African Journal of Plant Science Vol. 3 (7), pp. 147-156, July 2009
Available online at http://www.academicjournals.org/AJPS
ISSN 1996-0824 © 2009 Academic Journals

Full Length Research Paper

Agronomic, culinary, and genetic characterization of selected cowpea elite lines using farmers' and breeder's knowledge: A case study from Malawi

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Accepted 24 June, 2009

Cowpea (*Vigna unguiculata* L.) is an important crop in Malawi. It provides dietary nutrients and income to poor-resource farmers. However production and productivity are below the potential level due to lack of suitable varieties. The objective of the study was to select the productive and diverse cowpea varieties that are acceptable to farmers and consumers using a participatory variety selection (PVS) strategy. Farmers' perceptions based on focused group discussions, and interviews varied little among the villages. Yield was the most frequently used selection criteria by farmers, regardless of gender profile. There was great variability for seed production among entries. Other agronomic traits such as days to maturity, seed size, pod shape, disease resistance, growth habit, culinary traits including taste, cooking time, broth color and thickness were used at different stages of the selection process. Initially, farmers were invited at the research stations to select the best 20 lines out of 127 entries. These selected lines were subjected to further evaluation in community plots managed by male and female farmers. The genetic analysis revealed a high level of genetic variation among accessions and confirms the absence of redundancy within the genetic materials used. At the end, farmers selected six entries that were released in the two agricultural development divisions (ADDs). The present study is the first documented case of multidisciplinary approach for the selection of elite accessions while maintaining biodiversity.

Key words: Participatory variety selection, *Vigna unguiculata,* Malawi, agrobiodiversity, indigenous knowledge.

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) Walp, is considered the second most important legume crop in Africa (Kitch et al., 1998; Muleba et al., 1997; Sabiti et al., 1994). It is also an important food crop in Malawi and provides dietary nutrients especially carbohydrates, proteins, minerals, and vitamins. It also provides income to farmers when sold on open markets. The cowpea crop is widely adapted and shows great tolerance to moisture stress (drought). Production is countrywide particularly in warm areas with low rainfall such as Shire valley, Bwanje valley, Lakeshore and Phalombe plains as well as dry plateau areas of Machinga. Despite the importance of cowpeas as a staple food and its wide range of ecological adaptation, yields are quite low and cowpea is not among the main crops grown by farmers. Average grain yields range from 250 to 600 kg per hectare but potential yields of up to 2,000 kg per hectare are possible in pure stand. Lack of suitable varieties and limited breeding work has resulted in low productivity and low rate of adoption of improved varieties by farmers.

The low rate of adoption for many of the crop varieties, especially in subsistence and small scale farming systems, has been attributed to the release of station-bred varieties that were evaluated and managed by researchers under conditions that are most favorable to crop growth without regard to local constraints and Far-

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mers (Gyawali et al., 2007; Weltzien et al., 2003). More recently, plant breeding strategies that make use of, and maintain crop diversity have been advocated by some researchers as one way of improving crop yields, productivity, stability, and rate of adoption (Witcombe et al., 1996; Mekbib 2006). Participatory plant breeding (PPB) or participatory variety selection (PVS) is one such strategy that aims at strengthening cooperation between researches, especially breeders, and farmers in evaluating plant germplasm and establishing plant breeding goals that take into account farmers' knowledge and gender factors. Witcombe et al. (1996) usefully distinguish between working with segregating or stable lines. They refer to work involving farmers in evaluating stable lines as "participatory variety selection" (PVS) reserving "PPB" for work with still-segregating material. The strategy is premised on the observation that the agronomic, socio-economic, and socio-cultural requirements of smallholder farmers and consumers are too diverse to be filled by a limited number of genotypes.

Although both men and women are involved in agricultural activities, cowpea is generally considered as a women's crop, hence women have more knowledge of cowpea than men. Like in many other subsistence crops, women's specialized knowledge on genetic resources makes them essential custodians of agricultural biodiversity for food and agriculture. However, this fundamental contribution by women in time, labour, and expertise in agricultural production continues to be under appreciated, under-supported and often negatively affected by prevailing economic growth and development processes.

Efforts to develop agriculture in a manner that will benefit the poor must fully address gender equality and the empowerment of women. Sex-disaggregated data, gender analysis, and women's participation in decision-making are necessities in agricultural planning and implementation, including agricultural research.

The objective of the study was to select productive and diverse cowpea varieties that are acceptable to farmers and consumers using a participatory variety selection (PVS) strategy.

