Performance of Hybrid Maize

BH-140

Under Sub-optimal Soil Fertility Condition Around Bako

Abdisa Gemedo

Research Report No. 28

Institute of Agricultural Research
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Maize hybrids yield better than open-pollinated varieties (OPVs). However, they have not been used widely for their higher input and management requirements, which most small holding farmers cannot afford. Fertilizer is one of the complementary inputs for optimum yield from hybrids. Fertilizer use, however, has been constrained by exorbitant cost and supply/delivery problems. Hence, farmers around Bako apply 10 kg ha\(^{-1}\) of N and 25 kg ha\(^{-1}\) of \(P_2O_5\) on maize, while the recommended rate is 100 kg ha\(^{-1}\) of N and 50 kg ha\(^{-1}\) of \(P_2O_5\).

On-station yield trials using BH-140 hybrid maize showed that it has adapted the area and is giving better yield. The performance of BH-140 under farmers' management was not verified. Consequently, in 1992 BH-140 was compared with two OPVs; namely Beletech and local Burrie in farmers' fields around Bako. Maize types differed significantly in yield potential. BH-140, Beletech, and local Burrie yielded 37.08, 34.33, and 32.17 q ha\(^{-1}\), respectively. BH-140 was more liked by farmers for its early maturity, lodging tolerance and prolificacy. Production of BH-140 was also highly profitable.
Maize is the major crop enterprise in area of coverage, volume of production, dietary source and cash earning of the farmers in the Bako area (Legesse et. al. 1987). Different segments of the society directly or indirectly are engaged in producing, distributing and/or consuming maize. In 1991, maize occupied 58% of land under production around Bako. Currently, maize is the principal commodity to which substantial amounts of resources are being allocated in order to support research and extension work on it.

Under optimum conditions, hybrids are better yielders than open-pollinated varieties (OPVs) (Purseglove 1972). However, they have not been preferred by farmers for their high input and intensive management requirements, which are beyond the resource capability of small holding farmers around Bako. Because of this, less emphases was given to the development of hybrids. Consequently, only a few small holding farmers grow hybrids in Ethiopia. They mostly plant OPVs of their own landraces or improved composites. On the other hand, the majority of farmers in countries like Kenya, Tanzania and Zimbabwe grow hybrids and get yield benefit out of them (MoA 1989).
Studies on the adoption of technologies around Bako revealed that farmers adopt technologies in a step-wise manner, not at once. This implies that each new technology has to be verified separately so that its effect will not be complicated with other technological components. BH-140 hybrid was developed at Bako Research Center and released in 1988. However, the performance of the hybrid was not verified in comparison with local cultivars, under farmers’ crop husbandry situation, socio-economic and agro-ecological circumstances. Such information is useful to researchers and extension workers. The objectives of the study were:

- to evaluate the agronomic and economic performances of BH-140 under farmers’ current management conditions such as suboptimal fertilizer rate,
- to assess farmers’ perceptions or impressions about hybrids in comparison with their local cultivars, and
- to indicate conditions under which the adoption of hybrids could be enhanced.
Materials and Methods

The trial was conducted in 1992 at eleven sites within radius of 30 km from Bako Research Center. These were Bacharaoda-waldie (one site), Checka haga-Amara (two sites), Ebicho (two sites), Muri-Dambi (one site), Sonbokejo (two sites), Tullu-Dhanku (one site) and Wandie (two sites). The area, where the sites are located, is a mid-altitude (1650 m) zone with an average annual rainfall of 1213 mm. The soil type is reddish-brown Nitosols locally known as "Bolale". The following two approaches were implemented in the verification trial.

Researcher Designed—Farmer Implemented Trial (RD–FIT)

The trial was laid out in a randomized complete block design with three maize types and two replications per site. The maize types were BH-140, Beletech (standard check), and Burrie (local check). The gross plot size was 10 m x 10 m (100 m²) and net plot size was 9.6 m x 9 m (86.4 m²).

Based on the farming systems diagnostic survey result of 1986
(Legesse et al. 1987), the non-experimental variables that were kept at model farmer's practice include:

- spacing of 55 cm between rows and 40 cm between plants, one plant per station (giving a plant population of 45,455 ha⁻¹) at approximately 25 kg ha⁻¹ of seed rate,
- fertilizer rate of 0.48 kg urea and 54.35 kg DAP (equivalent to 10 kg ha⁻¹ of N and 25 kg ha⁻¹ of P₂O₅.

