PARTICIPATORY PEARL MILLET VARIETAL EVALUATION  
AND SELECTION IN PAKISTAN

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ABSTRACT

A number of improved pipeline pearl millet varieties including PARC MS-1, PARC MS-2 and Millet 7777 were planted in various agro-ecological zones of Pakistan for 2 years (2004 and 2005). The participatory Mother Trial methodology was for the first time used in Pakistan for varietal evaluation and selection. Six varieties of millet were evaluated along with the local checks. In general, the pipeline varieties developed at the National Agricultural Research Centre had a yield advantage of 22 to 44% over the local checks, and other improved varieties included in the trial. The farmers were involved in varietal selection process. These varieties were selected by the farmers on the basis of plant height, maturity, higher yield, resistance to leaf blight, downy mildew and ergot diseases, drought tolerance, and dual (grain cum fodder) nature of the varieties. Based on the evaluation and selection, these varieties are being released for general cultivation in various ecologies. The results from participatory trials on various agronomic aspects are to be presented and discussed.

Key words: Millet, Participatory, Evaluation, Selection, Pakistan


INTRODUCTION

Pearl millet [Pennisetum glaucum (L.) R.Br.] locally known as “Bajra” is a nutritious course grain cereal. Globally, it is grown on an area of 34.6 million ha with annual production of 28.8 million tons (FAO, 2005). Pearl millet is grown as food and fodder in arid and semi-arid tropical environments. It is an indispensable source of fodder in many countries of the world (Bhatnagar et al., 1998). It has a high nutritional value as feed for poultry and livestock. Its cultivation in crop rotation has been shown to reduce nematode problems in wheat, soybean and potato, which increases its relevance in biological approaches to pest management. Alternative uses of pearl millet grains show its potential for health foods, bakery products and brewing. Millet is the third important cereal in livestock feed in Pakistan. It is a major contributor in the feeding of rural cattle and poultry. In Pakistan millet is the most popular bird seed commodity fed to pet birds (Chughtai et al., 2004). The stover of millet after the harvest of grains is used as a dry fodder, particularly during winter months when feeds are usually scarce. Stover represents up to 50% of the total value of the crop and its value and consumption increases in drought years. In addition, pearl millet is especially grown for its production of green fodder and it serves as an important kharif fodder.

Pearl millet grains are not only nutritionally comparable but are also superior to major cereals with respect to protein, energy, vitamins and minerals. Besides, they are rich source of dietary fibre, phytochemicals, micronutrients, neutraceuticals and hence they are termed us “nutricereals” (Malleshi and Desikachar, 1985).

In Pakistan, it is annually grown on an area of 0.3 million hectare with grain production of 0.20 million tons and a yield of 563 kg ha⁻¹ (FAO 2005). Millet production in Pakistan has literally remained unchanged for the last three decades (Chughtai et al., 2004). During the same period, millet area has declined while the yield has marginally increased.(502- 563 kg ha⁻¹ ) Also the percent millet production used for human food consumption has remained stagnant and now this use is declining.

Currently about 45% of total millet production is used for food while about 50% is used in rural poultry and cattle feeding but not in commercial poultry ration. Industrial processing and non conventional utilization of millet may increase in the near future. Any how it will continue to play a significant role in fulfilling the food, feed and fodder requirements in the dry land areas. Therefore it deserves more attention by researchers, extension workers and policy makers (Chughtai et al., 2004).

The current millet yield in Pakistan (563 kg ha⁻¹) is much lower than the world’s average (831 kg ha⁻¹) (FAO, 2005). Even in Pakistan, the yields up to four or five times higher have been obtained in the experimental plots and at the progressive farmer’s field. This yield gap can be attributed to a number of factors. However, the lack of improved production technology and high yielding improved varieties and the lack of their quality seed have been identified as the most critical factors limiting the production of millet in the rainfed areas. Furthermore, it is grown
under such harsh climatic conditions where other cereals hardly grow to produce grains. These regions are usually characterized by erratic distribution of annual rainfall, high mean temperature and depleted soil fertility. With shrinking land resources and ever increasing population, the best option is to strive for progressive yield growth in pearl millet by using improved variety seed and production technology.

During the last two decades, the research efforts at various public research institutes have resulted in the development and identification of high yielding, drought tolerant cultivars of millet. These have the potential to replace the local low-yielding varieties cultivated by the farmers (Naeem et al., 1990, 1992; Akmal et al., 1992; Shakoor, 1994, 1995). Also, the crop is cultivated by the farmers under conventional methods.