MATERIALS AND METHODS

Participatory rural appraisals (PRAs) were conducted in two agricultural development divisions (ADD), Blatynre and Machinga to identify the major characteristics of cowpea varieties. In each ADD, two extension planning areas (EPAs) were selected, Phalula and Nansenga EPAs in Machinga ADD and Thuchila and Khonjeni EPAs in Blatynre ADD (Figure 1). PRAs were done through village meetings, focused groups discussions (FGDs) and interviews. The project officers (PO) and development officers (DO) along with their field assistants assisted in identifying farmers who participated in the focus groups discussions. For each ADD, separate FGDs were held for women and men in order to facilitate open discussion and free expression especially by the women. In total 56 farmers (28 per ADD) participated with equal representation of men and women. All the socio-economic classes perceived by the community were represented adequately.

Participatory variety selection

The same Agricultural Development Divisions (ADDs), Blantyre ADD (BLADD) and Machinga ADD (MADD) selected for PRA were selected for PVS activities. This was based on the contrasting agro-ecologies and importances of cowpeas in these two ADD. In BLADD, two community trial sites (CTS), Lomola (Tyolo district) and Phalombe CTS (Phalombe district) were selected. These CTS were each located in a different Extension Planning Area (EPA). For the MADD, the PVS was carried out in Phalula CTS (Machinga district). Ten farmers were required to participate in the PVS program at each CTS. Farmers' selection was based on willingness to participate as well as their knowledge of cowpeas and its production. Care was taken for gender considerations including involvement of both men and women. Staff members from each ADD participated in the site and farmer selection. Participating farmers were briefed on their role as well as the objectives and expectations of project activities.

The community plot at each of the three CTS was ploughed and ridged at a spacing of 0.9 m between ridges. Each CTS had 20 cowpea entries selected previously from the 127 entries evaluated in the 1999/2000 cropping season. All the accessions used in the present study were provided by the National Gene Bank at Chitedze Research Station and Bunda College of Agriculture. Planting was done on four ridges measuring 5 m each. Three seeds were planted per station at spacing of 0.30 m apart. Gross plot (experimental unit) size comprised of four ridges, 5 m long and 0.9 m wide (18 m^2) while the net plot was 5.4 m^2 (two ridges, 3 m long and 0.9 m wide). The trial was a completely randomized block design (RCBD) with 3 replicates.

Farmers managed the community plots as a group. Data was collected on yield, yield components, and culinary characteristics. Yield was from net plots calculated at 10% moisture content (MC). Farmers' selections of accession were made by ranking (best entry first and second best etc). Each group of farmers was given a maximum of five choices. Women and men preferences were recorded separately to isolate gender differences. Mixed groups (male and female) were also allowed to participate in the selection process. Each of the groups recorded the reasons for each of their selections.

In 2001, fifteen of the 20 entries that were top ranked were further evaluated based on taste (Table 3). In 2001/2002, a final selection of six elite lines was made based on agronomic traits and taste. These lines were further characterized in relation to cooking time, broth color and thickness, seed and broth taste (Table 4).

Genetic analysis

DNA extraction: To determine any redundancy and to identify closely related accessions, inter-simple sequence repeats (ISSR) analysis was performed using the procedure described by Nkongolo et al. (2005). The total cellular DNA from 1 g of individual samples was extracted from needles using the method described by Nkongolo et al. (2003) with some modifications. The concentration of each sample was determined using the DNA quantitation kit from Bio-Rad and the purity was determined using a spectrophotometer (Varian Cary 100 UV-VIS spectrophotometer).

Amplification of ISSR markers: Seven ISSR primers described by Nkongolo et al. (2005) were selected for DNA amplifications. These primers include ISSR 17898B, ISSR 17899, ISSR HB 13, ISSR HB 15, SC ISSR 5, SC ISSR 9, ISSR UBC 841. DNA amplification was performed following the procedure described by Nagaoka and Ogihara (1997) with some modifications. Each PCR reaction was performed in a 25 µl volume containing 5 ng of genomic plant DNA, 10 mM Tris-HCl, pH 8.3 (at 25°C); 50 mM KCl; Applied Biosystems, Foster City, CA, 3.5 mM $MgCl_2$, 200 µM of each dNTP (Applied

