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ON-FARM VERIFICATION OF IMPROVED BREAD WHEAT VARIETIES AND MANAGEMENT PRACTICES IN GOJAM REGION OF ETHIOPIA

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ABSTRACT

Three released bread wheat varieties, namely Dashen, HAR 407, and HAR 416, were evaluated on-farm for two consecutive years (1988 and 1989) in four awrajas of West Gojam Administrative Region which were considered potential areas for the expansion of bread wheat production. The varieties were tested under both high and low management at each site. The performance of the varieties in terms of grain yield and economic return varied across sites, basically in line with the level of soil fertility, management practices (i.e. land preparation, fertilization and weed management) and other localized factors such as vertebrate pests and drainage problems. From farmers' pre- and post- assessment of the varieties, Dashen would have potential acceptability in the Adet and Bahir Dar mixed farming zones.

INTRODUCTION

North-western region in general and Gojam region in particular are among the important wheat growing areas of Ethiopia (Alelign 1988; Amanuel *et al.* 1989), and are considered as potential areas for the expansion of bread wheat production. Despite the perceived potential of the region in general, bread wheat production in mid-altitude zones of Yilmana Densa, Bahir Dar, Mecha and Achefer awrajas of West Gojam administrative region is scanty and is commonly produced only in highland zones (greater than 2500 m). In the high altitude zones of these awrajas a local, very tall and awnless bread wheat known as Israel is produced. In the mid-altitude area, producer cooperatives and a few individual farmers have started producing to a lesser degree improved bread wheat varieties such as Enkoy and ET13. Durum is the wheat type commonly grown, in Yilmana Densa, it grows on black clay soils with residual moisture and sometimes faces moisture stress. In Mecha and Achefer awrajas it is also grown under a tree known as "Warka".

Many families especially those with less than two oxen, face food deficit usually in July-August (Alelign 1988; Alelign and Regassa 1989). One of the possible reasons for the seasonal food shortage

is the low productivity of crops and/or crop varieties managed by farmers. For instance, the local durum and bread wheat cultivars yield between 0.4-0.8 t/ha. On the other hand, an on-station bread wheat variety verification trial conducted from 1986 to 1987 at Adet Research Center indicated that the varieties Dashen, HAR 407 (Veery), HAR 421 and HAR 416 can give yields of 3.3-4.4 t/ha depending on variety (IAR, 1986/87). It was hypothesized that introduction of such high yielding bread wheat varieties may increase productivity per hectare and help to alleviate the seasonal food deficit problem for those who face it and help to generate marketable surplus for those who do not face food deficit problem. The objective of this study was to assess the performance of improved bread wheat varieties under high and low management levels in farmers' fields.

MATERIALS AND METHODS

The experiment was conducted in four awrajas of West Gojam administrative region namely, Yilmana Densa, Bahir Dar, Mecha and Achefer awrajas for two consecutive years (1988 and 1989). The total sites planted were eighteen, however, data are available for only twelve sites (four sites from 1988/89 and eight sites from 1989/90).

Six sites were lost due to bird attack and drainage problems resulting from excess rainfall received during the 1988/89 cropping season. The distribution of the sites among awrajas was based on their perceived potential for bread wheat production.

The treatments were arranged in randomized complete block design with two replicates per site. The plot size was 50 m^2 (5 m x 10 m). The test varieties in 1988/89 were Dashen, HAR 407 (Veery), HAR 421 and HAR 416 and these were tested under high and low management levels as main plots. In the 1989/90 cropping season, the variety HAR 421 was not included in the experiment because of its susceptibility to major wheat diseases. The high management package included two hand weedings at 25-35 and 45-55 days post-emergence, and fertilizer at a rate of 60-60 kg N-P_2O_5 per hectare (130 kg DAP and 80 kg Urea) at planting. The low management package consisted of the average farmers' practice for barley in the area (i.e. fertilizer at a rate of 13.5-34.5 kg N-P_2O_5 hectare (75 kg DAP) and one hand weeding or selective weeding of major weeds. A seed rate of 150 kg/ha was used for all treatments. The cooperating farmers were advised to weed the low management plots but only six sites were weeded. These six sites were weeded once, either selectively or intensively and the rest were left unweeded. The land preparation (time, method and frequency) was determined by farmers according to their will. The number of land preparations varied from three to five including covering and was dictated by the type of precursor crop. At most of the sites three plowings were done using oxen plow (Maresha). The soils of the experimental sites were mostly reddish-brown Nitosols.