There is a need for on-farm verification of appropriate germplasms and developed varieties of millet adapted to dry ecology of the rainfed areas. In addition, the introduction and adoption of the improved technology to popularize it among the farmers through on-farm demonstrations and verifications may serve as catalyst to increase the productivity as has been proved in many other cases (Tabo et al., 1999 a,b).

The rate of adoption of improved production technology and improved varieties of millet is very slow, practically close to non-existent in the dryland areas. It is very obvious that improved seeds developed by researchers are not readily available to the farmers. Farmers keep their own seed year after year. The yield potential of the farmers' varieties deteriorates over time. Also the farmers plant their crops under unimproved traditional cultural practices. Therefore, to address the improved technology development and quality seed problem, a project activity was undertaken to initiate participatory research in selected districts of Pakistan. The selected districts represent the areas where Millet is the most important cereal crop.

The participatory research approach adopted in the project involves the collaboration of farmers and scientists in agricultural research and development (Bentley, 1994). The project involved the participation of farmers, researchers and extension workers collaborating in a group. Participatory on-farm varietal evaluation and selection activities in several countries are yielding excellent results because the interventions are readily adopted by the farmers (Gautman et al., 2002; Tiwari et al., 2002; Bellon, 2002).

Under this project, the participatory Mother-Baby trial methodology was for the first time used in millet variety evaluation and selection. Two pipeline varieties developed by the National Agricultural Research Centre, two released improved varieties developed by other regional research centres and one hybrid millet alongwith the local checks were evaluated at 6 different locations across the country. Based on the results of the project, the NARC developed varieties on their outstanding performance and selection by the farmers are now being approved and released for general cultivation by the millet growers in Pakistan.

MATERIALS AND METHODS

Two promising pipeline varieties (PARC MS-1 and PAC MS-2) developed by the National Agricultural Research Centre, Islamabad. Two varieties (RARI Composite-1 and RARI Composite-4) released by Regional Agriculture Research Institute, Bahawalpur. One Hybrid Millet-7777 from Pioneer Pakistan Seed Limited and one variety DB-2003 released by Agriculture Research Institute D.I. Khan were included in the trials. The participatory trials were planted at six locations: Islamabad, Chakwal, D.I. Khan, AJK, Bhawalpur and Umerkot. The mother baby trial methodology was for the first time adapted in Pakistan for evaluation and selection of pearl millet varieties planted in different ecologies. At each location, the improved variety already planted by the farmers of the area was included as check for comparison. The mother trials were replicated thrice and planted in Randomized Complete Block Design. These were planted at the research stations. These trials managed by the researchers, were visited by the farmers at different stages. The data were collected and selections were made by the technical staff and the scientists. The farmers were also asked to make their own selections. The baby trials were the two non replicated subsets of the mother trials generally planted at the farmers’ fields and managed by the farmers themselves under the supervision of the scientist. The farmers were asked to select the variety (ies) which fulfilled their requirements. At each location the varieties were grown in a plot size of 4 rows five meter long with 75 cm row to row and 15 cm plant to plant distance. Fertilizers were applied @ 90-45-0 kg NPK ha\(^{-1}\). Half of the N with full dose of P\(_2\)O\(_5\) was incorporated in the soils at planting and the other half was applied when the crop was at six-leaf stage. For plant protection, Furadon Granules @ 16 kg ha\(^{-1}\) was used to control stem borer and shoot fly. Grain yield was recorded from the middle two rows of each plot measuring 7.5 m\(^2\). Grain yields were calculated at 15% moisture level. Data were recorded on days to 50% flowering, plant height, grain and stover yields, disease and insect resistances. Data were statistically analyzed by using Analysis of Variance and the means were compared by Duncan’s Multiple Range Test (Steel and Torrie, 1960).
RESULTS AND DISCUSSION

The data from 6 different locations on four agronomic characteristics, that is, grain yield, days to 50% flowering, plant height and stover yield are presented in Tables 1 to 4. The data on disease and insect reactions were not recorded at all the locations and, therefore, are not presented in this manuscript. Also, the data from the non-replicated baby trials are not presented.