The remaining non-experimental variables such as weeding were left to be applied by farmers according to their own frequency, method, and time of operation.

**Farmer Designed–Farmer Implemented Trial (FD-FIT)**

About two kg of BH-140 seed was given to each of the 14 sample farmers. They were advised to plant and manage the hybrid maize as they do their local maize. During the growing season of the crop, researchers made frequent visits to the farmers' fields in order to observe the performance of the crop and record data on farmers' impressions.

For both trials, follow-up studies on non-yield characteristics and farmer's acceptance of hybrid maize were undertaken. Farmers were advised not to plant the grain obtained from BH-140 for the next cropping season, because of yield inferiority due to loss of hybrid vigor.

Variables measured for analysis of the on-farm data were selected based on the criteria defined by farmers to evaluate maize types. These were yield tolerance to lodging and
disease, prolificacy, and other characteristics. The yield data were subjected to statistical analysis of variance. Least significant difference test was used for mean separation. Yield stability was measured by coefficient of variation: standard deviation of yield across sites divided by mean yield of sites multiplied by hundred. Mean percentage of lodged, barren, and diseased plants were also calculated.

Economic Analysis

Estimates for economic analysis were made with the assumption that only costs of variable items determined by maize types could affect the investment decision of farmers and under the new economic policy of the country seed organizations would stabilize seed cost. Hence, cost of seed was assumed not sensitive to demand and supply fluctuations.

Assumptions

- Market price of local or composite maize seed was Birr 60.00 q⁻¹ and farmers use their own seed.
- Market price of hybrid seed was Birr 300.00 q⁻¹ and farmers buy from seed organizations.
- Regardless of type, market price of maize grain was Birr 60.00 q⁻¹.
- Cost of transporting seed from market to farm (cost of hiring a donkey for a day) was Birr 3.00.
- Alternative (opportunity) cost of harvesting and shelling labor was Birr 1.00 q⁻¹.

Hence, field price of hybrid seed (input) was estimated at Birr
303.00 q\(^{-1}\) (Birr 75.75/25 kg seed). Field price of maize seed was Birr 56.00 q\(^{-1}\) (Birr 14.00/25 kg seed).

The on-farm maize grain yield was adjusted downward by 2.5\% to account for the difference that might exist between yields from experimental plots and farmers’ fields. The yield adjustment coefficient was very low, because management operations were kept at farmers’ level and operated by themselves.

All yield and non-yield parameters as mentioned by farmers were considered. Farmers’ preference to each maize type for the different characteristics was ranked based on the number of farmers responding.
Results and Discussion

Statistical analysis of on-farm verification of BH-140 revealed that the sites were not homogeneous (P=0) (Table 1). The major sources of variation appeared to be the difference in management practices of farmers. These included:

- frequency of land preparation (3-4 times),
- frequency of weeding (1-4 times),
- date of planting with respect to the onset of rain (late, early, and timely),
- weeding method (hoeing, ox-cultivation, hand pulling, and slashing),
- time of harvesting with respect to the physiological maturity of maize types (early, late, and timely) and
- the previous crop, which will affect fertility of experimental plots.

Maize types have different yielding potential (P<5) (Table 1). BH-140 out-yielded both the standard check (Beletech) and the local check (Burrie) (P=1) (Table 2). Least significant difference test, however, indicated that Beletech was not different from Burrie. The performance of the varieties did not differ in different sites, i.e., there was no site by maize type interaction (P>5) (Table 1).

As exposed by the coefficient of variation (CV%) the farmers'
variety, Burrie, was more stable across the sites than BH-140 or Beletech. Consequently, BH-140 and Beletech could be more responsive to different management levels such as optimum fertilizer rates than Burrie.

