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Farmer participatory varietal selection in pearl millet: Experience across some states of Northern Nigeria

Angarawai I. I.[1]*, Bukar B.[1], Olabanji O. G.[1], Iro N.[2], Haussmann B. G.[2], Weltzien E. V.[2], Gwadi K. W. [1], Gubio T. [1] and Yahaya Y.[1]

[1]Lake Chad Research Institute P. M. B 1293 Maiduguri, Nigeria.
[2]International Crop Research Institute for Semi-Arid Tropics (Niamey & Bamako), Mali.

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Farmers participation in the process of on-farm research does not only enrich the speed up of information gathering, but also result in large scale adoption of the product of research. A small farmer deals with a variable environment and has multiple production objectives that will affect his or her choice of crops and selection of genotypes. In areas where farmers are unfamiliar with available improved varieties, there is need of conducting effective variety evaluations with farmers. 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. Participatory plant breeding/selection has shown success in identifying more number of preferred varieties by farmers in shorter time (than the conventional system), in accelerating their dissemination and increasing cultivar diversity. This paper describes how plant breeders and farmers worked together to test and selected farmers preferred pearl millet varieties; PE05684 and PE05532 from a diverse pearl millet accessions in a participatory varietal selection program conducted across some states of Northern Nigeria.

Key words: Diversity, pearl millet, participatory plant breeding, varietal selection, ranking.

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] provides diet for over 40 million people who live especially in the arid and semi arid regions of Northern Nigeria. With an average annual production of 3.8 million tons, Nigeria ranks second after India in global millet production (FAO, 2012). In Nigeria, the crop can be used for a variety of purposes. The flour is processed into thick porridge called 'tuwo' served with traditional vegetable soup and fried snack called 'Masa' and non-alcoholic beverages called 'fura'.

Addressing poverty in rural Semi-Arid West-Africa and especially Nigeria requires interventions in the dry-land 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 disadvantaged access to markets, especially opportunities for marketing grain surpluses which hinder adoption of improved varieties. In areas where farmers are unfamiliar with available improved varieties, there is need of conducting effective variety evaluations with

*Corresponding author. E-mail: angarawaiijantiku@gmail.com.

farmers. This ideology was based on reconnaissance survey which indicated that, the uptake and sustained use of improved varieties is constrained by lack of awareness of the improved varieties, traditional values, seed unavailability, early maturity, bird damage, and fertilizer unavailability.

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 (than the conventional system), in accelerating their dissemination and increasing cultivar diversity (Weltzien et al., 2003). According to several authors (Kornegay et al., 1996; Van Oosterom et al., 1996), it is well suited for niche breeding, or development of varieties that perform well in specialized environments.

Farmer participation in the breeding of crop varieties for low-resource farmers is regarded by some as necessary to help ensure acceptance and eventual adoption (Franzel et al., 1995; Gyawali et al., 2007; Maurya et al., 1988; Mekbib, 2006; Prain et al., 1992).

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 breeders 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.

The specific objective of this project was to select from diverse and productive pearl millet lines received from ICRISAT Niamey during the BMZ and IFAD projects, that are adapted to local conditions and accepted by farmers and consumers' at large using farmers' indigenous knowledge and breeders' scientific approach.

METHODOLOGY

Participatory rural appraisal

The Lake Chad Research Institute/Community Based Agricultural and Rural Development Project (LCRI/CBARDP) team carried out community consultation across trial implementation sites before each of the 2006 to 2008 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, replications (3 to 4) to enable yield evaluation (possibility of trying 2 replications per farmer were sought), 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, production system with respect to striga management and documentation of available food products from millet/sorghum 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 CBARDP 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 Ngetera-Gubio (Borno) is Kanuri, at Tikau (Yobe) is Karekare, while at Sabon-Gari (Jigawa), Garin-Garu (Katisna), Gusau (Zanfara), and Alero (Kebbi) is Hausa, and presentations were translated accordingly. Attendances for each location were recorded.

