EVALUATING PEARL MILLET VARIETIES WITH FARMERS IN BARMER DISTRICT

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ABSTRACT

A newly formed NGO, operating in Barmer district in western Rajasthan, applied and modified methods of farmer participatory variety evaluation develop by ICRISAT scientists in other regions of Rajasthan. Barmer district has the largest area under pearl millet of all the Indian districts; it is characterized by low and erratic annual rainfall.

The first year results of varietal evaluations with farmers indicated that farmers from Barmer district assigned the two highest ranks to varieties with medium to late maturity, large panicles and high yield potential. The farmers from the more sandy, drier areas of Barmer district did prefer higher tillering, earlier maturing varieties, commonly with larger grain size as a secondary group of desirable materials. The traits used to compare varieties most often were also the characteristics of the most preferred varieties. Farmers insisted on at least one more year of such evaluations before a decision on initial adoption of any of these varieties could be taken.

INTRODUCTION

The Society to Uplift Rural Economy (SURE) has recently begun to manage and direct a Krishi Vigyan Kendra (KVK), a farmer training center, with the approval of the Indian Council of Agricultural Research (ICAR). In collaboration with ICRISAT, the KVK has started a program to identify cultivars of pearl millet [*Pennisetum glaucum* (L.) R. Br.] suitable for cultivation in Barmer district. Barmer district has no previous research results on the adaptation of newly released varieties of pearl millet. The current program was designed to evaluate a broad range of genetic diversity on the KVK-farm and on farmers' fields. The new varieties were exposed to a wide range of growing conditions, and farmers were able to observe the material throughout the growing season before their preferences were obtained.

GENERAL CHARACTERISTICS OF THE AGRICULTURE IN BARMER DISTRICT

Barmer district is located in western Rajasthan and is part of the Great Indian Desert (Thar). The whole district is part of the Western Arid Plain Zone (1A) in the state's classification of agro-ecological regions. The only river is the Luni river which rises in the Aravalli hills near Ajmer and, after passing through Barmer district, drains into the Runn of Kutch.

Among the five desert districts, Barmer has the highest percentage of population (83%) engaged in agriculture. This may be due to the lack of other job opportunities. This percentage is higher for women than men. The district is lacking modern transportation and communication facilities. The district has a geographical area of 2.82 million ha. In 1993-94, about 0.9% of the area had

forest cover, 7.3% constituted pasture land, 19.4% was fallow land and 55.9% was cultivated crop land. The remainder was either not available for cultivation or culturable wasteland (Table 1).

Table 1: Changes in land use pattern in Barmer district from 1956 to 1994: area (in '000 ha) and percentage of total geographical area in Barmer district used for different purposes

Type of land use	Area 1956-60 (1000 ha)	% of total area	Area 1985-89 (1000 ha)	% of total area	Area 1993 (1000 ha)	% of total area
Total geographical area	2809.6	100.00	2817.0	100.00	2817.0	100.00
Forest area	7.2	0.26	23.4	0.83	24.7	0.88
Area not available for cultivation	222.2	7.91	198.2	7.03	200.3	7.11
Pastures and tree crops	150.6	5.36	210.4	7.47	206.5	7.33
Cultivable waste land	242.4	8.62	285.8	10.14	266.1	9.45
Total fallow land	994.6	35.40	769.2	27.30	545.8	19.37
Net area sown	1192.6	42.45	1330.5	47.23	1573.7	55.86

Source: State Agricultural Department and Revenue Department of Barmer (Rajasthan)