Table 1. ANOVA of on-farm verification of BH-140 around Bako, 1992

<table>
<thead>
<tr>
<th>Source</th>
<th>Degree of freedom</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>F value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sites(S)</td>
<td>10</td>
<td>8440.71</td>
<td>844.10</td>
<td>11.33**</td>
<td>0.00</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>819.09</td>
<td>74.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize types(V)</td>
<td>2</td>
<td>314.32</td>
<td>157.16</td>
<td>3.63*</td>
<td>0.04</td>
</tr>
<tr>
<td>S x V</td>
<td>20</td>
<td>1545.99</td>
<td>77.30</td>
<td>1.78NS</td>
<td>0.09</td>
</tr>
<tr>
<td>Error</td>
<td>22</td>
<td>951.51</td>
<td>43.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>12071.61</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CV (%) = 19.16
** = Significant at p=1, * = Significant at p=5, NS = Not significant at p=5.

Table 2. Grain yield and stability of BH-140, Beletech and Burrie tested on 11 farms around Bako, 1992.

<table>
<thead>
<tr>
<th>Maize type</th>
<th>Grain yield* (q ha⁻¹)</th>
<th>Difference from local check (q ha⁻¹)</th>
<th>Stability index (CV%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-140</td>
<td>37.08</td>
<td>6.44**</td>
<td>37</td>
</tr>
<tr>
<td>Beletech</td>
<td>34.33</td>
<td>2.16NS</td>
<td>40</td>
</tr>
<tr>
<td>Burrie</td>
<td>32.17</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>LSD(5%)</td>
<td>2.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD(1%)</td>
<td>3.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = Average of 11 sites, two replications per site. ** = Significant at p=1, NS = Not significant at p=5.
Prolificacy, Lodging and Cob Diseases

Farmers reported that the prolificacy (number of cobs/plant) of local maize cultivars is deteriorating, probably due to genetic factors. This is in agreement with the data in table 3, which show the highest number of barren plants recorded on Burrie. BH-140 was more prolific than Beletech and Burrie.

Around Bako, hail storm occurs for one to two days from mid August to mid September, almost every year and causes heavy lodging of maize plant. BH-140 and Beletech were found to be more tolerant to lodging than Burrie, mainly due to their reduced heights (Table 4). Hence, farmers can minimize the risk of lodging by planting one of the two maize types.

Most frequently grain quality determines the market price of maize. Grain quality is a function of tolerance of the cob to diseases and insect pests. BH-140 was less attacked by cob diseases (grain mould) as compared to the other maize types (Table 3). However, BH-140 is more susceptible to weevils than other maize types.

Many farmers do not produce sufficient food for at least one year. In June and July farmers usually run out of maize and the food shortage lingers until August or September when green maize would be available (Legesse et. al. 1987). BH-140 approximately matures for harvesting green cob 15 to 35 days earlier than the other maize types (table 4) and yields more than the others.
Table 3. Mean percentage of plants barren, lodged and diseased cobs of the three maize types planted in 11 farms around Bako, 1992

<table>
<thead>
<tr>
<th>Maize type</th>
<th>Barren</th>
<th>Lodged</th>
<th>Cob diseased</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-140</td>
<td>5.20</td>
<td>5.00</td>
<td>7.30</td>
</tr>
<tr>
<td>Beletech</td>
<td>20.00</td>
<td>4.03</td>
<td>10.00</td>
</tr>
<tr>
<td>Burrie</td>
<td>38.90</td>
<td>20.00</td>
<td>8.00</td>
</tr>
</tbody>
</table>

Table 4. Characteristics of introduced and local maize types around Bako, 1992

<table>
<thead>
<tr>
<th>Maize type</th>
<th>Height</th>
<th>Days to green cob harvest</th>
<th>Days to dry harvest</th>
<th>Yield potential (q ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(cm)</td>
<td></td>
<td></td>
<td>on-farm*</td>
</tr>
<tr>
<td>BH-140</td>
<td>125</td>
<td>115</td>
<td>140</td>
<td>60</td>
</tr>
<tr>
<td>Beletech</td>
<td>260</td>
<td>130</td>
<td>160</td>
<td>48</td>
</tr>
<tr>
<td>Burrie</td>
<td>398</td>
<td>150</td>
<td>175</td>
<td>50</td>
</tr>
</tbody>
</table>

Source: Banti and Ransom 1991; Asfaw et al. 1991
* Yield under relatively optimum management condition

Economic Analysis

Among the three maize types, BH-140 gave the highest net benefit. Burrie was dominated by Beletech, hence not considered for recommendation. The MRR from Beletech to BH-140 was 143% (Table 5). This implies that for each one Birr invested on BH-140 seed, a farmer could recover the one Birr and get an extra Birr 1.43. Assuming the minimum acceptable rate of return 100%, growing BH-140 would be profitable.
Table 5. Partial budget, dominance and marginal rate of return (MRR) for on-farm verification of BH-140 around Bako, 1992.

