COWPEA BREEDING AT IITA - AN OVERVIEW

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The cowpea improvement process at IITA begins with systematic collection and evaluation of germplasm materials (Fig. 1). The World Cowpea Germplasm Collection maintained at IITA is comprised of over 7,300 accessions belonging to Vigna unguiculata and 145 accessions belonging to 32 species of Vigna. Of these, 5,976 accessions of wild, weedy and cultivated V. unguiculata have been evaluated for 46 botanical, agronomic, disease resistance, insect tolerance and biochemical characters. The details of the first evaluation of 4,224 accessions have been recently published in Cowpea Germplasm Catalog No. 1 and it is expected that Catalog No. 2 will be published by October 1975. Further analysis of range of variation is being carried out in collaboration with the Taximetrics Laboratory, University of Colorado, Boulder, U.S.A. From such evaluation, information regarding various characters of interest is obtained and the accessions with desirable traits are recombined.

Extensive hybridization between various species of Vigna and cultivated V. unguiculata suggested that the primary gene pool of cowpeas includes all cultivars, spontaneous wild and weedy forms belonging to subspecies mensensis and dekindtiana and the hairy variant V. pubescens. The range of crossing ability appears to be restricted and it is possible that like many other grain legumes, V. unguiculata does not have secondary and tertiary gene pools.

BREEDING NURSERY

The F_1 plants are grown under maximum care and best available control of insect and disease pests in 1 m single rows. As many F_2 seeds as possible are harvested and grown in 20 m or longer single rows. Disease spreaders are planted at 4 m within the row preferably two weeks prior to planting. Up to 50% selection pressure is exerted on the F_2 progeny depending upon the objectives for which the crosses were made. Single plants are harvested and grown on plant-to-row basis in 4 m long rows. They are subjected to disease stress by planting disease spreader lines on both ends of the rows. The remnant F_3 seeds are bulk harvested and grown into 30 m or longer single rows and also subjected to disease stress. The selection by discarding inferior types is continued in subsequent generations.

Under IITA conditions as many as 4 generations of cowpea crosses can be grown within a year. With a short-term objective to incorporate multiple disease resistance into erect, determinate, photosensitive cultivars with acceptable seed quality, pedigree crosses and back-crosses are carried to 6th to 10th generation by plant-to-row selection method. At this level of advancement a preliminary evaluation of yield is obtained by sample harvesting the selected rows.

