Urea and DAP were valued at the official prices of EB 192.00 and 256/100 kg, respectively. The cost of labour for weeding was EB 3.50 day^{-1}.

RESULTS AND DISCUSSION

Cropping season: Combined yields across years were averaged 2388 kg ha^{-1}, but 1937 and 2839 kg ha^{-1} in Shambo and Arjo (Table 3 and 5). Mean plant height over years averaged 102 cm, but 104 and 99 cm in Shambo and Arjo (Table 2 and 4). Mean plant height and grain yield were varied from location to location indicating differently performance of wheat varieties in two locations. Year significantly ($p<0.05$) affected mean plant height and grain yield of wheat at Shambo and Arjo (Table 1). This might be probable due to the variation environmental factors during the growing season. Similarly Khan *et al.*[10] yearly yield difference may have been the results of temperature and rainfall distribution occurred during growing season. Year x variety interaction significantly ($p<0.05$) affected grain yield but non-significant effect on plant height of wheat at Shambo but at Arjo year x variety interaction significantly ($p<0.05$) affected mean plant height and grain

Table 1: Mean square of plant height and grain yield of wheat due to varieties and management levels across years and location at Shambo and Arjo

		Shambo		Arjo	
SOV	DF	Plant height	Grain yield	Plant height	Grain yield
Year	2	4065.547**	10724565.608**	249.417**	22671837.300**
Varieties	4	9671.830**	4140301.896**	5585.185**	3896991.488**
Year x Varieties	8	78.971	2224133.483**	273.609**	1005902.487**
Error	36	34.284	101546.365	45.577	199823.499
Management level	1	635.26**	2494481.408**	118.405	15142.533
Year x Management level	2	716.536**	487826.558**	86.801	159456.233
Varieties x Management level	4	13.858	78042.596	53.838	577485.762**
Year x Varieties x Management level	8	52.872	98135.121	117.801**	163757.838
Error	45	54.731	84329.147	29.116	150158.606

** Significant at 1 and 5% level of probability, respectively

Table 2: Effects of varieties and management levels on plant height (cm) of wheat at Shambo and Arjo, Ethiopia

	Treatments	Varieties					
Location	Management practices	HAR-710	HAR-1685	HAR-1709	ET-13	Local	Mean
Shambo	Farmers management	90	82	104	102	135	102
	Improved management	94	87	109	109	138	107
	Mean	92	84	106	105	137	
Arjo	Farmers management	88	80	103	101	118	98
	Improved management	87	81	104	108	120	100
	Mean	87	81	103	105	119	

Table 3: Mean effects of variety and management levels on grain yield (kg ha^{-1}) of wheat at Shambo and Arjo, Ethiopia

	Treatments	Varieties					
Location	Management practices	HAR-710	HAR-1685	HAR-1709	ET-13	Local	Mean
Shambo	Farmers management	1707	2489	1573	1376	1764	1782.00
	Improved management	2021	2822	1942	1794	1884	2093.00
	Mean	1864	2655	1758	1585	1824	
	Yield change (%)	18.39	13.38	23.46	30.38	6.80	17.45
Arjo	Farmers management	2561	3598	2661	2575	2747	2828.00
	Improved management	2565	3467	2582	3130	2510	2851.00
	Mean	2563	3533	2622	2853	2628	
	Yield change (%)	0.16	-3.64	-2.97	21.55	-8.63	0.81

Table 4: Combined mean effects of varieties and management levels on plant height (cm) of wheat at Shambo and Arjo, Ethiopia

Treatments	Varieties					
Management levels	HAR-710	HAR-1685	HAR-1709	ET-13	Local	Mean
Farmers management	89	81	103	102	127	100
Improved management	91	84	106	109	129	104
Mean	90	82	104	105	128	

yield. This indicates the performance of different wheat varieties were affected by the variation environmental factors across cropping season.

Year by management practices interaction significantly affected mean plant height and grain yield at Shambo indicting variation in performance of varieties across cropping season with management practices. At Arjo year by management practices interaction non-significantly affected mean plant height and grain yield indicting similarity performance of varieties across cropping season with management practices. Year by variety and management practices interaction were non-significantly affected mean plant height and grain yield of wheat at Shambo (Table 1). At Arjo year by variety and management practices interaction significantly affected mean plant height of wheat (Table 1). This indicated that mean growth wheat varieties vary with management practices applied across cropping season.

Plant height: Plant height of wheat significantly ($p<0.05$) different among varieties at Shambo, Arjo and combined over locations. This justifies that different varieties performed differently in a similar environment. Mean plant height ranged from 84 to 137, 81 to 119 and 82 to 128 cm at Shambo, Arjo and combined over locations recorded from HAR-1685 and local varieties (Table 2 and 4). Relatively higher plant height was recorded from local varieties compared to improved varieties. This indicated local variety significantly taller than improved varieties.

Management practices significantly ($p<0.05$) increased mean plant height at Shambo and combined over locations but non-significant at Arjo (Table 1, 2 and 4). Higher mean plant height of wheat was obtained from improved management practices. Varieties by management practices interaction exhibited non-significant effects on plant height at both locations and combined over locations.