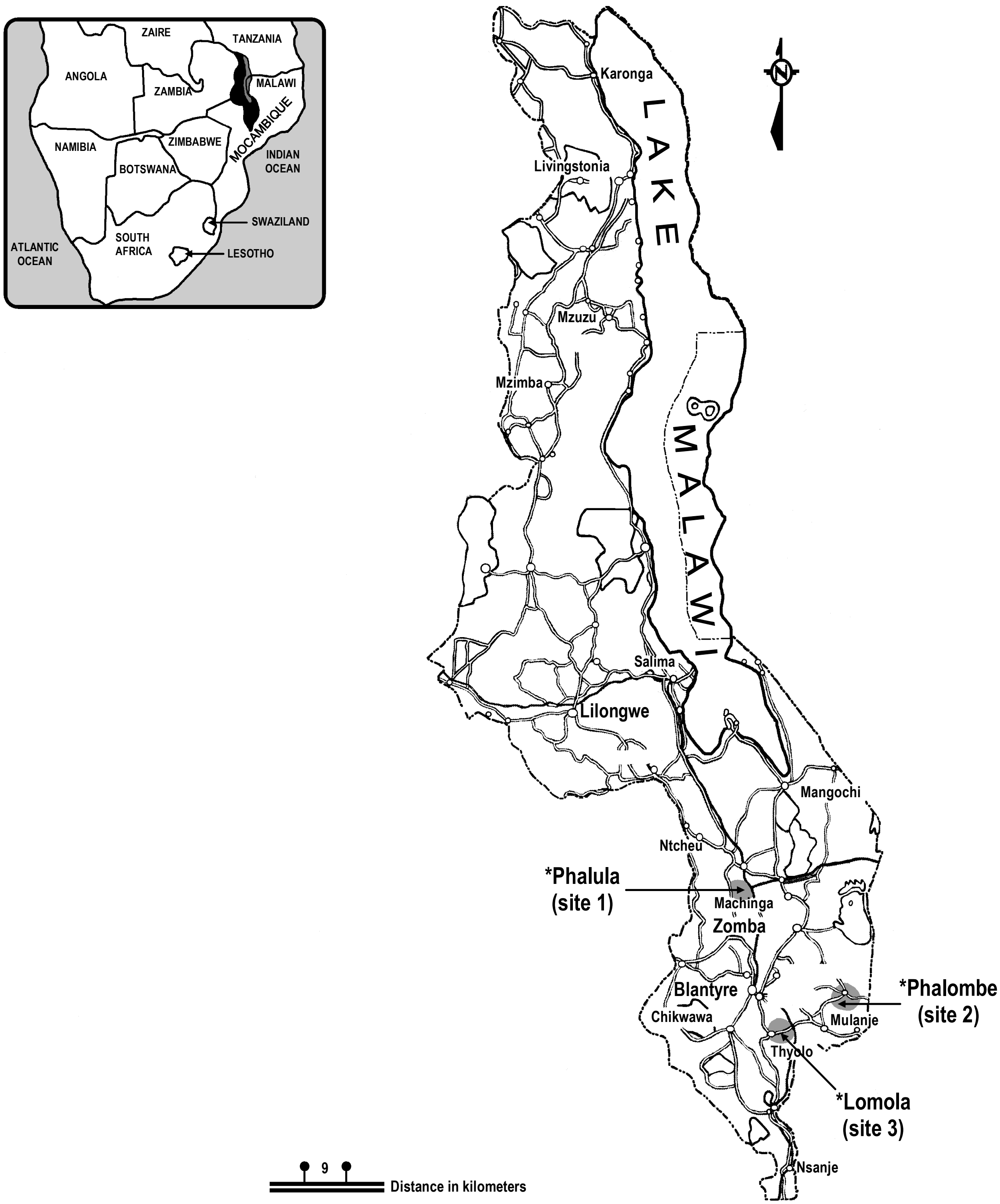

Figure 1. Malawi map showing different sampling sites.

Biosystems, Foster City, CA), 0.5 µM primer and 0.625 U of *Taq* DNA polymerase (Applied Biosystems, Foster City, Calif.). For each primer, a negative control reaction with double distilled water was included. A drop of mineral oil was added to each reaction and the samples were amplified on a DNA thermal cycler (Perkin Elmer, Foster City, CA). The cycles performed were as follows: an initial denaturation at 95°C for 5 min followed by a 2 min incubation at 85°C at which point the polymerase was added; 42 cycles of 90 s at 95°C, 2 min at 55°C and 60 s at 72°C were performed; a final extension at 72°C for 7 min and a subsequent incubation at 4°C

Table 1. Passport data of 20 cowpea entries evaluated in community plots by males and females farmers during the 2000/2001 cropping season.

Entry #	Serial #	Accession #	Collection site/Source
1	40	727	Machinga
2	25	576	Chiladzulu
3	61	239A	Bunda
4	17	468	Mulanje
5	86	TITATIV 210-10	USA
6	43	755	Machinga
7	31	633	Thyolo
8	66	395	Bunda
9	3	305	Mzimba
10	30	622	Thyolo
11	5	387	Nsanje
12	42	753	Machinga
13	4	309	Mzimba
14	73	416	Bunda
15	96	544	Phalombe
16	24	570	Chiladzulu
17	62	239B	Bunda
18	36	664	Blantyre
19	85	TVX 33-1G	USA
20	49	UCR 430	USA

followed. PCR products were loaded onto 1% agarose gels (invitrogen) in 0.5 X Tris-borate-EDTA (TBE) buffers containing ethidium bromide and run at 2.8 V/cm for 90 min. The agarose gels were documented using the Bio-Rad ChemiDoc XRS system and analyzed with the Discovery Series Quantity One 1 D Analysis Software.

