What is a variety: investigating farmers‘ concepts as a base for participatory plant breeding in Rajasthan, India

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Abstract

Western Rajasthan is a marginal environment for farming, with low and erratic rainfall. Conventional plant breeding has so far failed to develop successful varieties of pearl millet, the staple crop, for marginal conditions. In the presented study, farmers’ own concepts of pearl millet varieties were investigated as a base for participatory plant breeding. The same cultivars that were assessed by farmers were evaluated in field trials. Results demonstrate the relevance of farmers’ criteria for describing environmental adaptation and yield potential. Furthermore, the farmers’ method to increase production security by combining plant types offers new options for co-operation with plant breeders.

Keywords: pearl millet, farmers’ knowledge, participatory plant breeding

Introduction

In western Rajasthan, it is commonly reported by farmers that on an average, out of ten years there will be two to three severe drought years, one or two good rainfall years whereas the rest of years can be more or less good or bad years. The total amount of rainfall as well as its distribution during the growing season and the onset of monsoon follow a highly variable and unpredictable pattern (Oosterom et al., 1996). Pearl millet (*Pennisetum glaucum* [L.] R.Br.) is the staple crop in Rajasthan, which is grown on 4-6 million ha annually, mostly rainfed. Grain yield of 100kg/ha or even less is not uncommon in western Rajasthan (Gupta et

al., 1994), varying between around 1000 kg/ha in very good years and total failure. Given this situation, crisis prevention is an integrated part of life for rural people and finds expression in all main activities including farming.

Conventional plant breeding has so far failed to develop successful varieties for such marginal conditions. Participatory plant breeding was suggested as a possible approach for crop improvement leading to more benefits for poor farmers in western Rajasthan (Weltzien et al., 1998). Understanding farmers' own concepts and experiences could, in this context, help to identify useful traits and selection criteria as well as farmers' expectations of a useful variety. This type of basic information on farmers' knowledge had not been systematically documented so far.

Objectives

The research objective was to investigate farmers' concept of pearl millet varieties as a base for developing new participatory approaches for pearl millet breeding. Emphasis was placed on how farmers describe and evaluate pearl millet varieties, and particularly which traits they consider.

Methods

Evaluation of pearl millet plant types with farmers

In the growing season of 1997, a workshop was organized at the Rajasthan Agricultural University experimental station Mandor in western Rajasthan. Altogether, 58 farmers from four villages, that are characterized by different agro-climatic conditions (Table 1), participated. Farmers from villages 1, 2 and 3/4 attended the workshops on three consecutive days. Because women in Rajasthan would usually not participate in a conversation in the presence of men, separate discussion groups were organized for the 19 female participants. The methods applied to facilitate the expression of farmers' knowledge were semi-formal interviews in combination with PRA exercises such as classification and ranking. A field trial which included a wide range of pearl millet plant types provided the material for visualization.

From preliminary studies, it was known that farmers use mainly two categories for classifying pearl millet plants: “desi” represents a landrace type and “sankar” exotic types. In order to find out more about this concept, the workshop was organized in three steps. Farmers were asked: (1) To give a detailed description of the “desi” type and select one single plant which represented a typical “desi” pearl millet; (2) To explain what other plant types they had found in the trial (except “desi”), and to select one single plant to represent each type; (3) To rank these plant types according to usefulness for the conditions of their own village.

Field trials

The same pearl millet populations that were evaluated by the farmers during the workshop were also evaluated in formal field trials. The major part of trial entries were grain samples previously provided by the participating farmers. The 69 farmers’ grain samples, along with 12 modern varieties recommended for this region, were evaluated under varying drought stress conditions at three locations in western Rajasthan across two years. Plant traits that are used by both farmers and scientists to describe the performance of pearl millet were recorded in order to assess the productivity and characteristics of entries. These traits included leaf shape, stem thickness, panicle size, number of basal and nodal tillers, grain weight, grain yield as well as grain color.

Table 1: Important agro-climatic conditions in the participants’ home villages

	Village 1	**Village 2**	**Villages 3&4**
Mean annual rainfall	250 mm	350 mm	450 mm
Prevalent soil types	Sandy, sand dunes	Sandy, partly mixed with loam	Sandy mixed with loam
Irrigation facilities	No	Rainwater harvesting in special fields	Partly available
Pearl millet varieties used	Original landrace, small amounts of modern varieties for experimental purpose	Original landrace often in mixtures with modern varieties	Modern varieties and further generations of the same, no original landrace

Results

Farmers' description of "desi" pearl millet

The description of a typical "desi" millet plant did not differ much between farmers from different villages. Women farmers described quality aspects such as taste, storability, nutritional value and effects on people and animals in more details than men. Farmers from the area with the lowest rainfall and most sandy soils (Village 1) gave a more detailed description regarding adaptation to environmental conditions (Table 2).

All farmers emphasized the adaptability of "desi" millet plants to the local environmental conditions. The ability to develop many tillers seems to be of major importance in this context, as well as the ability to adapt the time to flowering and maturity to rainfall distribution. The ability of "desi" millet to grow under less favorable conditions and with little manure was repeatedly mentioned by farmers. Furthermore, quality needs for grain as well as animal fodder are well met with regard to quality and the relation of grain and straw yields.