During 2004, the NARC developed promising varieties PARC MS-1 and PARC MS-2 gave 43% and 32% higher mean grain yield, while hybrid Millet -7777 gave 29% higher yield. The released varieties developed by other institutes RARI Composite-1 and RARI Composite-4 produced 23% and 20% more yield while DB-2003 gave 21% higher mean grater yield as compared to the local checks (Table 1). The results from the mother trials during 2005 (Table-1) also indicate the superior yields of the pipeline varieties, NARC developed varieties, hybrid millet and the released varieties over the local checks. The NARC developed varieties out yielded the local checks by 36 to 45%. The hybrid millet-7777 gave 28% higher yield while the released varieties out yielded the local check by 2.22 and 30% in grain yield RARI Composite-1 and RARI Composite-4 developed by Regional Agriculture Research Institute, Bahawalpur out yielded the local checks by 22-30% while the DB-2003 released variety of Agriculture Research Institute, D.I. Khan although with a narrow difference yet it produced 2% higher mean grain yield than that of the local checks.

Table 1. Participatory pearl millet varietal selection mther trial across locations during 2004-05 (Grain Yield Kg/ha)

<table>
<thead>
<tr>
<th>VARIETIES</th>
<th>NARC</th>
<th>D.I.KHAN</th>
<th>AJK</th>
<th>CHAKWAL</th>
<th>BAHAWALPUR</th>
<th>UMARKOT</th>
<th>MEAN</th>
<th>% OF CHECK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>PARC MS-1</td>
<td>2733</td>
<td>1889</td>
<td>2593</td>
<td>1890</td>
<td>3722</td>
<td>2444</td>
<td>2545</td>
<td>143</td>
</tr>
<tr>
<td>PARC MS-2</td>
<td>1867</td>
<td>2222</td>
<td>2309</td>
<td>1985</td>
<td>3333</td>
<td>2370</td>
<td>2348</td>
<td>132</td>
</tr>
<tr>
<td>Millet-7777</td>
<td>2687</td>
<td>1750</td>
<td>2000</td>
<td>1670</td>
<td>3500</td>
<td>2180</td>
<td>2298</td>
<td>129</td>
</tr>
<tr>
<td>RARI Composite-1</td>
<td>1289</td>
<td>1806</td>
<td>2379</td>
<td>2163</td>
<td>3795</td>
<td>2075</td>
<td>2191</td>
<td>123</td>
</tr>
<tr>
<td>RARI Composite-4</td>
<td>1600</td>
<td>1833</td>
<td>2166</td>
<td>2040</td>
<td>3306</td>
<td>1850</td>
<td>2133</td>
<td>120</td>
</tr>
<tr>
<td>DB-2003</td>
<td>2267</td>
<td>1833</td>
<td>2009</td>
<td>1800</td>
<td>3000</td>
<td>2000</td>
<td>2152</td>
<td>121</td>
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<tr>
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<td>934</td>
<td>1556</td>
<td>2028</td>
<td>1540</td>
<td>2833</td>
<td>1792</td>
<td>1781</td>
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<tr>
<td>LSD (0.05)</td>
<td>815</td>
<td>681.00</td>
<td>NS</td>
<td>615</td>
<td>714</td>
<td>713</td>
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</tr>
<tr>
<td>CV (%)</td>
<td>14.89</td>
<td>18.00</td>
<td>15.13</td>
<td>6.15</td>
<td>15.6</td>
<td>14.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2005</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>PARC MS-1</td>
<td>2600</td>
<td>2400</td>
<td>2290</td>
<td>2000</td>
<td>3419</td>
<td>2673</td>
<td>2563</td>
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<tr>
<td>PARC MS-2</td>
<td>2533</td>
<td>2114</td>
<td>2111</td>
<td>1925</td>
<td>3203</td>
<td>2454</td>
<td>2390</td>
<td>136</td>
</tr>
<tr>
<td>Millet-7777</td>
<td>2267</td>
<td>2051</td>
<td>1993</td>
<td>1683</td>
<td>3071</td>
<td>2474</td>
<td>2256</td>
<td>128</td>
</tr>
<tr>
<td>RARI Composite-1</td>
<td>2000</td>
<td>2250</td>
<td>2225</td>
<td>1970</td>
<td>3182</td>
<td>2085</td>
<td>2285</td>
<td>130</td>
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<tr>