Test sites selections were based on the following criteria: (a) easily accessible from a paved road (less than 20 km from the main road in rainy season; (b) the community is responsive to the innovations; (c) place of intensive sorghum production in the western states; (d) place of intensive millet production in the eastern states.

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.

These sites were situated within the target zones of IFAD investment projects (CBARDP) in six states of Northern Nigeria and were used to both implement a Farmer Field School where proven technologies were proposed to farmers and participatory trials to check their local adaptation and interest and to realize participatory activities on variety improvement, that is, tests of varieties from the whole region, selection within the breeding populations in process and organisation of a community level seed production.

While presenting the proposals, willing farmers were selected based on the following criteria: active and willing to participate,

volunteering, should be resident in the community, have group spirit, willing to share experiences, ready to follow rules and posses good human relations.

Project officers (POs) and development officers (DOs) along with their field assistants assisted in identifying farmers who participated in the focus groups discussions with representation of both men and women.

Priority ranking

Participatory rural appraisals were conducted on the major characteristics of pearl millet and sorghum landraces. 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 ICRISAT_NIAMEY through BMZ and IFAD TAG817 project. During 2007, 27 entries selected from the 360 Germplasm materials were evaluated on two row plot of 5 m length with 2 replications across seven IFAD-CBARDP participating states (Kebbi, Katsina, Zamfara, Jigawa, Yobe, and Borno) where farmers were exposed to the diversity and expressed their opinion. During 2008 cropping, 17 entries selected from the 2007 cropping season were repeated across the seven participating states to confirm farmers' choice. These were established in 12 villages each with an average of 200 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 growth, stem thickness, resistance to lodging, drought resistance, insect resistance, time to maturity, 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) White/Green ballot paper, good and acceptable for men/women, respectively.
(b) Blue/Yellow ballot paper -accepted as alternative for men/women respectively.
(c) Red/Pink ballot paper, rejected for men/women, respectively.
Ballot papers were dropped in black polyethylene bags by farmers and these are counted per plot and expressed in % as follows:

(1) % white for men/green for women;
(2) % blue for men/yellow for women;
(3) % red for men/pink for women.

Selected entries scores of at least 70 to 100% white/green votes of the total farmers per site were considered selected. Alternatives scores were between 51 and 69% blue/yellow votes, while rejected entries scores were between 50 and 100% red/pink votes.

Data analysis using Genstat Discovery Edition was carried out for individual locations, while combined analyses were carried out on only those that were consistent for parameters across the locations and years.

RESULTS AND DISCUSSION

Priority ranking

Result from priority ranking from some selected sampled locations (Tikau, Gubio and Gwoza) 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 groundnut.
(2) Early maturing cultivars escape bird's damage at migration and striga infestation.
(3) Drought escapes, since most people living in these areas where pearl millet or sorghum is being produced have short rain periods ranging from 75 to 100 days.

Field data

Data for 2008 cropping season for some selected locations is presented. Data analysis of the 2008 participatory selection, showed that farmers across sites gave the highest scores to the 2 most common entries; PE05684 and PE05532 of 76 and 80% acceptance, respectively (Table 2), characterized by earliness, bold grain, stout stalk, compact panicle, less downy mildew, and no insect pest attack. Accordingly, most farmers expressed that, these varieties met their earlier criteria from priority ranking (Table 1), that is, earliness and yield ranking 1st and 2nd, respectively. PEO5984 though early scoring 45% acceptance was considered as alternative choice due to its short panicle which may not be suitable for bundling.

