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Research Article

Farmer participatory varietal selection in pearl millet: Experience in vertisol tract of Southern districts of Tamil Nadu

R. Thangapandian*[1], P. Sumathi[2], A. Yuvaraja[2], M. Joseph[1] and V. Sanjivkumar[1]
[1]Agricultural Research Station, Kovilpatti, Thoothukudi District, Tamil Nadu -628 501
[2] Departments of Millets, Tamil Nadu Agricultural University, Coimbatore-641 003.
E-mail: ricetha@gmail.com

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Abstract
Farmers' participation in on-farm research can speed up of large scale adoption of the new crop varieties among farmers and replace the traditional agricultural practices. A small farmer in a variable environment will be affected by adoption of traditional practices especially for choice of crops and selection of suitable varieties. In areas where farmers are unfamiliar with available improved varieties, there is need of conducting effective varietal evaluation with farmers. The participatory approach for identifying suitable high yielding cultivars for harsh environments would be boon to the dry land farmers and could retain the sustainability in rainfed zones. This paper describes how plant breeder and farmers worked together to evaluate and identified the farmers' choice pearl millet varieties; TNAU hybrid CO9 and Pioneer 86M86 from a diverse genetic background in a participatory varietal selection programme conducted in vertisol tract of southern districts of Tamil Nadu.

Key words
Pearl millet, participatory varietal selection, ranking.

Introduction

Agriculture is the backbone of Indian economy. Its production and productivity is affected by soil, rainfall pattern and social factors. Rainy season crops play a sustainable role to maintain Indian food stocks. In general, rainy season refers to the planting, cultivation and harvesting of any domesticated plant sown in the rainy (monsoon) season on the Asian sub-continent (Benbi, 2010). These crops are sown with the onset on monsoon towards the end of September in the vertisol tracts of southern districts of Tamil Nadu during the advent of North-East monsoon.

Addressing poverty in rural vertisol tracts of southern districts of Tamil Nadu and especially Thoothukudi district requires interventions in the rainfed cereal production systems that continue to provide the basis of life in the region. Farmers' prospects are more at risk in this zone due to both the vagaries of weather as well as their traditional agricultural practices, especially cultivating local varieties or private hybrids. In areas where farmers are unfamiliar with available improved released varieties/hybrids, there is need of conducting effective variety evaluations with farmers.

In a world of limited resources, research must be cost-effective. The usefulness of the participatory approach for identifying cultivars for harsh environments, which are difficult to replicate in research stations, has been recognized by the crop breeders (Gowda et al., 2000). Interestingly, farmers are increasingly participating in agricultural research as scientists and development workers become more aware of the philosophy of 'farmer first' and its effectiveness. Participatory plant breeding/selection has shown success in identifying more number of preferred varieties by farmers in shorter time (Weltzien et al., 2003). Thus farmers' requirements have to be identified first so that they can be given more appropriate genetic materials to test based on the following potentials inherit in participatory selection.

(1) Farmers participation in the process of on-farm research does not only enrich in the speed up of information gathering but also result in large scale adoption of the product of research.
(2) It gives the breeder a great deal of confidence when presenting the varieties to the release committee.
(3) It provides impetus for release if popularity among farmers is documented.
(4) It helps in overcoming the initial inertia in bulking and distribution of newly released varieties.

By making selection criteria more relevant to end user needs, it can reach poor households that have not yet benefited from multiple varieties, increases the benefits and is more effective at reaching women and the poor (Michael and Mauricio, 2004). This provides a rationale for on-farm farmers' participatory variety evaluation and selection.

This paper describes how plant breeder and farmers worked together to test and selected farmers preferred pearl millet varieties from a range of pearl millet accessions in a participatory varietal selection program.

Materials and Methods

Participatory rural appraisal: Tamil Nadu Agricultural University, Agricultural Research Station, Kovilpatti and ICAR-All India Co-ordinated Research Project on Dry land Agriculture Project (ARS, TNAU/ICAR-AICRPDA) team carried out community consultation across trial implementation sites before each of the 2014-15 to 2015-16 cropping seasons.