Classification exercise of pearl millet plant types

When asked which other types of pearl millet were present in the field experiment, all farmers described 4-6 major groups, sometimes comprising several sub-groups, so that up to 11 different plant types were described by the participants. The main classification criteria were: Plant height, head size, color and size of grain, compactness of panicle, presence of bristles, number of tillers, nodal tillers and whether tillers are productive, whether tillers are uniform in maturity, number and shape of leaves, thickness of stem and whether the stem is hollow or not, earliness.

A plant type that was contrasting to the aforementioned "desi "type with regard to all relevant traits was qualified as "the purest form of sankar": Uniform plants with thick stem, one main tiller, only one thick and relatively lose panicle with large, round, grayish grain, high grain yield and uniform maturity. Disadvantages of this plant type are that the food quality and market value of grain is low, that the stover is not useful for

Table 2: Description of a typical "desi" millet plant as given by farmers from four villages ("MVs" = modern varieties)

Trait	**Typical expression in "desi" millet plant**	**Related quality aspects**	**Related aspects of environmental adaptation**
Panicle	Thin, compact and of short or medium length, tips of heads slightly bending at maturity	Taste and keeping quality of bread superior to modern varieties; grain can be stored over long periods without quality loss, more nutritious and positive health effects for humans as well as animals	A thin middle axis of panicles indicates drought resistance
Grain	Small, hard, heavy, yellowish color		
Glumes	Short		
Leaves	Long, narrow, hairy, smooth	Straw is preferred by animals and more nutritious as compared to modern varieties; no need to chop the straw, can be fed directly, no need for supplements, can be stored over years without losing its quality	Thin stems and narrow leaves indicate drought resistance; the stems can withstand heavy thunderstorms without breaking
Stem	Thin, smooth		
Tillers	High tillering potential, basal as well as nodal tillers nodal tillers are typical for desi, so that in many cases	Grain from nodal tillers and ratoon tillers tastes particularly sweet; such tillers also produce high quality fodder (thin stems)	Ability to adapt to nearly any type of rainfall distribution by forming new basal or nodal tillers according to moisture availability; ability to produce ratoon tillers after cutting the straw in the case of late rainfalls; even if crop establishment is poor due to extreme heat or sandstorms, the remaining plants will spread and produce enough tillers to compensate low plant densities; pollen is produced over a longer time period with positive effects on seed set during rainy periods
Overall plant type	Medium plant height, many basal as well as nodal tillers, compact and well-filled panicles of short or medium length, many leaves		Grain yield potential is less than that of MVs in good years, but superior under drought conditions; straw yield mostly superior to MVs, particularly under drought conditions; this plant type is adapted to sandy soils and low nutrient availability, and to the climatic conditions (heat, duststorms, thunderstorms, unpredictable rainfall distribution)

fodder and that there is a high risk of lodging if the crop is affected by heavy rainfall.

The further plant types were described as intermediate forms between desi and sankar types. A most interesting view of farmers is that these intermediate types develop if the exotic sankar type is sown in their fields for several years: “When sankar has been sown for three or more times, it becomes like this”.

Ranking of plant types according to their usefulness for farmers
All participants preferred at least two or three contrasting plant types, so that they did not want to rank one of them highest. They made clear that they needed more than one plant type for different environmental or field conditions. The views of farmers from different villages varied according to which plant types they would select, and whether these would preferably be grown as a mixture in one field or in different fields. Farmers from villages 3 & 4 preferred the sankar type because of its grain yield potential as well as a similar type with better grain qualities and one with more tillers for less fertile fields. Farmers from villages 1 and 2, however, preferred the desi type and intermediate types with many tillers, whereas the sankar type was considered to be useful as a component in seed mixtures. The need for contrasting plant types for seed mixtures was particularly emphasized by the women participants.

Results from field trials
Analysis of the five test environments revealed a significant phenotypic relationship between morphological traits farmer use to describe pearl millet plant types . Nodal tillering, a key trait for a “desi” variety, has a strong association with those traits that are used by farmers to describe “desi” plants, but it is negatively associated to traits which are related to “sankar” varieties. A thick panicle, on the other hand is associated to traits representative for “sankar” varieties and shows a negative relation to “desi” characteristics (Table 3). The relationship between grain yield and tillering under different climatic conditions, strongly suggests that tillering is an effective trait for drought avoidance (Figure 1).

