Table 1. Pearl millet genotypes evaluated by workship participants at Rajasthan Agricultural University, Agricultural Research Station, Mandor, Jodhpur, Rajasthan, rainy season 1998.

Landraces (ICRISAT genebank)	
Nokha	Landrace from Nokha, Bikancr district (annual rainfall <350 mm)
Jakharana	Landrace from Jakharana, Alwar district (annual rainfall >650 mm)
Farmers' cultivars	
4 samples	Collected from three farmers in the village Aagolai (Jodhpur district), representing different seed management strategies
2 samples	Collected from one farmer in the village Kichiyasar (Bikaner district), representing seed grain from two different seasons
2 samples	Collected from one farmer in the village Nunwa (Ajmer district), representing grain from two different seasons following distribution of the varieties RCB-IC 911 and CZP-IC 923
Improved varieties and hybrids (adapted from Yadav and Weltzien 1998)	
Raj 171	A full-season grain and stover variety, bred from selections from Inter-Varietal Composite, released in 1992
ICMV 155	A full-season grain and stover variety, bred from 59 plants of New Elite Composite C4 (ICMV 84400), released in 1991
RCB-IC 911	Rajasthan Composite, bred by random mating 140 S_1 progenies of RCB-IC 901 (Bold Seeded Composite of ICRISAT)
CZ-IC 923	Bred by random mating 21 S_1 progenies selected from ICMV 82132 x ICMV 87901, released in 1996
FCB-IC 846	A product of RAU-ICRISAT collaboration, based on Early High Tillering Population (CO) selected for grain yield

It was suggested that participatory variety selection could be a possibility for the higher rainfall areas of Rajasthan, or where farmers have access to irrigation. For the marginal regions of western Rajasthan, identifying ready-made solutions seems to be more difficult. Participants, therefore, suggested that farmer participation in earlier breeding stages could help to produce adapted plant material. Germplasm specialists underlined the need to conserve landraces from those regions where the mixing strategy is prevalent. Institutional challenges emerging from more farmer-oriented research work were also discussed.

A detailed workshop report is available free of cost from the authors.

References

Yadav, O.P. and E. Weltzien R. 1998. New pearl millet populations for Rajasthan, India. Integrated Systems Project Report Series 10. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Patancheru 502 324, Andhra Pradesh, India.

Agronomy

Participatory Evaluation of Pearl Millet Cultivars in Northern Nigeria

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the most important food crop in the drier areas of the Sudan Savanna agro-ecological zone of Nigeria where rainfall is inadequate for such other cereal crops as maize (*Zea mays* L.) and sorghum. Major constraints to millet production are poor soil fertility, drought, and biotic stresses e.g., *Striga* and downy mildew [*Sclerospora graminicola* (Sacc.) J. Schrot.] (Singh and Thakare 1986; Yusuf 1996). Although many improved varieties have been developed and released by the Institute for Agricultural Research (IAR), Zaria, Nigeria, only Ex-Bornu (SAMMIL-1) has been adopted by farmers.

Table 1. Location and bio-physical details of nine villages in northern Nigeria selected for participatory evaluation of pearl millet cultivars, 1996.

State	Village name	Agro-ecological zone	Coordinates		Soil type	Rainfall (mm)
			Latitude	Longitude		
Kano	Kofa	Southern Sudan	11° 34'	8° 17'	Loamy	898
	Panda	Southern Sudan	11°31'	8° 04'	Loamy	875
	Badume	Northern Sudan	12° 12'	8° 19'	Sandy	704
Jigawa	Kantoga	Southern Sudan	11° 30	9° 23'	Sandy loam	850
	Dalari	Northern Sudan	12° 36'	9° 48'	Sandy	639
	Gijigami	Northern Sudan	12° 34'	9° 25'	Sandy	673
Katsina	Gora	Southern Sudan	11° 55'	7° 43'	Loamy	1050
	Rimaye	Northern Sudan	12° 19'	7° 54'	Loamy	728
	Barhim	Northern Sudan	12° 58'	7° 41'	Sandy	734

GB 8735 is an improved pearl millet variety that was released in Chad and Mauritania and is reported to be grown by many farmers in those countries. It is early (70-80 days to maturity) and is well-suited to very dry areas as it can escape terminal drought. It is high-yielding and has large gray seeds. It is resistant to downy mildew and because it flowers early usually escapes damage from head miner [*Heliocheilus albipunctella* (de Joannis)], but is susceptible to stem borer *(Coniesta ignefusalis* Hampson). The objective of this study was to introduce this promising variety to farmers in northern Nigeria, assess its performance, its acceptability to farmers, and the costs of production in the region.

The study was carried out in Jigawa, Kano, and Katsina states in northern Nigeria, in the rainy season, 1996. Three villages were chosen in each state on the basis of the rainfall gradient. Table 1 shows the biophysical details of the nine study villages. Fifteen farmers participated in the trial in Jigawa, 12 in Kano, and 7 in Katsina. These farmers were chosen in the light of their previous interaction with extension agents and their willingness to collaborate in this work. Plot sizes were about 0.1 ha.

Pearl millet grain yields obtained in the nine study villages are shown in Table 2. There were no significant differences among yields of the different varieties across the villages, except at Kantoga where yields were low due to waterlogging. The improved variety GB 8735 outyielded the local variety in all nine villages, and its grain yields were stable across the three states.