<table>
<thead>
<tr>
<th>Item</th>
<th>Maize types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BH-140(A)</td>
</tr>
<tr>
<td>Average yield (q ha(^{-1}))</td>
<td>37.08</td>
</tr>
<tr>
<td>Adjusted yield (q ha(^{-1}))</td>
<td>36.15</td>
</tr>
<tr>
<td>Gross field benefit (Birr ha(^{-1}))</td>
<td>2024.40</td>
</tr>
<tr>
<td>Costs that vary:</td>
<td></td>
</tr>
<tr>
<td>Seed cost (Birr ha(^{-1}))</td>
<td>76.75</td>
</tr>
<tr>
<td>Net field benefit (Birr ha(^{-1}))</td>
<td>1948.65</td>
</tr>
<tr>
<td>MRR</td>
<td>143%</td>
</tr>
</tbody>
</table>

\(^\circ\) Denotes dominated treatment that has net benefits of less than or equal to those treatments with lower costs that vary.

Farmers Assessment

Table 6 presents farmers’ assessment of the performance of maize types. Trials under both RD-FIT and FD-FIT were assessed. Farmers reasoned out the basis for ranking maize types for a specific criterion. For example, they reported that sometimes harvesting maize could be delayed when there is a shortage of labor. When harvesting is delayed, the stalk of BH-140 becomes hallowed and easily breaks. Farmers also considered stalk/stover yield as a criterion for evaluating the performance of maize types, as they use the stalk/stover as firewood and to build farm structures like "gotera" (a traditional storage structure). Hence, BH-140 with low stalk/stover yield was ranked last. Because of its early maturity and short height BH-140 was highly susceptible to vertebrate pests mainly porcupines and wild pigs.
Table 6. Farmers’ ranking* of maize types on the basis of certain criteria, 1992.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>BH-140</th>
<th>Beletech</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating quality (&quot;Esheet&quot;** sweetness)</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Earliness</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tolerance to lodging</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tolerance to foliar diseases</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Susceptibility to vertebrate pests damage</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Yielding potential</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ease for intercropping with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>climbing beans (in the absence of hail storm)</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Ease for intercropping with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>climbing beans (in the presence of hail storm)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Performance under very low fertile soil</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Susceptibility to late harvest</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Stalk and stover yield</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Prolificacy</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

*Ranking by 37 farmers. Rating of maize types for a specific criterion was based on the assessment scale of the majority of farmers around Bako as: 1 - High, 2 - Medium and 3 - Low

** Green cob
BH-140 yielded significantly more than Beletech and Burrie under farmers conditions around Bako. Beletech and Burrie did not differ from each other in yield. However, as Beletech is less susceptible to lodging farmers are advised to grow Beletech rather than Burrie.

Both BH-140 and Beletech were highly responsive to different management conditions. As a result, optimum yield could be obtained by applying the recommended fertilizer rate and other crop husbandry practices.

If not for early green cob harvest, susceptibility of BH-140 to vertebrate pests damage could be minimized by synchronizing its maturity with local cultivars, i.e., late planting of BH-140.

Producing BH-140 was highly profitable. Its sustainable production depends on availability seeds adequately. Therefore, the Federal and Regional Governments have to encourage organizations and individuals in the production and distribution of improved seeds.
Credit schemes which could provide farmers with seed and fertilizers and agricultural cooperatives are essential to the area.

Farmers' evaluation of maize types depends not only on grain yield, but also on other characteristics, specially differences in maturity time, plant height, prolificacy under poor soil conditions, tolerance to lodging, disease, and pests.

The higher yield performance of BH-140 compared to the local cultivar under farmers conditions disproved the idea that, performance of hybrids under low inputs and farmers management levels is poor, but optimum yield is a function of optimum management levels, thus, the use of recommended fertilizer rate and management operations/levels could rise the current yield level near to yields of on-station conditions.

References