Table 3: Coefficients of phenotypic correlation between specific plant characteristics used by farmers and panicle size in modern (“sankar”) varieties and nodal tillering in landrace (“desi”) varieties

Trait representative for:		“sankar”	“desi”
	Traits	Thick panicles	High nodal tillering
“sankar“	Thick panicles	-	-0.94**
	Large leaf size	0.87**	-0.88**
	Thick stems	0.88**	-0.93**
“desi“	Yellow grain colour	-0.88**	0.78**
	High basal tillering	-0.93**	0.92**
	High nodal tillering	-0.95**	-

** significant at the 0.01 probability level.

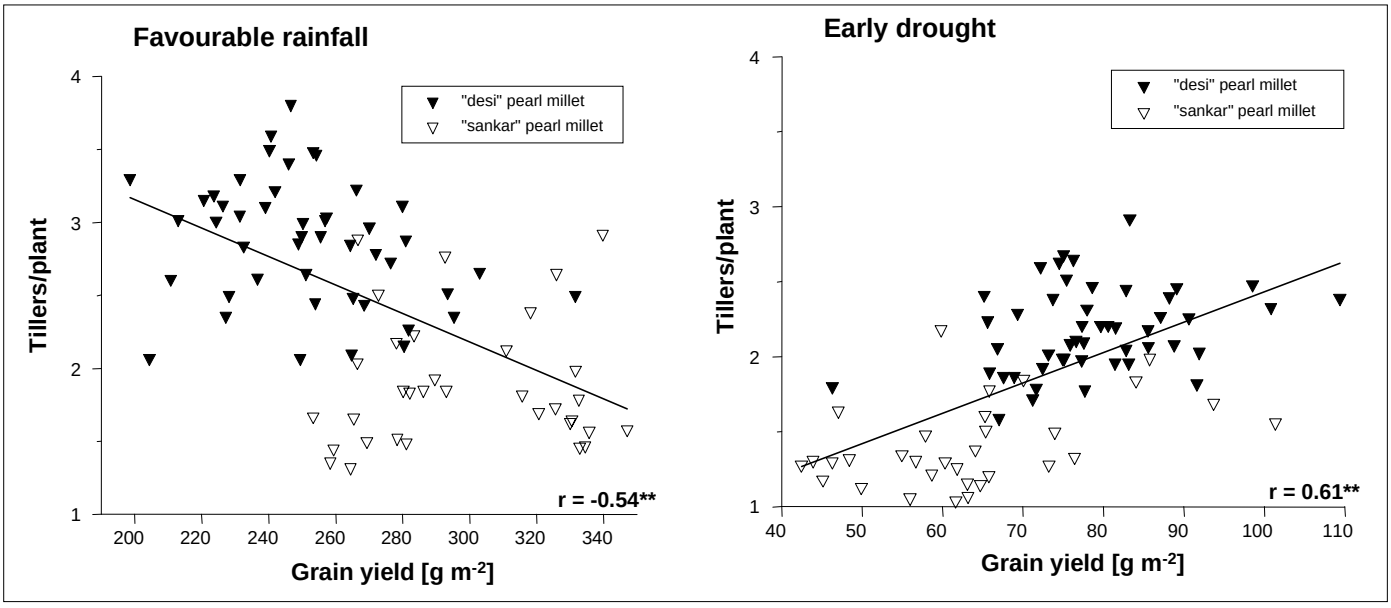

Figure 1: Regression of landrace („desi“) and modern („sankar“) variety mean grain yield on the location mean of tillers/plant under favourable conditions in 1997 and under early drought conditions in 1998 at Mandor research station in western Rajasthan.

Discussion and conclusions

Farmers’ description of plant types and their concept of a variety

The field trial data show that the traits used by farmers for classifying pearl millet plants and their potential adaptation to environmental conditions are indeed relevant. Involving farmers in the evaluation of breeding material for marginal environments could, therefore, be of great value for a breeding program, as these traits are difficult and costly to assess in multi-locational trials. A most interesting result is that the farmer participants did not use the term “variety” in the same way as

plant breeders would: as a stable, uniform and distinguishable plant population. The farmers' concept of a variety was rather that of a plant type, which is seen as continuously evolving under the influence of climatic and soil conditions. The farmers' concept is therefore dynamic and environmental conditions are always considered immediately when plant characteristics are described.

Preference of contrasting plant types

The fact that farmers preferred contrasting plant types questions the conventional approach of plant breeders to develop a uniform varieties which should replace other varieties. The wish to have access to a range of plant types for seed mixtures was particularly strong among women participants, and reflects their responsibility for food and fodder supply under highly variable and unpredictable climatic conditions. Evaluating plant material for its suitability to combine with local varieties in seed mixtures could be an option for plant breeders to support the farmers' own approach to increasing food security in western Rajasthan.

References:

Gupta BS, Mathur BK, Dave BK (1994) Effect of weather on yield of pearl millet (*Pennisetum glaucum*) in Jodhpur district. Indian Journal of Agricultural Sciences 64: 53-55

Oosterom EJ van, Whitaker ML, Weltzien R. E (1995) Integrating genotype-by-environment analysis, characterisation of drought patterns, and village surveys to identify adaptive plant traits for pearl millet in Rajasthan. In: Cooper M, Hammer GL (eds) Plant Adaptation and Crop improvement. CAB International, ICRISAT, IRRI, pp 383-402

Weltzien R. E, Whitaker ML, Rattunde HFW, Dhamotharan M, Anders MM (1998) Participatory approaches in pearl millet breeding. In: Witcombe JR, Virk DS, Farrington J (eds) Seeds of choice. Making the most of new varieties for small farmers. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi Calcutta, pp143-170