Most of the farmers obtained yields above the average of 0.73 t ha^{-1} needed to recover the costs of production. Labor costs accounted for 83% of the total production costs while the costs of inputs (seeds and fertilizers) constituted only 11% (Table 3). GB 8735 gave the highest returns, ₦15834 compared to ₦11635 from the local variety. The positive returns per hectare indicate that more labor could be profitably used to produce these varieties.

Table 2. Mean grain yields (t ha^{-1}) of improved pearl millet GB 8735 and local cultivars in nine villages in Kano, Jigawa, and Katsina states in northern Nigeria, rainy season 1996.

State/village	GB 8735 (Improved)	Local
Kano		
Kofa	1.25	-[1]
Panda	1.23	0.85
Badume	1.26	0.90
Jigawa		
Kantoga	0.93	0.76
Dalari	1.29	1.09
Gijigami	1.23	0.93
Katsina		
Gora	1.39	1.15
Rimaye	1.16	0.85
Barhim	-	-
Mean	1.22	0.90
SE	± 0.145	± 0.171

1. - = Data not available

Farmers liked GB 8735 mainly because of its earliness. Other desirable characteristics were the bright color and large size of the seeds, and the uniformity of the plants at maturity. Farmers also liked the taste of the food prepared from GB 8735. Because it is very early, GB 8735 had the tendency to mature before the end of the rains, rendering the panicles prone to mold. It is also

Table 3. Costs and returns of producing improved pearl millet GB 8735 and local cultivars in northern Nigeria, 1996.

Costs/returns	GB 8735 (Improved)	Local
Output (t ha^{-1})	1.22	0.90
Gross revenue (₦ ha^{-1})[1]	15834	11635
Labor cost (₦ ha^{-1})	7960	7920
Other costs (₦ ha^{-1})		
Seeds	300	300
Fertilizer	800	800
Depreciation	500	500
Total cost (₦ ha^{-1})	9560	9520
Net Income (₦ ha^{-1})	6274	2115
Returns (₦ ha^{-1})	35.76	25.34
Yield required to cover cost (t ha^{-1})	0.74	0.73

1. US$1 = ₦80

more susceptible than local cultivars to attack by birds because of its earliness. If sown late, it does not establish well. It is therefore necessary to follow such recommended agronomic practices as sowing on the appropriate date to avoid some of these problems. The earliness of this variety enables farmers to practice double cropping.

GB 8735 generated a lot of interest from both participating and non-participating farmers. Non-participating farmers did everything they could to obtain seeds from participating farmers to sow in the following season.

This participatory on-farm evaluation of pearl millet varieties, that was a part of a larger diagnostic study, facilitated the characterization of production systems and the selection of benchmark sites in the study area. The study demonstrated the new improved variety to farmers who were very excited about it, and are willing to continue to grow it. This enthusiasm should further enhance the release process.

References

Singh, L. and Thakare, R.B. 1986. Yield response and nitrogen uptake of pearl millet (*P. americanum*) cultivars to nitrogen application in the Savanna region of Nigeria. Fertilizer Research 10: 113-118.

Yusuf, M. 1996. The farming system of Tambau, Kano State, Nigeria. Soils, cultivars and livelihoods in north-east Nigeria. Working Paper 1. University of Cambridge/ Bayero University, Cambridge/Kano. 82 pp.

Cytogenetical Studies on Chromosomal Interchanges of Pearl Millet

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Reciprocal translocations or chromosomal interchanges refer to the exchange of segments between non-homologous chromosomes of a complement and can be used in chromosome mapping of genes. In pearl millet, *Pennisetum glaucum* (L.) R. Br. syn. *P. americanum* (L.) Leeke syn. *P. typhoides* (Burm.) Stapf. & Hubb. (2n=2x=14), a number of interchanges including a tester set were developed (Minocha et al. 1982). Hence, it became imperative to have relevant information on the chromosomes involved and breakpoint points of interchanges (pi) before these could be put to use. Nine interchange stocks (RT-1, RT-2, RT-3, RT-4, RT-8, RT-9, RT-17, RT-23, and RT-32) were developed and maintained as homozygotes by following standard testcross procedures while four stocks, (RT-7, RT-31, RT-33, and RT-34) were maintained in the heterozygous state. All thirteen interchange stocks revealed the exchange of segments between two non-homologous chromosomes, one of which was detected as chromosome 7, a nucleolus organizer, in RT-23 and RT-34. In order to establish the unambiguous identity of translocated chromosomes and map their pi in various interchanges, cytological, cytogenetical, biochemical, and genetical methods were followed. The results are summarized in Table 1.

In most of the interchange stocks studied, the pi were found distributed in the heterochromatic region of the telomeres and centromeres of their involved chromosomes. This confirms observations that in pearl millet major heterochromatic blocks are located near the centromeres and telomeres of the chromosomes (Kaul and Sidhu 1998). Heterochromatin is known to be susceptible to break in tomato (Gill et al. 1983) and this appears to be true for pearl millet as well.

Once the interchanges were documented with details of their involved chromosomes/arms and pi, these were crossed with various genetic marker stocks. Based on the joint segregation of semi-sterility (in the form of quadruple) and gene markers in the F_2 and/or testcross generations, 13 genes for qualitative traits (basal car branching *Bebl ;* purple bristle *Bep;* bristling *Br1* and *Br2 ;* hairy leaf *hl1* and hl2*;* hairy node *Hn1* and *Hn2,* purple anther *Pal* and *Pa2,* purple plant and seed pigmentation *Ppl;*