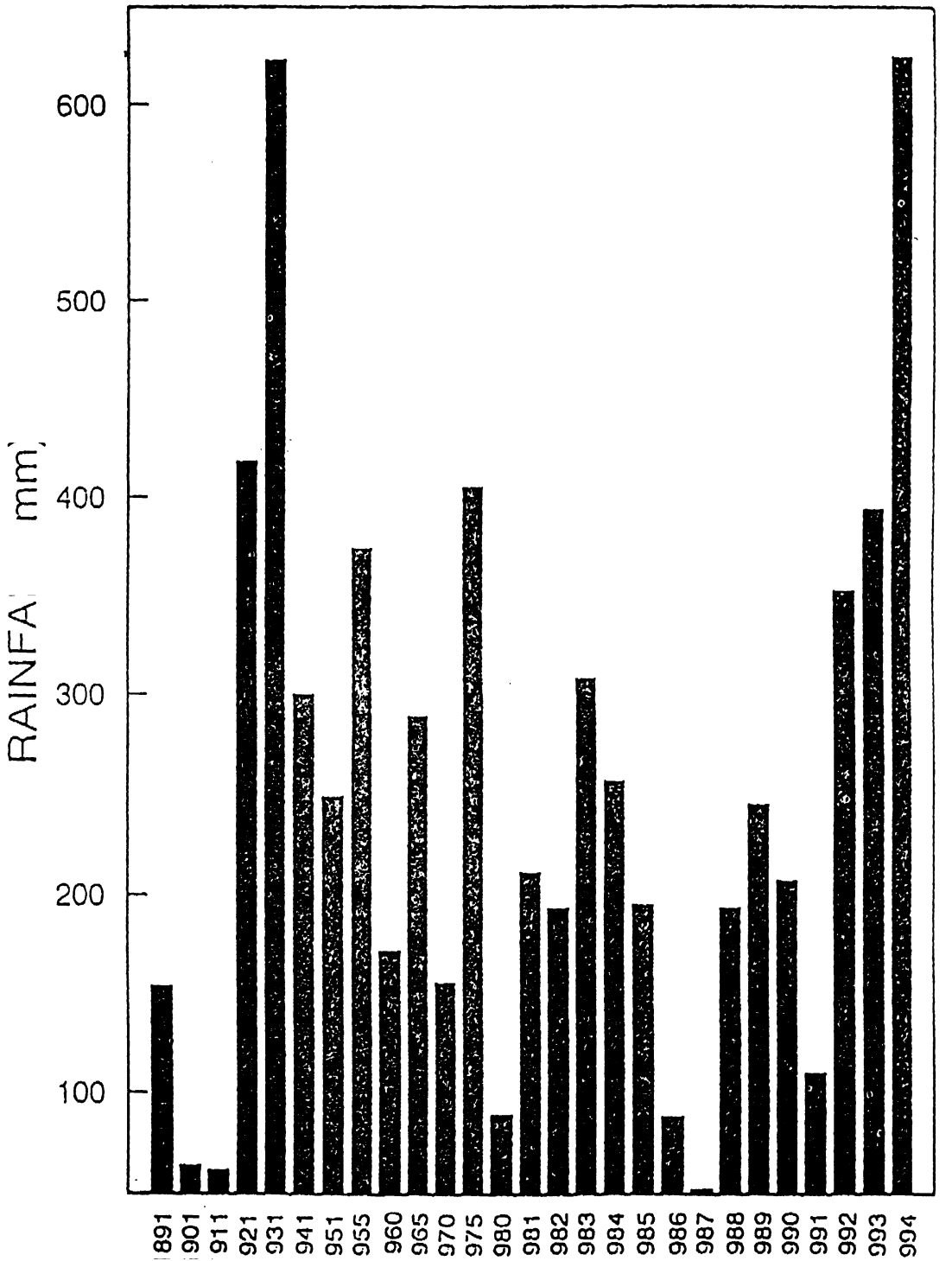
The district is characterized by low rainfall with an erratic distribution (Figure 1), resulting in frequent drought and crop failures. The mean annual rainfall varies from 209.7 mm at Sheo to 34.5 at Siwana, with the mean number of rainy days varying from 9.4 to 15.2. May and June are the hottest months recording mean maximum temperatures of 41.9 and 40.3°C. The lowest mean minimum temperatures (10-12°C) occur during December and January. The mean monthly wind speeds vary between 5.3 and 14.2 km/h. The potential evapotranspiration across the district varies between 1500-2000 mm per year and is highest from April to June.

Table 2 shows that 49.7% of the land holdings are larger than 10 ha, and these account for 82.35% of the agricultural land. Large land holdings are a reflection of the harsh environmental conditions, and hence low population density (51 people km^{-2}).