The data collected include grain and straw yield, labor data on weeding and harvesting, price of fertilizer and labor and Adet local market price of bread wheat. Farmers' opinions and observations of the varieties with respect to certain characteristics like maturity length, grain color and size and uniformity of maturity were gathered.

RESULTS AND DISCUSSION

The combined statistical analysis of grain yields of the three cultivars in common over twelve sites (site-year combinations) indicated significant differences among varieties, sites and between the two management levels. The mean grain yields of the varieties at different sites and under the two management levels in 1988/89 and 1989/90 cropping seasons are shown in tables 1 and 2. Over all, there was much variation in yield across sites. The lowest average grain yield (543 kg/ha) was recorded at Woreb and highest (2448 kg/ha) was at Enguti. This can be attributed to variability in soil fertility and level of weed infestation (burden) among sites. The variability of the sites in soil fertility is supported by the results of on-farm fertilizer response trial conducted in the area in 1988

to 1989 using Dashen (Amanuel *et al.* 1989). There was a high level of fertilizer by site interaction reflecting a high degree of heterogeneity within the area with respect to fertility.

In 1988/89 cropping season, Dashen gave the best grain yield under both management levels whereas in 1989/90 the best grain yield was obtained from HAR 407 (Veery) (Tables 1 and 2). The superiority of Dashen in yield to others in 1988/89 under low management may be due to weed management. In this year, the trial was hosted by individual farmers and most of the low management plots were at least partially weeded; while in 1989/90 the trial was hosted by producer cooperatives and most of the low management plots were left unweeded. Improvement in management (fertilization + weeding) resulted in, a 47-80% yield increment depending on the variety. Overall, the management x variety interaction effect was non-significant indicating the similarity of the response of the varieties to the two levels of management. In 1989/90 cropping season HAR 407 gave the highest yield under low management at five out of eight sites. This is in agreement with the previous unpublished report that HAR 407 produced the highest mean grain yield compared to Dashen, HAR 416 and ET13 under unfertilized condition.

Varietal response varied across sites as the variety x site interaction effect was significant. At sites characterized by poor soil fertility, poor seedbed preparation and high weed populations such as Dibikan, Abchikly and Woreb the varieties performed inconsistently. Moreover, the altitudes of these sites are relatively low.

Partial budget analysis was carried out using labor, fertilizer and yield data for each variety x management combinations (Table 3). The total costs that vary ranged from 400-420 Birr/ha for high management treatments and from 165-173 Birr/ha for low management treatments. Under high management, over 45% of the total costs that vary was spent on the labor input for weeding. Among the three varieties, Dashen demanded the highest labor input (101 work-days per ha) for weeding followed by HAR 407 which required 97 work-days per hectare.

Dashen gave the highest net benefit under both management levels, providing an additional net benefit of 171 Birr/ha under high management and 160 Birr/ha under low management relative to HAR 416. The incremental net benefit of Dashen relative to HAR 407 was 40 and 129 Birr/ha under high and low management levels, respectively.

A separate partial budget analysis was done for the two management levels (Table 4). The net benefit for the high management of 478 Birr/ha has not got an acceptable marginal rate of return (MRR) (34%) relative to the corresponding net benefit for the low management (396 Birr/ha). In most economic analysis, it is assumed that farmers require a 50% rate of return, that is, an increase in net return of at least 1 Birr for every 2 Birr invested. In most countries the range is between 50-100% (CIMMYT 1988). Therefore, application of 60-60 kg N-P_2O_5/ha and two hand weedings was not profitable under the current prices of labor, fertilizer and wheat.