The goals were to:
(1) Discuss participatory selection/breeding results and suggest which variety to replace modalities on how to share seeds harvested from trial among participating farmers, agronomic conditions for the trial-evaluate target condition, uniformity of dates of sowing, population density, three replications to enable yield evaluation, cases of intercrop, which seeds should be uniform for all farmers.
(2) Mobilize rural entrepreneurship through the use of processing technologies that are affordable and sustainable for rural community for millet products.
(3) Discuss opportunities for grain and product commercialization from farm-gate to urban centres.
(4) Select farmer groups for activities in Breeding and seed systems and documentation of available food products from pearl millet/maize and commercial opportunities.

At each location, the discussions were first preceded by paying a courtesy call on the local village head, introduction of the visitors, and drawing of the village map with the community participation and Agricultural Research Station, Kovilpatti staff. This is to ascertain the spread of the sites were the trials will be conducted. The village maps were first demonstrated by placing small stones representing settlements and later transferred unto papers as a map with well written names of the villages. The major spoken language at Muthukrishnapuram is spoken telugu and tamil, at Thoopureddipatti is spoken telugu and Tamil. Attendances for each location were recorded. Test sites selections were based on the following criteria: (a) easily accessible from a paved road (less than 2 km from the main road in rainy season; (b) the community is responsive to the innovations; (c) place of intensive maize production in the assured irrigated zone; (d) place of intensive pearl millet production in the rainfed zone.

Despite the mentioned criteria, the following was also considered critical for the site selection. Land must be suitable for the activities, accessible, acceptable to all members of the community, non-conflict area and is recognized by the community.

*Priority ranking:*Participatory rural appraisals were conducted on the major characteristics of pearl millet. Priority ranking for setting breeding objectives using matrix approach was used to determine what traits the farmers prefer most in a variety of interest. A set of traits were identified by farmers at various locations which were tabled against each other in a matrix. In the process farmers were asked to score the traits in a pair-wise comparison by raising their hands and counted. The trait with the highest score was ranked as the first, followed by the second highest and so on.

Participatory variety selection: Participatory variety selection was carried out to select from diversified pearl millet lines that possess farmer's preferred plant and grain traits (earliness to maturity, high grain yield, downy mildew resistance, etc). The pearl millet accessions were provided by ICAR AICRPDA project. During 2014-15, CO Cu 9 (a composite variety) and TNAU cumbu hybrid CO9 received from the Department of Millets, TamilNadu Agricultural University, Coimbatore were evaluated with Nattu cumbu (local variety) and private check hybrid Pioneer 86M86 on 5 x 8 m (40 m^2) size plot with 3 replications in Muthukrishnapuram and Thoppureddipatti villages of Kovilpatti taluk of Thoothukudi district where farmers were exposed to the diversity and expressed their opinion. During 2015-16 cropping, CO Cu 9 (a composite variety), Nattu cumbu (local variety) and TNAU cumbu hybrid CO 9 along with Pioneer 86M86 hybrid were repeated in the same villages as farmers' choice. These were each with an average of 300 farm families.

Rather than being provided with a package of improved technologies, as usually happens under conventional on-farm testing, each group of farmers was advised to conduct the trial in community plots using existing management practices. The objective was to enable the farmers to select those genotypes with better performance *per se* rather than genotypes which perform better in a higher-input management environment that they may be unable to sustain once external support is withdrawn. Farmers carried out all cultural operations including planting, thinning, weeding, fertilizer applications, harvesting, and grain processing. The selection was based on plant height (cm); earliness to maturity, stem thickness, resistance to lodging, drought tolerance (stay green trait), downy mildew resistance, yield, grain size, and grain color. For each evaluation, 30 farmers in the village assembled and visited all the plots together. Informal interviews were used immediately after the field review to elicit farmers' preliminary evaluation of the varieties tested.

Ballot paper approach: Ballot papers of different colours were used to rate their choices:
(a) Green ballot paper, good and acceptable for farmers, respectively.

(b) Yellow ballot paper, accepted as alternative for farmers respectively.
(c) Red ballot paper, rejected by farmers, respectively.
Ballot papers were dropped in black polyethylene bags by farmers and these are counted per plot and expressed in % as follows:
(1) % green for selection of variety/hybrid (choice variety/hybrid);
(2) % yellow for alternative against adopted variety/hybrid;
(3) % red for rejection of adopted variety/hybrid.