<td>RARI Composite-4</td>
<td>1600</td>
<td>2319</td>
<td>2154</td>
<td>1957</td>
<td>2960</td>
<td>1920</td>
<td>2151</td>
<td>122</td>
</tr>
<tr>
<td>DB-2003</td>
<td>1733</td>
<td>2177</td>
<td>2084</td>
<td>1792</td>
<td>2805</td>
<td>1998</td>
<td>1809</td>
<td>102</td>
</tr>
<tr>
<td>Local Check</td>
<td>1533</td>
<td>1753</td>
<td>2010</td>
<td>1557</td>
<td>1654</td>
<td>1691</td>
<td>1759</td>
<td>100</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>82.58</td>
<td>158.00</td>
<td>2.65</td>
<td>120.6</td>
<td>134.5</td>
<td>72.86</td>
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<tr>
<td>CV (%)</td>
<td>17.8</td>
<td>4.15</td>
<td>0.55</td>
<td>1.6</td>
<td>2.61</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The improved varieties already released (RARI Composite-1, RARI Composite-4 and DB-2003) being cultivated by the farmers in different areas, were generally better in yield performance in their specific areas of adaptability (Table 1). For example, DB-2003 developed at the Agricultural Research Station D.I. Khan was particularly high yielding in this area. Similarly, RARI Composite-1 and RARI Composite-4 developed at the Regional Agricultural Research Institute (RARI), Bahawalpur were well adapted to the Bahawalpur area. Hybrid millet -7777 specifically developed for the irrigated areas was significantly out yielded by the released varieties and by the NARC developed pipeline varieties, since most of the trials were planted in high temperature and low rainfall ecologies. In contrast, the NARC developed pipeline varieties (PARC MS-1 and PARC MS-2) performed excellent in all the major millet growing areas of the country. PARC MS-1 gave the highest mean grain yield during both the years and was closely followed by PARC MS-2 (Table-1). The stalk yield data at harvest (Table-4) also indicate superior performance of the pipeline varieties over the local checks and released varieties. PARC MS-1, PARC MS-2, RARI Composite-1 and RARI Composite-4 had 55%, 40%, 35% and 35% higher stover yield than the checks, respectively. Similarly during 2005 again the stalk yield of pipeline varieties and released varieties was 20%, 13% 10% and 10% than the local checks, which indicates that the pipeline and already released varieties are dual purpose, that is, they can give good grain and stover yields. Hybrid millet 7777 was significantly out yielded by the local checks, pipeline and released varieties, since most of the trials were planted in rain fed conditions where as hybrids are generally recommended for irrigated areas. Also the data on plant height (Table-3) indicate why the hybrid millet-7777 is lowest producer of stalk yield. On the other hand the stalk yield data of pipeline varieties indicate, that these varieties are dual purpose, that is, they can give good grain and stover yields.
The data on the days to 50% flowering (Table 2) indicate that in general the NARC developed pipeline varieties were a bit later in maturity than the local checks, anyhow they can fit well for the rainfed ecologies. The plant heights of the NARC developed and other improved varieties were relatively lower than the local checks (Table 3). PARC MS-1, RARI Composite-4 and DB-2003 are, however, the tallest varieties and thus may be more susceptible to lodging and stem breaking. The hybrid millet-7777 is however lowest of all the tested varieties therefore, it can successfully be grown in irrigated areas without any danger of lodging, but the same time it will yield lowest stover weight.