The effect of variation in price of wheat on profitability of application of 60-60 kg N-P_2O_5/ha and twice hand weeding was assessed using sensitivity analysis. Assuming minimum acceptable rate of return to be 50% and keeping price of labor and fertilizer constant, application of 60-60 kg N-P_2O_5/ha and twice hand weeding would be profitable only if the current field price (54.55 Birr/100 kg) is increased by more than 12.25%. However, if the minimum acceptable rate is assumed to be 100%, which might be realistic given the farmers' weeding practices and cost and unavailability of fertilizer in Ethiopia, application of 60-60 kg N-P_2O_5/ha and twice hand weeding would be profitable if the current field price of wheat is increased by more than 51%.

Pre- and post-harvest farmers' assessment of the varieties were made. The pre-harvest assessment included all host farmers (18 farm families). In addition group discussion was conducted with the

neighboring farmers. In pre-harvest assessments yield potential and the ability of the variety to produce synchronous tillers were reported by most farmers as important criteria determining varietal preferences (Table 6). In assessing the yield potential farmers used the tillering and head size as indicators. In yield potential almost all farmers preferred Dashen followed by HAR 407 and HAR 416 respectively (Table 5). However, Dashen failed to produce synchronous tillers which created the problem of non-uniformity in maturity.

Post-harvest farmers' assessment of the varieties were taken from seven host farmers. In addition, grain from the trials was threshed back at the station and each variety labelled with different color was given to five households. The farm families were allowed to consume each variety in different forms such as bread, "injera" and "kolo" (roasted grain). A month later, the farmers were interviewed about post-harvest qualities of the varieties. The most important post-harvest qualities noted to influence farmers preferences were seed size, seed color, and appearance since these factors have a considerable impact on the marketability of the crop. None of the three varieties are comparable to the local bread wheat cultivar ("Israel") in seed size, seed color and appearance, however, the latter is low yielding. Among the three cultivars Dashen ranks first in seed size, grain color and appearance. In bread quality HAR 416 was rated first followed by Dashen.

CONCLUSIONS

- The performance of the varieties in terms of yield and economic return varied across sites, basically in line with the level of soil fertility, management practices (land preparation and weeding) and other environmental factors such as bird and rat attack and drainage problems.
- The differential response of the varieties to level of management was statistically not significant; however, Dashen performed better than both HAR 407 and HAR 416 under high management. According to the 1989/90 cropping season results, variety HAR 407 performed slightly better in grain yield than Dashen and HAR 416 under low management condition.
- According to farmers, the local bread wheat cultivar, Israel, has got the best post-harvest qualities which include white seed color, big seed size, and good appearance in comparison to the three varieties tested. Dashen is slightly closer to the local cultivar in the above mentioned post-harvest qualities.
- From farmers' pre-and post-harvest assessment of the varieties, Dashen would have potential acceptability be in Adet and Bahir Dar mixed farming zones.
- A major weakness of this study is the exclusion of a local wheat as a check. This was included when the study was planned but omitted as one of the experimental variables after the center management suggested that the local wheat, Israel was already known to be a poor performer.

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Table 1. Mean grain yield of four bread wheat varieties under high and low management levels at four sites in 1988 (kg/ha).

Variety	Sites				Variety mean
	Adet Hana	Debremewi	Fereswega	Dibikan	
High management					
HAR 416	1310	1770	1150	1060	1323
HAR 421	1955	1870	1465	1150	1610
HAR 407	1890	2415	2960	655	1980
Dashen	2570	2075	2200	1325	2043
Site mean	1931	2033	1944	1048	1739
Low management					
HAR 416	1050	1635	935	815	1109
HAR 421	955	1080	780	1525	1085
HAR 407	610	1165	1240	790	951
Dashen	1385	3030	1225	2135	1944
Site mean	1000	1728	1045	1316	1272
Grand mean	1466	1881	1495	1182	1506
C.V.(%)					30.12
LSD(.05)					467.9

Table 2. Mean grain yield (kg/ha) of three bread wheat varieties under high and low management levels at eight sites in 1989.