Only the ISSR primers which gave consistent profiles across the populations were selected. The presence and absence of bands were scored as 1 or 0 respectively. Faint bands were not recorded for analysis. The data were analyzed using RAP Distance Program version 1.04 (Armstrong et al., 2005).

RESULTS

Indigenous knowledge of cowpeas

Two main groups of cowpea were commonly identified: the large seeded called “Khobwe” and the small seeded named “Nseula”. In addition to the seed size, the two types are also distinguished by several characteristics such as seed colour, time to maturity, growth habits, and taste. Khobwe is usually late maturing although there are some varieties that mature early. It is generally prostate (indeterminate) in its growth habits and the seed color ranges from red, light red, variegated to black. On the other hand, Nseula is bunch or determinate in its growth habits and the leaves are small as compared to Khobwe. It matures early and can be grown twice in one growing season. Seeds from Nseula cowpeas tend to take more time to cook and are less tasty. The characteristics that farmers prefer in Nseula are early maturing and hence two crops can be grown in a season. Additional characteristics to early maturity include soft leaves for use as vegetables, high yielding, grain size, taste, resistance to pests and diseases. Khobwe is preferred for seed size, high yielding, fast cooking and taste.

Cowpeas are grown both as pure crop and in mixed stands. Nseula is mostly grown in pure stand to avoid pests and to allow for high yields. Many farmers grow two crops of Nseula per year, one at the beginning of the season and the second towards the end of the season. Khobwe is usually grown in mixtures with other crops such as maize and sorghum. To control the pests, farmers use a number of cultural practices including, the application of ashes, intercropping specially for Khobwe and planting early at the first sign of rain (to enable the crop to escape damaging pests and to harvest before the pest population increases). The pure crop is planted 0.3 m apart especially those grown in the “dimba”. When the crop is mixed with maize, the maize crop determines the plant spacing. Usually, maize is spaced at 90 cm apart and the cowpeas are planted between the maize planting holes. Two to three seeds are planted per hole to avoid overcrowding and encourage better plant growth and high yield. Pests that attack cowpeas in the field are aphids, white grub, caterpillars, beetles, cutworms and elegant grasshopper. After harvest, the viability of the seed is maintained by storing seed in a kitchen without shelling, with ash in bottles or pots with cooking oil in bottles. Cowpeas that are stored for consumption are mixed with ash or finger millet bran and kept in pots. Weevils are a menace to cowpeas in storage. Farmers exchange seeds either to increase variability or for future use.

There are several methods that farmers employ to process cowpea before use. Cowpeas leaves and the seeds are both used for relish and as a snack when the fresh pods are boiled. Fresh cowpeas are covered with plates and shaken for some time to remove the testa. The cowpeas are then cooked and mashed into paste for relish. Leaves are cut into small pieces with a knife or hands before cooking. Fresh pods are broken into smaller pieces which are mixed with leaves and cooked. Dry cowpeas are shelled, winnowed, washed and cooked for relish. Sometimes, the testa is removed by grinding on a stone or pounded in a mortar and the cowpeas cooked and mashed for relish. No special processing is involved when fresh pods are cooked for snack.

Field evaluation of cowpea accessions

The selection steps from the first evaluation of 127 accessions to the release of six elite accessions are summarized in Figure 2. Table 1 gives passport data of the 20 entries. The results indicate greater variability for agronomic and culinary traits among the 20 entries eva-