Table 2: Number and size of operational holdings in Barmer (1985)

Holding size class (ha)	No. of holdings	% distribution	Area (ha)	% distribution
<1	4583	2.96	2243	0.10
1-2	7151	4.63	10719	0.48
2-4	17368	11.23	51968	2.32
4-10	48696	31.51	530511	14.75
>10	76763	49.67	1844859	82.35
Total	154561	100.00	2240300	100.00

Figure 1: Rainfall at Barmer, Rajasthan State, India



Productivity of major crops in Barmer district is low (Table 3). Productivity and thus production of rainfed crops (pearl millet, mung bean (*Vigna radiata*), moth bean (*Vigna aconitifolia*), guar (*Cyamopsis tetragonoloba*) and sesame (*Sesamum indicum*) fluctuates with annual rainfall. Although 20% of Rajasthan's pearl millet area and 22% of its area under guar are grown in Barmer district, the contribution to the total production is low. Pearl millet is the most important crop in Barmer district, grown on 55.7% of the cropped area, followed by Guar (25.2%) and moth bean (5.3%). Irrigation is available on only 4.3% of the area, which allows double cropping with a variety of specialty crops like cumin, mustard or isabgol.

Table 3: Area, production, and grain productivity of major dry land crops during five years (1990-94) in Barmer district

		Crop				
		Pearl millet	Guar	Moth bean	Mung bean	Sesame
Area (1000 ha)	1990	896	469	149	14	5
	1991	950	316	69	16	9
	1992	1032	410	126	20	8
	1993	806	407	203	25	12
	1994	863	416	280	34	10
Production (1000 t)	1990	750	158	57	2	1
	1991	32	6	2	1	0
	1992	222	77	22	4	1
	1993	13	14	5	2	1
	1994	180	85	61	3	1
Grain productivity kg/ha	1990	837	336	382	165	190
	1991	34	19	34	86	38
	1992	215	186	177	191	118
	1993	16	34	25	88	51
	1994	208	204	217	97	91

Source: State Agricultural Department and Revenue Department of Barmer (Rajasthan)

Common rotations found in different rainfed areas in the district are:

1. Pearl millet - fallow (rabi = postrainy season);
2. Pearl millet - fallow (rabi)- mung/moth bean - fallow (rabi);
3. Guar - fallow (rabi) - pearl millet - fallow (rabi).

FARMERS' PREFERENCES FOR PEARL MILLET VARIETIES

At present, farmers in Barmer district grow predominantly local varieties of pearl millet. Initial discussions with farmers revealed that during the mid-seventies a single cross hybrid, BJ 104, was popular in the district. Seed of BJ 104 is no longer produced because this hybrid became susceptible to downy mildew (AICPMIP 1975-91). Farmers are keen to test newly released and

advanced experimental varieties under their growing conditions. We selected six villages for on-farm trials in 1994. Four varieties, HHB 67, ICMH 90852, CZ-IC 922 and ERajPop were grown in these villages. Twenty farmers, who were interested in experimentation were selected in each village. Each farmer compared one of the new varieties to his/her own. Thus five farmers in each village tested the same new variety. The on-farm trials were evaluated through group discussions (Weltzien *et al.*, 1995b). Farmers were asked to compare the varieties for traits of importance to them.

At the KVK-farm in Bhadka, 35 km north of Barmer, these same four varieties were grown under two soil fertility treatments. In addition, a demonstration of 16 pearl millet varieties was grown with two replications. At the time of maturity farmers were invited to visit the KVK-farm, and discussions were held to evaluate these varieties. The villages are all villages in which the KVK is active; two are located three to five km west of Barmer (Marudi and Balera), Aati is located 15 km west of Barmer and Bijard is located in the sand dune area on the western border of Barmer district, near Chotan. A total of 42 male farmers from these four villages participated in discussions, on two consecutive days. All these farmers are participating in the KVK activities on a regular basis. Groups of three to five farmers visited the demonstration plot to evaluate the varieties individually. Each farmer's comments on individual varieties was recorded separately. Each farmer was then asked to name the five highest ranked entries. These results were used to arrive at an overall ranking of varieties for each village (Table 4), and ranking of the traits, based on the frequency with which farmers used them for the assessment of individual varieties (Table 5).

Table 4: Highest ranked varieties, based on pooled ranking of individual farmers' choices from a demonstration plot of 16 diverse pearl millet varieties

Rank	Balera/Marudi (8)[1]	Aati (14)	Bijard (20)
1	RCB-IC 911	RCB-IC 911	RCB-IC 911
2	MH 179	MH 179	MH 179
3	CZP-IC 923	CZP-IC 923	RCB-IC 926
4	ICMH 90852	ICMH 90852	CZH-IC 313
5	WRajPop/RCB-IC 926	WRajPop	Local
6	CZP-IC 315	HHB 67	HHB 67
7	CZP-IC 311	ICMP 94881	RCB-IC 924/ CZP-IC 315

Figures in parentheses are number of farmers.