Variety	Sites								Variety mean
	Kore	Bachma	Abchikly	Dibikan	Enguti	Debremewi	Meshenti	Woreb	
High management									
HAR 416	1536	1931	1076	2111	2414	1535	1122	578	1538
HAR 407	2159	1938	957	1469	2924	1927	1529	662	1696
Dashen	1588	1517	942	2107	3073	2141	1845	801	1752
Site mgmt mean	1761	1795	992	1896	2804	1868	1499	680	1662
Low management									
HAR 416	1053	658	451	525	2072	912	837	418	866
HAR 407	865	863	492	1265	2212	931	977	483	1011
Dashen	676	928	341	1079	1993	1582	350	315	908
Site mgmt mean	865	816	428	956	2092	1142	721	405	928
Grand mean	1313	1306	710	1426	2448	1505	1110	543	1295
C.V.(%)									21.48
LSD(.05)									NS

Table 3. Partial budget for on-farm bread wheat variety verification trial at twelve sites (Adet, 1988-89).

	High management			Low management		
	HAR 416	HAR 407	Dashen	HAR 416	HAR 407	Dashen
Average yield (kg/ha)	1466	1790	1849	947	991	1253
Adjusted Yield (kg/ha)	1319	1611	1664	852	892	1128
Gross field benefit (Birr/ha)						
Grain value (Birr/ha)	720	879	908	465	487	615
Straw value (Birr/ha)	56	40	59	33	43	51
Total gross field benefit (Birr/ha)	776	919	967	498	530	666
Costs that vary						
Fertilizer cost (Birr/ha)	196	196	196	75	75	75
Weeding cost (Birr/ha)	184	194	202	72	73	79
Harvesting cost (Birr/ha)	20	22	22	18	18	19
Total costs that vary (Birr/ha)	400	412	420	165	166	173
Net benefit (Birr/ha)	376	507	547	333	364	493

Notes:

1. Bread wheat field price = 56.55 Birr/100 kg - 2 Birr/100 kg = 54.55 Birr/100 kg (Jan./1989 to Jan./1990 average Adet price minus transport cost).

2. Barley and tef straw value was estimated at 0.024 Birr/kg in the area based on farmer interviews. In the absence of an alternative, this value was used in the analysis, though wheat straw is of inferior quality.

3. Price of labor: farmers in the region pay 1.00 to 1.50 Birr/day plus the provision of lunch and sometimes dinner depending on the closeness of relationship. The rate used in this analysis was 2 Birr/day.

4. Weeding labor costs under low management were estimated by regressing weeding labor on yield using the data taken from high management plots.

5. Yield adjustment = 10%.

Table 4. Partial budget for the two management treatments.

	High management		Low management
Average yield (kg/ha)	1702		1064
Adjusted yield (kg/ha)	1532		958
Gross field benefit (Birr/ha)			
Grain value (Birr/ha)	836		523
Straw value (Birr/ha)	52		42
Total gross field benefit (Birr/ha)	888		565
Costs that vary			
Fertilizer cost (Birr/ha)	196		75
Weeding cost (Birr/ha)	193		75
Harvesting cost (Birr/ha)	21		19
Total costs that vary (Birr/ha)	410		169
Net benefit (Birr/ha)	478		396
Marginal cost (Birr/ha)		241	
Marginal benefit (Birr/ha)		82	
Marginal rate of return (%)		34	

Table 5. Ranking of the varieties for criteria influencing farmers' varietal preferences.

No.	Criteria	Varieties		
		Dashen	HAR 407	HAR 416
1	Yield potential (yield)	1*	2	3
2	Earliness	3	2	1
3	Seed size	1	2	3
4	Seed color	1	3	2
5	Appearance	2	3	1
6	Bread quality	2	3	1
7	Synchrony of tillering (uniformity in maturity)	3	2	1

* number indicates ranking of the varieties for a given criterion.

Table 6. Factors determining the choice and rejection of wheat varieties.

Factors	Answer
Yield potential (yield)[1]	100
Seed size[2]	100
Uniformity in maturity[1]	94
Seed color[2]	92
Appearance[2]	83
Injera quality[2]	75
Bread quality[2]	67
Earliness[1]	33
Kolo quality[2]	25

[1] number of samples for pre-harvest qualities = 18.
[2] number of samples for post-harvest qualities = 12.