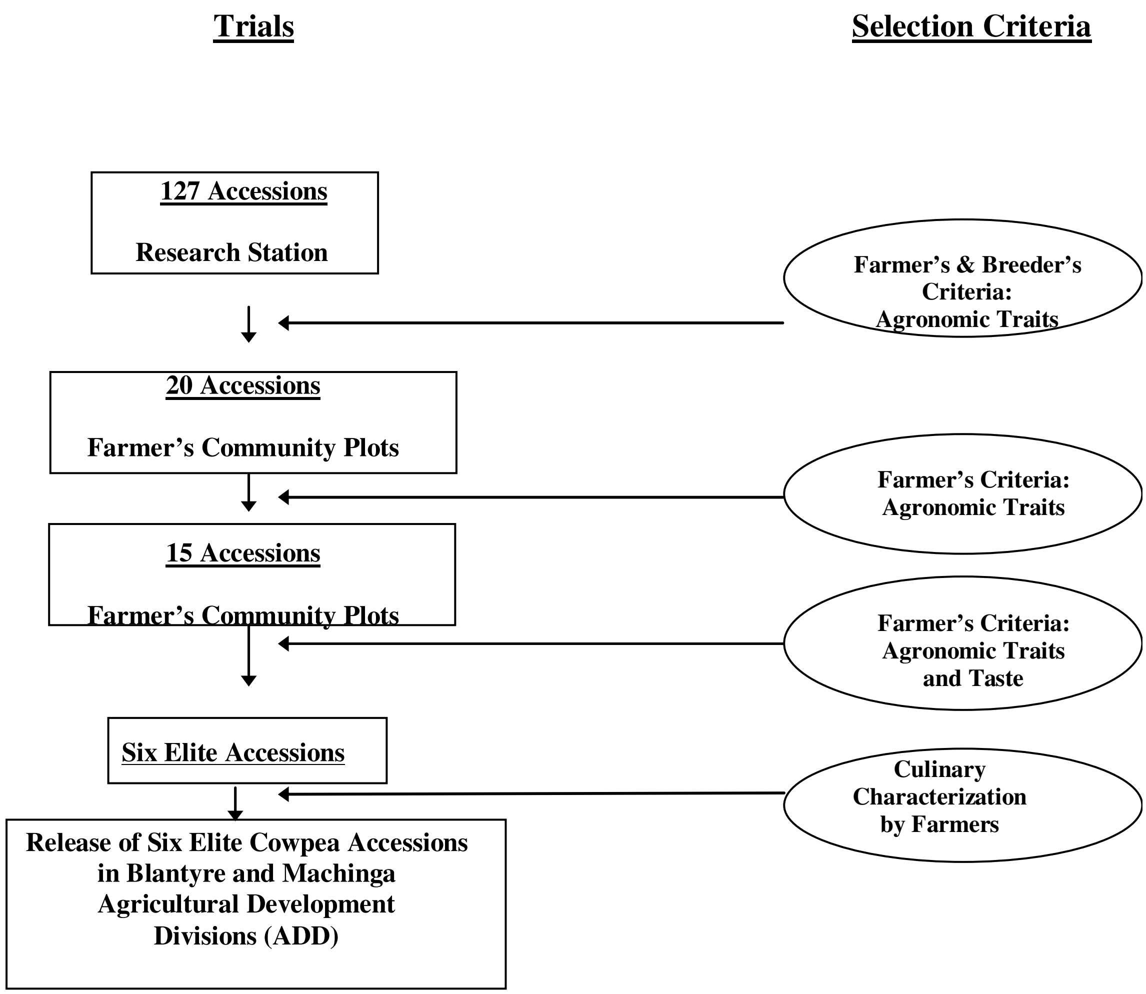

Figure 2. Participatory selection of cowpea in Malawi (1999-2004).

luated under farmer-managed fields (Tables 2 and 3). The most frequently used selection criterion by both men and women was yield, underscoring the importance of this trait in cowpea improvement programs. Other agronomic traits such as days to maturity, seed size, pod shape, disease resistance, and growth habit were also used as selection criteria.

Table 2 shows the performance of the 20 entries at the three sites, Lomola, Phalombe and Phalula. Table 3 describes the average yield of selected accessions across sites. Analysis of variance (ANOVA) showed no significant (p = 0.05) Site X entry interaction, indicating that the performance of all entries was consistent over sites. The mean yield over all sites for all the entries was 256.7 g/ plot. Accession 309 produced the lowest mean yield (148.5 g / plot) over sites while accession 576 gave the highest seed production (461.4 g / plot).

Varietal selection and gender considerations

The mean yield at Lomola and Phalombe sites were quite similar (292 and 282 g/plot, respectively). Disease resistance and yield were the most important selection criteria in Lomola. Pod shape and days to maturity were also considered by farmers during their selection. In general, selection was made for high yield, disease resistant, straight shaped pods, and early maturity. The farmers in Phalombe were more consistent in the selection process. They were also the only group that considered "adaptation" as a selection criterion in addition to the high yielding, large seed, and early maturity. Phalula as a site produced the lowest mean yield (208 g / plot). As in other sites, yield was the main selection criteria, but farmers at the Phalula sites were the only ones who considered marketability as an important se-lection criterion. In general variety selections were based on yield potential, disease resistance, pod shape, and days to maturity. Farmers liked high yielding, disease resistant, straight podded and early maturing entries.

The results from Lomola site indicated that accession 387 was ranked the best performer. This accession was highly preferred because it was perceived to have high

Table 2. Yield data of 20 cowpeas accessions at three different locations, Lomola, Phalombe, and Phalula in 2000/2001 cropping season.