Table 5. Desirable plant traits as mentioned by farmers during variety selection from a demonstration of 16 pearl millet varieties (x times mentioned by one farmer on average)

Desirable traits	Marudi/Balera	Aati	Bijard
No. of farmers	8	14	20
No. of responses	48	40	224
Large panicle size	3.60	1.07	3.00
Large grain size	0.00	0.79	1.85
High tillering	0.00	0.07	1.70
Good seedset	0.38	0.07	0.95
Tall plant height	1.50	0.21	0.60
Low water requirement	0.00	0.00	0.65
Sweet taste	0.00	0.00	0.55

Traits mentioned, but rarely:

Marudi/Balera: Bristles, high grain yield, and suitable for fodder.
Aati: Bristles, high grain yield, strong growth, high stover yields, and tillering.
Bkjard: High grain yield, strong growth, earliness, adaptation to low fertility, thick stems, thin stems, food from tillering, low bird damage, and no diseases.

The farmers who grew experiments on their own farms in Bhadka village were asked to compare the four test varieties and the local varieties grown in their village. To structure the discussions and allow for interaction among farmers, a matrix ranking table (Table 6) was made with the farmers, following the method described by Weltzien R. *et al.*, (1995b). The scientific description of the plant type of the test cultivars is summarized in Table 7.

Table 6. Matrix ranking of four experimental varieties grown by KVK Bhadka in six villages, Barmer district. Summary of farmers' group discussions

	HHB 67	ERajPop	ICMH 90852	CZ-IC 912
Grain yield	1	3	2	4
Grain size	1	3	2	4
Grain color	1	2	3	4
Height	4	3	1	2
Soft stem	2	1	4	3
Fodder qual.	1	2	4	3
Lodging	1	2	3	4
Bird damage	4	1	3	2
Earliness	1	3	2	4
Uniformity	2	4	1	3
Cut hay	2	3	1	4

Other traits mentioned: disease intensity, panicle size, leaf softness, growth

Table 7: Main characteristics of the varieties evaluated by farmers in Barmer district during the rainy season 1994

Variety	Characteristics
HHB 67	extra early single-cross hybrid, bold grain, short panicles, the ability to produce basal tillers regularly, short plant height
ICMH 90852	medium to late maturity, high tillering potential, thin intermediate panicles and medium grain size, topcross hybrid
CZ-IC 922	medium maturing, open-pollinated variety, low tillering potential, medium to large panicles, medium thick stems, medium-tall plant height, medium grain size
ERajPop	early maturing, open-pollinated variety, good tillering potential, including nodal tillers, medium long, thin panicles, small seed size, intermediate plant height
RCB-IC 911	medium maturity, open-pollinated variety, very large grain size, thick compact panicles, low tillering potential
MH 179	late maturing single-cross hybrid, long panicles, low tillering potential, thick stems, medium grain size, bristles, medium-tall plant height
CZP-IC 923	late maturing, open-pollinated variety, long, thick panicles, low tillering potential, tall plant height, large grain size, thick stems
WRajPop	very similar plant type to ERajPop, except that it is later maturing
RCB-IC 926	early-medium maturing, open-pollinated variety, medium tillering potential, short compact panicles, large grain size, medium plant height
RCB-IC 924	very similar to RCB-IC 926, except that it's panicles are longer, but thinner, seed set is less uniform
CZH-IC 313	early maturing, topcross-hybrid, medium-high tillering potential, large grain size, and medium long panicles
CZP-IC 315	medium-late maturing, open-pollinated variety, with high tillering potential, medium-long, thin, compact panicles, with small-medium grain size, and medium plant height
CZP-IC 311	similar plant type as CZP-IC 315, but higher nodal tillering potential, and less compact panicles
ICMP 94881	late maturing, open-pollinated variety, with intermediate tillering potential, tall plant height, intermediate panicle size, grain size
Local variety	very high tillering potential, short and very thin panicles, very small grain size and intermediate plant height

The farmers from the three villages close to Barmer (Marudi, Balera and Aati) chose exactly the same five varieties as the highest ranked (Table 4). For the sixth and seventh ranked varieties, they both chose crosses between varieties with large panicles and local varieties, achieving a balance between panicle size and tillering. This indicates that the farmers from these three villages have similar preferences for specific varietal traits, as supported by the results in Table 5.