Grain yield: Grain yield of wheat significantly ($p<0.05$) different among varieties at Shambo, Arjo and combined over locations. This may be attributed due to variation in productivity potential of different wheat varieties. This indicates that variation in growth and yield potential existed between wheat varieties. Moreover, the result justify that wheat varieties was varying in yield ability for the same location. Yield optimisation of wheat is possible by providing different varieties of wheat for producers of a given area. Significantly higher grain yield 2655, 1864 and 1824 kg ha^{-1} was recorded from HAR-1685, HAR-710 and local varieties at Shambo (Table 3). At Arjo HAR-1685 followed by ET-13 and local was produced significantly higher grain yield of 3533, 2853 and 2628 kg ha^{-1}(Table 3). Combined higher mean grain yield of 3094, 2226 and

Table 5: Combined mean effects of variety and management levels on grain yield (kg ha^{-1}) of wheat at Shambo and Arjo, Ethiopia

Treatments	Varieties					
Management levels	HAR-710	HAR-1685	HAR-1709	ET-13	Local	Mean
Farmers management	2134	3043	2117	1976	2256	2305
Improved management	2293	3145	2262	2462	2197	2472
Mean	2213	3094	2190	2219	2226	
Yield change (%)	7.45	3.35	6.85	24.60	-2.26	7.25

Table 6: Partial budget and Marginal Rate of Return (MRR) analyses for the effects of management levels on the mean grain yield of wheat at Shambo and Arjo, Ethiopia

	Management levels	
Items	Farmers management	Research management
Average yield (kg ha^{-1}) wheat	2305.00	2472.00
Adjusted yield (kg ha^{-1}) wheat	2074.50	2224.80
Gross field benefit of wheat	2966.54	3181.46
Total field benefit (EB ha^{-1})	2966.54	3181.46
Costs that vary (EB ha^{-1})		
Seed cost (EB ha^{-1})	306.00	287.25
Weeding cost (EB ha^{-1})	246.95	402.15
Total costs that vary (EB ha^{-1})	552.95	689.40
Net benefit	2413.59	2492.06
Values to cost ratio	4.36	3.61
Marginal Rate of Return (MRR)		57.51%

EB= Ethiopian Birr, 1$= 8.76

2219 kg ha^{-1} obtained from HAR-1685, local and ET-13 wheat varieties (Table 5).

Management practices significantly ($p<0.05$) increased mean grain yield of wheat at Shambo and combined over locations but non-significantly ($p>0.05$) different at Arjo (Table 1, 3 and 5). This indicated that management levels influenced the yield potential of different wheat varieties. Grain yield advantage of 17.45, 0.81 and 7.25% at Shambo, Arjo and combined over locations were obtained from improved varieties compared to local traditional practices. Similarly Akalu *et al.*[11] and Alem *et al.*[12] found 88% advantage of improved management practices over local practices and Ngaboyisong[13] grain yield of maize out yielded under improved package compared to local traditional practices. The result also Agree with Subhn and Khan[14] improved production practices increased wheat yield by 37 and 29%, respectively. This justifies that use of improved management technology boost the productivity of wheat varieties which is in consistence with Maman *et al.*[15] high management level increased grain compared to traditional farmer practices. Higher grain yield of wheat with improved agronomic practices is possible for the area. All varieties used have significant responses to management levels for both locations. Thus farmers can increase wheat yields by using improved management practices.

Varieties by management practices interaction non-significant effects grain yield of wheat at Shambo but significantly ($p<0.05$) increased at Arjo and combined over locations (Table 1, 3 and 5). Different varieties had different responses to management levels. Higher mean grain yield of wheat was indicated from improved management practices. Similarly Katyal[16] use of improved practices, cultivars and NPK application gave the highest yield, returns and profitability. Improved varieties had better responses to management levels. Improved management practices gave grain yield advantage of 6.80 to 30.38, -8.62 to 21.55 and -2.62 to 24.60% at Shambo, Arjo and combined over locations compared to traditional cultural practices (Table 3 and 5). Bhagat and Singh[17] improved agronomic practices gave a 47% increase in rice-equivalent yield compared with local farmers practices (local cultivars and 30 kg N ha^{-1}). This result was in consistence with Alem *et al.*[12] in faba bean; Ngaboyisong[13] and Majeed *et al.*[18] in maize; Hanif *et al.*[19] and Khan *et al.*[10] in wheat; Kumar and Singh[20] in mustard. This justify that aware of farmers with improved packages maximize the grain yield of wheat and profit earning of producers.

Improved wheat variety HAR-1685 gave higher mean grain yield at both locations. This justify that variety HAR-1685 had wide adaptability and stable compared to other varieties. HAR-1685 variety is the most adaptable variety to sites on the basis of high yielding. The result is in agreement with Nassiuma and Wasike[21] in soybean. Considering the advantage of improved agronomic practices to wheat production across two locations are very crucial to boost the productivity and sustainable production. Sayre[22] technologies for sustainable crop management practices relevant to small wheat farmers can become a reality. Providing different improved wheat varieties with improved packages to farmers are essential practices for maximum production and profit.

Economic analysis for management practices indicated that the highest net benefit of EB 2492 ha^{-1} with marginal rate of return of 57% and values to cost ratio of EB 3.61 profit per unit of investment for wheat were obtained from improved management practices (Table 6). The net benefit for farmers' cultural practices was EB 2414 ha^{-1} with values to cost ratio of EB 4.36 profit per unit investment for wheat production. The values to cost ratio with both management levels accommodate the price production and provides profit to wheat producers of the area. With the average current prices of input of

production use of both management technologies were economically optimal and profitable. The result of this finding justifies that improved management practices boost the yield of wheat.

In conclusion improved management practices yielded more plant height and grain yield. The economic analysis also confirm the use improved management practices for wheat production in Shambo and Arjo highlands are profitable. HAR-1685 variety showed wide adaptability compared to other varieties. Therefore, the use of HAR-1685 variety with improved management practices are profitable for wheat production at Shambo and Arjo highlands.

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