	Yield (g / plot)*		
Accessions	**Lomola**	**Phalombe**	**Phalula**
727	360	364	268
576	530	220	605
239A	150	352	63
239B	220	211	200
468	429	192	232
755	253	338	110
633	241	317	380
395	279	314	86
305	229	424	175
622	189	212	465
387	714	266	325
753	360	207	45
309	288	23	118
416	308	205	50
544	232	236	306
570	237	287	186
664	356	259	196
TITATW 210-10	136	236	206
TVX 33-1G	166	428	132
UCR 430	165	520	116
LSD	89	98	78

*Yield was measured at 10% moisture content and each plot measures 5.4 m^2.

Table 3. Field selection, cooking taste and yield performance of selected accessions across sites.

*Accesions	**Field selection			Cooking taste		***Average yield
	Phalula	**Phalombe**	**Lomola**	**Fresh**	**Dry**	**g / plot**
305	No	Yes	Yes	Yes	Yes	276
239B	No	No	No	Yes	Yes	210
TVX 331G	No	Yes	No	Yes	Yes	208
576	No	No	Yes	Yes	No	462
TITAV 210-10	Yes	No	No	Yes	No	177
239 A	No	No	No	Yes	Yes	188
622	Yes	No	No	Yes	No	289
570	Yes	Yes	No	Yes	Yes	236
727	Yes	No	Yes	Yes	No	333
633	Yes	No	No	Yes	Yes	313
387	No	Yes	Yes	Yes	Yes	435
544	Yes	No	Yes	No	No	239
755	No	Yes	No	No	No	234
664	No	No	No	No	Yes	256
395	No	No	Yes	No	No	224

*Accessions 305, 576, 570, 727, 633, and 387 were selected based on overall performance.
**Field selection was based on time to maturity, drought tolerance, and insect /disease resistance.
***Yield was measured at 10% moisture content and each plot represents 5.4 m^2.

yield potential in addition to large and straight pods, early maturing, and disease resistant. Farmers from Phalombe site selected the accession 305 as the best. This accession was ranked at the top regardless of the

Table 4. Culinary characteristics of six selected cowpea entries.

	Performance*				
Acc. #	**CT**	**BC**	**BT**	**ST**	**Br.T**
305	73 min	Brown	Thick	Tasteless	Good
576	140 min	Brown	Fairly thick	Fair	Fair
570	98 min	Brown	Thick	good	Good
727	174 min	Reddish brown	Thin	Fair	Fair
633	138 min	Brown	Thick	Fair	Fair
387	81 min	Pale brown	Fairly thick	Good	Very good

∗CT is cooking time, BC is broth colour, BT is broth thickness, ST is seed taste, and Br.T broth is taste.

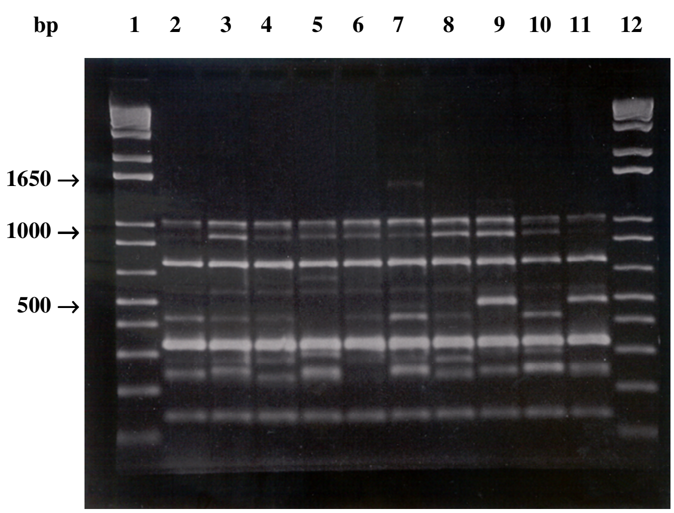

Figure 3. ISSR profiles of genomic DNA from cowpea accessions amplified with ISSR primer UBC 841 in a 2% agarose gel. Lanes 1 and 12 contain 1-Kb + DNA ladder. Lanes 2 to 11 contain amplified DNA products from cowpea accessions.

gender profile based on a combination of several agronomic and culinary criteria. Accession 570 was another entry that was selected by all gender groups. It was selected as second best by "men only" and "mixed" (men and women) groups but was ranked fifth by "women only" group. For Phalula site, Accession TITATIV 210-10 was the only entry selected by all gender groups but the ranking varied. Men ranked accession 544 as the best, women preferred accession 727, while the mixed group picked accession 633 as the best performer. Accessions 544, 633, and 570 were selected by at least two gender groups. The rest of the accessions were only selected by one of the gender groups.

Among the 20 elite lines evaluated at three sites, accessions 305, 576, 570, 727, 633, and 387 were selected based on overall performance. Culinary characteristics of these six selected entries are described in Table 4.