The farmers from Bijard village also ranked the RCB-IC 911 and MH 179 first and second but chose higher tillering, earlier maturing varieties for ranks three to seven. They included the local variety as one of the most desirable genotypes, despite the fact that the conditions for crop growth in 1994 were very favorable for later maturing genotypes with large panicles. The remaining four high ranked entries all represent breeding efforts to combine better panicle characteristics and downy mildew resistance with earliness and high tillering capacity. It is interesting to note that the majority of the preferred entries were open-pollinated varieties. There appeared to be no specific preference for uniformity expressed by farmers as no comments were made about this varietal attribute, either positive or negative.

The varietal trait that farmers from all four villages most often mentioned as desirable when comparing varieties was large panicle size (Table 5), which is consistent with the choice of the highest ranked varieties in all cases (Tables 4 and 7). Farmers from the three villages near Barmer further mentioned tall plant height, good seedset and large grain size regularly. The varieties that they ranked highly (Tables 4 and 7) all have these characteristics. Other traits were mentioned only rarely. Generally, these farmers appeared less responsive during this discussion.

Farmers from Bijard responded with more detailed observations. The second most important traits for them were large grain size and tillering, which is well reflected in the choice of high ranked varieties (Tables 4 and 7). Good seed set, tall plant height, low water requirement and sweet taste of the grain were mentioned regularly as desirable. Many other traits were also mentioned, but rarely.

The results from these discussions show that farmers from the drier, more sandy part of Barmer district place more emphasis on high tillering, and two other traits associated with adaptation to low rainfall: good seedset and 'low water requirement' (Table 5). Studies using similar methods in other districts of Rajasthan showed a similar differentiation between preferences from farmers from drier, sandier areas and farmers from other pearl millet growing regions in Rajasthan (Weltzien R. *et al.*, 1995a). There was a very close correspondence between the traits that farmers used to compare varieties and the actual preferred choice of varieties. Thus the ranking of varieties and the analysis of frequencies of traits both give very similar results.

The comparison of the four experimental varieties grown in on-farm trials in Bhadka village showed that these farmers were observing a wide variety of traits (Table 6). Several traits are directly related to stover (fodder) quality, emphasizing its importance in this production system. The farmers' ranking of the individual varieties for traits commonly evaluated are mostly consistent with expectations based on on-station trial results.

It is interesting to note that farmers only rarely mentioned differences in grain or stover yield *per se*, but rather spoke more often of their components, size of grain and panicles, tiller number and plant height. While the two grain yield components are commonly used in pearl millet breeding programs, the two stover yield components, tillering and plant height, are not. If they are used, selection is usually practiced in the opposite direction, for lower tillering capacity and medium to short plant height.

Stover yield itself is used only by some breeders in testing experimental varieties, very rarely in selection, and it is not regularly considered in the legal procedures for varietal release. These results support evidence that fodder yield is a major criterion for the adoption of new cultivars (Kelley *et al.* 1996). The potential for using this trait as a selection criterion should be explored. Fodder quality and grain quality characteristics are also regularly evaluated by farmers and considered important (Tables 5 and 6). Systematic attempts to consider these quality parameters in selection and variety testing by breeders are rare. Farmers in Barmer appear to use a variety of traits that are components of these quality traits, i.e., stem or leaf softness. These can apparently be rated visually and could thus be evaluated easily in a breeding program. It may be worthwhile to try this in on-station experiments in cooperation with specially interested farmers.

Farmers regularly mentioned that their selections were affected by the favorable climatic conditions of 1994 (rainfall 625 mm). Testing of these cultivars in contrasting years is required before farmers can make a balanced judgment on the usefulness of these varieties for their own farming conditions.

These results are preliminary. More detailed analyses of the diverse factors influencing farmers' choices and preferences are required. The results of these varietal comparisons will be useful in identifying new varieties suitable for farmers in Barmer district, and will also help to focus on-going pearl millet breeding programs in Rajasthan on traits relevant to farmers in the region.

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USING DIVERSITY

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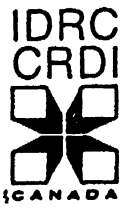

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