To confirm the farmers choice of lines selected, data analysis for the locations combined is presented on Table 3. Grain yield ranged from 1829 to 4366 kg/ha with PE05631×PE05393 having the highest grain yield of 4366 kg/ha. Days to 50% flowering ranged from 52 to 88 days with PEO5984 being the earliest (52 days to 52% flowering). PE05684 and PE05532 recorded grain yield of 3502 and 4046 kg/ha, respectively with both having a yield advantage of 30% over the local check confirming

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

Traits	Millet			Sorghum		
	Tikau	Gubio	Benesheikh	Gwoza	Dikwa	Daniski
Maturity (earliness)	1	1	1	1	1	1
Yield (high)	2	2	2	2	2	3
Plant height (medium)	11	11	11	5	6	5
Panicle length (medium)	9	9	8	11	11	11
Panicle size (medium)	12	12	13	12	12	12
Grain size (bold)	4	4	4	6	5	9
Grain colour (white)	6	7	6	3	3	2
Thresh ability	13	13	12	7	7	13
Grain hardness (hard)	5	5	5	8	8	6
Taste	8	8	9	9	9	8
Storability	10	10	10	10	10	10
Panicle compactness (compact)	3	3	3	4	4	7
Dm/Striga resistance	7	6	7	13	13	4

Table 2. Participatory pearl millet varietal selection score for locations combined in Northern Nigeria 2008 cropping season.

S/N	Pedigree	Percent acceptance (%√)	Percent alternative (%ф)	Percent rejection (% ×)	Remark
1	PE01490	30	29	35	-
2	PE00404	9	4	74	Rejected
3	PE05419	3	22	71	,,
4	PE05607	9	32	47	,,
5	PE05611	11	20	68	,,
6	PE05684	76	17	7	Selected
7	PE00382	21	18	61	Rejected
8	PE05449	14	17	61	,,
9	PE05463	20	17	50	,,
10	PE05631	16	37	46	
11	PE05532	80	7	11	Selected
12	PE05593	37	35	28	Alternative
13	PE05631XPE05393	39	40	21	,,
14	B-9 Tabi	21	49	30	,,
15	PE05984	45	26	28	,,
16	LCICMV-1 (SOSAT-C88)	76	11	12	Selected
17	LOCAL CHECK	58	1	32	-

%√ = percent score for selection. %ф = percent score for use as alternative. % × = percent score for rejection.

the farmers earlier choice of these lines.

PE05631×PE05393 with the highest grain yield of 4366 kg/ha was not selected due to variability within plot as a result of segregation for days to 50% flowering. Plant height ranged from 175 to 310 cm with mean of 272 cm. PE05684 and PE05532 selected by farmers were of medium height of 228 and 303 cm, respectively, thus good stalk height for fencing and roofing purposes.

Downy mildew infestations were generally ≤1% indicating the genotypes are moderately resistant across the sites tested.

Conclusion

Result from both participatory and field evaluation suggest that participatory variety evaluation offers the possibility of bringing modern and traditional plant breeding traditions 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 medium maturing PE05684 and PE05532 which recorded grain yield of

Table 3. Performance of pearl millet lines for some agronomic characters across some selected states (Zanfara, Jigawa and Yobe) combined during 2008 season.

Entry	Pedigreee	Downy mildew score (%)	Days to 50% flowering	Plant height (cm)	Grain yield (kg/ha)
1	PE01490	0	69	272	3235
2	PE00404	0	77	271	2837
3	PE05419	0	88	283	1951
4	PE05607	0	76	321	1829
5	PE05611	0	77	239	2039
6	PE05684	0	61	228	3502
7	PE00382	0	75	309	2716
8	PE05449	0	79	306	2494
9	PE05463	0	86	310	2550
10	PE05631	1	73	272	2693
11	PE05532	1	62	303	4046
12	PE05393	1	66	296	3906
13	PE05631XPE05393	0	69	299	4366
14	B-9 Tabi	0	66	213	3556
15	PEO5984	1	52	175	3680
16	LCICMV-1 (SOSAT-C88)	0	61	267	4212
17	LOCAL CHECK	1	62	265	2870
mean		0	71	272	3087
se±		0	2.9	15.4	389.6
cv%		-	5.8	13.9	30.9

3502 and 4046 kg/ha, respectively can further be subjected to on-farm adaptive trials.

Conflict of Interests

The authors have not declared any conflict of interests.

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