Genetic analysis

A genetic analysis of 20 elite lines was conducted using ISSR markers. This analysis revealed that the level of variability among accessions was very high. The within-accession variation was very high (65%) indicating an uncontrolled gene flow among populations. The analysis of molecular variance revealed that among accessions variations accounted for 96.4% of the total molecular variance. In general the 20 accessions analyzed were unique and have distinctive banding patterns (Figure 3).

DISCUSSION

The preference for high yield, adaptation, and early maturity may not be surprising for Phalombe considering that this site is a plain that normally has a warm climate with low rainfall. In fact, Marfo et al. (1997) indicated that the increasing importance of cowpeas in the Sub-Saharan Africa is due to the crop's ability to produce reasonable grain and haulm yields in areas with limited rainfall as low as 200 mm per annum. In such areas, breeders aim at developing varieties, which mature early to avoid terminal drought. On the other end, the low yield in Phalula appears to be caused by the site location near a "Dambo" (marsh) and the water logging did affect the performance of the entries. This water logging problem also contributed to a higher occurrence of root rot. The most severely affected entries were 395, 309 UCR 430, TVX 33-1G, 416, 753,755, and 239A.

A combined analysis across sites showed no significant site X entry interaction, indicating that entry performance was consistent over all test sites, Lomola, Phalombe, and Phalula. Because of this lack of interaction, a comparison of entry means, averaged over all sites was done. Accession 576 produced the highest mean yield over all sites. In terms of selection criteria, yield was the dominant selection criterion across all sites, regardless of the gender profile. This means that selection and breeding for high yield should remain the most important goal in cowpea improvement. However, Ngugi et al. (1994) illustrate the influence of stress in selecting for yield; common problem being that it is much more difficult to discriminate between genotypes on the basis of their yield in a low yielding environment than in a high-yielding one. Muleba et al. (1997) recommends a strategy of combining genes for high yield and adaptation using parental lines that are highly adapted to extreme environmental conditions as the most effective. They describe this strategy as most suitable for mitigating yield losses due to environmental hazards in order to guarantee food security to resource-poor farmers.

Great physical diversity in the environment increases the likelihood that farmers will adopt more than one line. The six elite accessions were genetically distinct and represent a small but diverse genetic pool. To conserve biodiversity, all the 127 accessions collected during this program are being maintained *ex situ* in the Malawi National Gene Bank. In the longer term, an extension of this PVS to other regions should have a beneficial effect on biodiversity. If many more farmers are exposed to many more accessions, the number of accessions adopted will increase and a more complex patchwork of accessions between fields, districts, and regions will be produced. The logical second stage to this PVS is PPB. The PPB increases genetic variation by deliberate hybridization between landraces. It also enhances the efficiency of selection by raising farmers' awareness and knowledge through interaction with scientists. Several crosses have been made among the landraces and some cultivars and the participatory breeding of cowpea is in progress. A study conducted in Maroua (Cameroon), showed that farmers invited at experimental stations to select breeding lines were strongly influenced by market preferences (Kitch, 1998). These results reflect the increasing role of cowpea as a cash crop.

In addition to yield, other traits of prime importance that were considered include days to maturity, disease resistance, seed size, seed colour, pod curvature, and growth habit as well as culinary characteristics such as taste, cooking time, broth colour and broth thickness. Cooking time is of critical importance because of the scarcity of wood for cooking due to deforestation. Faster cooking cowpea germplasm reduces the time taken to prepare cowpea relish and would also offer the potential to save the cost of fuel wood and time women spend to collect firewood. The time and money resources saved could be put to other productive uses for the family. In this study, six cowpea entries were picked for further evaluation. Three of these entries (accession 305, 570, and 387) cooked under two hours while the other three (accession 576, 727, and 633) took over two hours (Table 4). Cooking time of less than two hours was considered to be fast cooking and more than two hours to be slow cooking. These arbitrary figures were deemed reasonable based on experiences observed in common beans, (*Phaseolus vulgaris* L.). The slow cooking accessions can be improved through breeding with fast cooking genotypes. None of the six selected accessions were of poor performance with regard to taste and broth characteristics. The relationship of these culinary characteristics to chemical composition of the cowpea grain, pod, and leaf needed to be well studied. This would assist breeders to select for preferred culinary traits without the cooking process if linkages/markers can be identified. Marker aided selection (MAS) using molecular markers would simplify the selection and increase the speed and accuracy of screening large gene pools of cowpea germplasm.

The level of variation in Malawian cowpea landraces is very high based on a RAPD analysis conducted by Nkongolo et al. (2003) and the current PPB program should take advantage of such variation. The present study which used ISSR markers also revealed that all 20 elite lines selected through PVS were genetically unique. This indicates that even though farmers' share or exchange seeds, they are able to maintain individual genotypes through selection.