Selected entries scores of at least 70 to 100% green votes of the total farmers per site were considered selected. Alternatives scores were between 51 and 69% yellow votes, while rejected entries scores were between 50 and 100% red votes. Statistical analysis of the data was carried out using standard analysis of variance (Gomez and Gomez,1984).

Result and Discussion

Priority ranking: Result from priority ranking from some selected sampled locations (Muthukrishnapuram and Thoppureddipatti) showed that earliness and yield ranked 1st and 2nd, respectively across all the sites (Table 1) due to the following reasons:
(1) For pearl millet, it is the first crop to be planted at the onset of rains and later intercropped with either cowpea or coriander.
(2) Early maturing cultivars escape bird's damage at migration.
(3) Drought escapes, since most people living in these areas where pearl millet is being produced have short rain periods ranging from 75 to 100 days.

The TNAU released pearl millet hybrid CO9 was ranked first due to its early maturity (80 days) and plant height (165 cm) which could have been preferable for manual harvest of ear heads. Plant height is the main attributes which may or may not favour lodging. Lodging was noticed due to the tallness of other hybrid and varieties which was not liked by the farmers (table 1). The yield difference between the TNAU released pearl millet hybrid CO9 and Pioneer 86M86 was meager which was not affected the farmers.

The check hybrid Pioneer 86M86 had shown highest grain yield (2684 kg/ha) under rainfed vertisol tracts of southern districts of Tamil Nadu (table 3). The TNAU hybrid CO9 was performed well and it might be revalidated in another season to access the yield potential under rainfed vertisol tract of Southern district of Tamil Nadu.

Conclusion

Results from both participatory and field evaluation suggest that participatory variety evaluation offers the possibility of bringing modern and traditional plant breeding together to increase the usefulness of new crop varieties to farmers, especially small-scale farmers working in stress environments with limited external inputs. It is however, suggested that the early maturing hybrids; TNAU cumbu hybrid CO 9 and private hybrid Pioneer 86M86 which recorded highest grain yield of 2622 and 2684 kg/ha respectively were the preference of the farmers. The farmers' preference towards the adoption of hybrids showed that the hybrid should possess early duration under harsh environment besides desirable plant height (155-165 cm) which is amenable for manual harvest. Hence, the TNAU cumbu hybrid CO 9 showed first priority ranking than private hybrid Pioneer 86M86.

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Table 1. Priority ranking for setting breeding objectives for pearl millet varietal selection criteria

Traits	Pearl millet Varities/Hybrids			
	CO Cu 9	Pioneer 86M86	CO9 hybrid	Nattu cumbu (local variety)
50%flowering (days)	55	60	50	70
Maturity (days)	85	90	80	100
Plant height (cm)	212	195	165	215
Panicle length (cm)	33	36	35	28
Panicle breadth (cm)	3-4	3.8	3-6	2-9
Tillers (No)	3-6	5 - 6	4-6	5-6
Panicle compactness	Candle to Cylindrical	Semi compact	Candle to Cylindrical	Candle
Yield (kg/ha)	1943	2684	2622	850
Grain color	Gray seed with yellow base	Dark Grey	Greyish yellow	Slate
Drought tolerance	-	-	Tolerance	Tolerance
Downy mildew resistance	Resistant	Resistant	Resistant	Susceptible

Table 2. Participatory pearl millet varietal selection score

Variety	Per cent (%) acceptance	Per cent (%) alternative	Per cent (%) rejection	Remarks
CO Cu9 variety	21	49	30	Rejected
CO9 hybrid	80	7	13	Selected
Pioneer 86M86	76	17	7	Selected
Nattu cumbu (Local variety)	37	35	28	Alternative

Table 3. Yield performance of pearl millet variety/hybrids in rainfed condition

Variety	Yield (kg/ha)			DSI	DTE	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio	RWUE (kg/ha-mm)
	Grain yield (kg/ha) in 2015	Mean grain yield (no. of years)	Stover / stalk yield						
CO(Cu)9	1943	First year	1860	-	Tolerance	22000	7150	0.33	4.08
Hybrid - CO9	2622		2105	-	Tolerance	22000	17325	0.79	5.51
Pioneer 86M86 (Check)	2684		2116	-	Tolerance	22000	18265	0.83	5.64
SEd	35.2								
CD (P=0.05 %)	97.6								