Table 2. Participatory pearl millet varietal selection mother trial across locations during kharif 2004-05 50% flowering (Days)

<table>
<thead>
<tr>
<th>VARIETIES</th>
<th>NARC</th>
<th>D.I.KHAN</th>
<th>AJK</th>
<th>CHAKWAL</th>
<th>BAHAWALPUR</th>
<th>UMARKOT</th>
<th>MEAN</th>
<th>% OF CHECK</th>
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</thead>
<tbody>
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<td>2004</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>PARC MS-1</td>
<td>74</td>
<td>66</td>
<td>56</td>
<td>58</td>
<td>60</td>
<td>71</td>
<td>64</td>
<td>103</td>
</tr>
<tr>
<td>PARC MS-2</td>
<td>73</td>
<td>63</td>
<td>56</td>
<td>55</td>
<td>60</td>
<td>71</td>
<td>63</td>
<td>102</td>
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<tr>
<td>Millet-7777</td>
<td>75</td>
<td>61</td>
<td>55</td>
<td>54</td>
<td>57</td>
<td>72</td>
<td>62</td>
<td>100</td>
</tr>
<tr>
<td>RARI Composite-1</td>
<td>73</td>
<td>58</td>
<td>56</td>
<td>50</td>
<td>61</td>
<td>70</td>
<td>61</td>
<td>98</td>
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<tr>
<td>RARI Composite-4</td>
<td>73</td>
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<td>52</td>
<td>57</td>
<td>66</td>
<td>60</td>
<td>97</td>
</tr>
<tr>
<td>DB-2003</td>
<td>69</td>
<td>57</td>
<td>54</td>
<td>54</td>
<td>58</td>
<td>69</td>
<td>60</td>
<td>97</td>
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<tr>
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<td>57</td>
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<td>59</td>
<td>55</td>
<td>70</td>
<td>62</td>
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<td>13.00</td>
<td>2.00</td>
<td>4.00</td>
<td>3.00</td>
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<tr>
<td>LSD (0.05)</td>
<td>6</td>
<td>3.00</td>
<td>4.00</td>
<td>2.00</td>
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<td>2005</td>
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<tr>
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<td>58</td>
<td>62</td>
<td>59</td>
<td>60</td>
<td>52</td>
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<td>DB-2003</td>
<td>58</td>
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<td>54</td>
<td>54</td>
<td>57</td>
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<td>58</td>
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<tr>
<td>Local Check</td>
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<td>61</td>
<td>58</td>
<td>59</td>
<td>59</td>
<td>58</td>
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<tr>
<td>LSD (0.05)</td>
<td>3.53</td>
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<td>2.87</td>
<td>2.82</td>
<td>3.05</td>
<td>1.55</td>
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<tr>
<td>CV (%)</td>
<td>3.67</td>
<td>2.5</td>
<td>2.11</td>
<td>2.46</td>
<td>2.95</td>
<td>1.48</td>
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</tr>
</tbody>
</table>

Based on these results, it is concluded that the pipeline varieties developed at the National Agricultural Research Centre are not only high yielding, both in the terms of grains and stover, but they are also widely adapted to the millet growing areas of the whole country. Until very recently, the millet varietal development in Pakistan was done mainly for high yield and other related characters. The preferences of the farmers were in general not considered during the selection process. Consequently, the varieties released have not been adopted by the farmers on large scale.

Table 3. Participatory pearl millet varietal selection mother trial across locations during kharif-2004-05 Plant Height (cm)

<table>
<thead>
<tr>
<th>VARIETIES</th>
<th>NARC</th>
<th>D.I.KHAN</th>
<th>AJK</th>
<th>CHAKWAL</th>
<th>BAHAWALPUR</th>
<th>UMARKOT</th>
<th>MEAN</th>
<th>% OF CHECK</th>
</tr>
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<tbody>
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<td>2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARC MS-1</td>
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<td>250</td>
<td>203</td>
<td>225</td>
<td>238</td>
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The participatory on-farm evaluation of millet cultivars, a part of a larger project study, facilitated the selection of the pipeline varieties by the farmers who were enthusiastic to grow them before their release. Based on these and some earlier evaluations, the millet cultivar PARC MS-1 has been very recently approved by the Variety Evaluation Committee of the Pakistan Agricultural Research Council, Islamabad under the name of “Bajra Super-1”. It is a bristled variety by virtue of which it is resistant to birds and therefore, very much popular among the farmers. The varieties have been recommended and released for large scale production and adoption by the farmers in the low-rainfall areas of the country. The enthusiasm of the farmers has certainly enhanced the release process of these varieties. Under the project, large scale seed production and distribution is under way and this is certainly going to improve the productivity of millet especially in the rainfed areas of Pakistan.

Table 4. Participatory pearl millet varietal selection mother trial across locations during kharif-2004-05

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Under the same project, varietal evaluation and selection of sorghum has also yielded excellent results and one of the NARC developed pipeline variety has been approved for general cultivation in the rainfed areas of Pakistan. The findings of the project are in general agreement with several similar studies and have strongly proved the effectiveness of participatory approach for millet improvement and adoption (Tabo et al., 1999 a,b)

Acknowledgements
We are thankful to the Pakistan Agricultural Research Council for financial support under the Agricultural Research Endowment Fund of Agricultural Linkages Programme (ALP).

REFERENCES


FAO. 2005. FAOSTAT Database results-crop production.