Decentralization

Decentralization is often intertwined with participation in PPB or PVS programs in ways that makes it difficult to separate out the effects of these two distinct phenomena (Weltzien et al., 2003). The decision to decentralize can be based on the extent of GXE (Genetics X Environment) interactions and the target region. In the present study, even though there was no significant G X E when yield of all accessions were considered, there was significant difference in ranking of accessions from locations to locations. For example, the two accessions UCR 430 and TV X 33-1G introduced to Malawi from USA did very well in Phalombe, scoring the first and second place, respectively, but showed very low yield in Lomola and Phalula. Likewise accession 622 performed very well in Phalula for yield being ranked s econd but did poorly in Lomola and Phalombe where it came 16th at both locations. There were site differences in field performance based on insect resistance, time to maturity, and drought tolerance as well resulting in some accessions being selected in one or two sites but discarded in other site (s) (Table 3). If decentralization is deemed to be beneficial based on these technical considerations, then organizational issues come into play in determining how to best structure a decentralized program. Particular models of farmer participation may be especially appropriate for highly decentralized programs. But the degree and nature of participation can and should be considered separately from decentralization. The present project was decentralized since it targeted only 2 ADDs and no multi-locational evaluation of the cowpeas accessions was conducted. Considering that the six elite lines have good culinary qualities; sites x genotype interaction was not significant; and that farmer preferences varied little among villages within the two ADDs, these selected accessions were released at all the EPAs in the two ADDs.

This study clearly confirms previous studies that collaborative breeding and selection with farmers is extremely useful for decentralizing breeding programs (Gyawali et al., 2007).

Role of indigenous knowledge (IK) in PVS

The quality of data on farmer's perceptions from well-conducted participatory trials is more relevant than conventional multi-locational trial data, which is subject to much greater genotype-environmental interactions, and which has yield as the overwhelmingly important selection criterion. In the present study, yield data were combined with other agronomic and culinary data for final selection. For example accession 622 that was ranked 5th overall based on average yield of the three locations was not selected because of poor field performance and long cooking time and bad taste of recipe with dry seeds.

Farmers' knowledge about the crops in their areas has a high potential to strengthen PVS/PPB programs. It would serve well to empower scientists' knowledge for designing site-, crop- and farmer-specific activity. Since cowpea is an under-researched crop in Malawi, care must be taken to incorporate the indigenous knowledge collected within the study sites. In addition, considering the difficulties in differentiating traditional knowledge from random local views, multiple methods were used in the present study to crosscheck the collected data. Given the variability of knowledge among farmers, care must also be taken to differentiate IK and scientific knowledge when cataloguing specific dimensions of IK. IK is considered parochial, confined to a small area, and limited to what rural people can sense, observe, and comprehend using their terms and concepts (Grenier, 1998). IK is embedded in culture and includes both explicit and implicit knowledge, and is at the same time complex. For instance, maintaining biodiversity at the farm level includes maintaining the different varieties and the related local management processes entailed by these varieties (Loevinsohn and Sperling, 1995). Attempts to "scientize" IK by removing it from its owners will tend to compromise the subtle nuances of this knowledge (Thrupp, 1989). Science and IK intersect in certain subject areas, such as technology, resource management, ecology, and the classification of living organisms (Grenier, 1998). There is abundant evidence supporting the fact that when the knowledge that farmers have is integrated in breeding scheme, it will increase the adoption rate of new varieties. This indigenous knowledge will also enrich the scientific knowledge that breeders and curators have in the selection, crossing, multiplication, and conservation of cowpea landraces.

Gender considerations in PVS

The farmer selection of varieties was done through ranking and scoring based on male and female farmers separately or together. Although the scores between male and female farmers were very close, the slight difference was an indication that male and female farmers have particular preferences for certain traits. For cowpeas, the most important culinary traits were cooking faster, mashing well to make a thick broth and creamy colour when fully cooked.

The present study was indeed a first documented case of multidisciplinary approach to assess, select accessions while maintaining biodiversity. The research combined indigenous knowledge and experimental data using farmer's criteria to select six elite accessions that were released in the targeted regions. This approach was successfully applied to sorghum crop in Malawi in different Agricultural development divisions (ADDs). The five selected accessions are still being grown in the main cowpea growing areas in Malawi five years after their local release.

ACKNOWLEDGEMENTS

This collaborative project between Laurentian University (Sudbury, Ontario) in Canada, the Government of Malawi, and Bunda College of Agriculture (Lilongwe, Malawi) was financed by the International Development Research Centre (IDRC), Ottawa, Canada and the Canadian International Development Agency (CIDA). We thank the Environmental Affairs Department (Ministry of Natural Resources) in Malawi and the Ministry of Agriculture (Malawi) for facilitating the implementation of project activities.

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