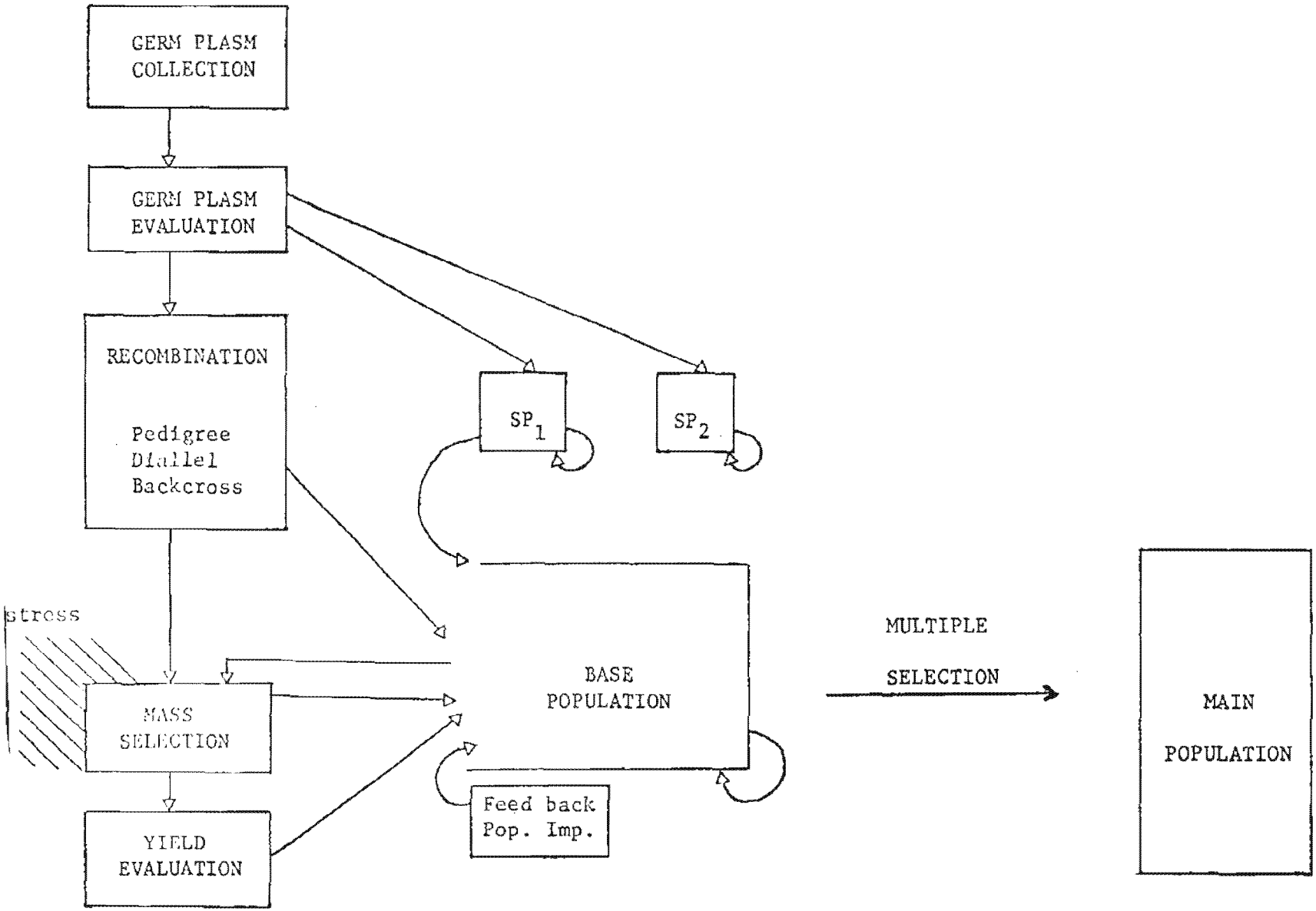


Fig. 1. A generalized flow chart of operations in cowpea breeding at IITA.

YIELD EVALUATION

The ultimate objective of any crop improvement program is to synthesize cultivars with stable yields higher than that obtained by farmers. As a matter of practice, 10-20% of single plant selection rows in the breeding nursery at F_6 and beyond are sample-harvested for yield each season. The best 25-30% of these are tested in a replicated preliminary yield trial grown as 4 meter long row plots. Detailed notes on disease incidence, growth habit, days to 50% flower, days to 50% first ripe pod, flower color and seed type are recorded. Three meter length of the two center rows are harvested, pods are dried and threshed, dry seeds are weighed and yield per unit area is computed.

The disease-free, high yielding lines are carried on to the following season for further testing. The promising lines are entered into advanced yield trials which are similar to preliminary trials except for number of replicates. Elite lines with consistent yield behavior over a number of seasons at IITA are assembled into cowpea uniform varietal trials and sent to several cooperators throughout the cowpea growing areas.

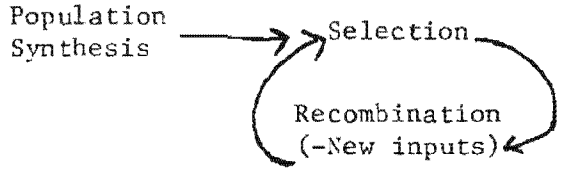
POPULATION IMPROVEMENT

Traditional breeding methods involving pedigree crossing are time consuming and laborious. The genetic base in such breeding lines tends to be small since crossing is limited to a few elite materials. Moreover the efficacy of selection is inadequate and, if the selection is based on multiple criteria, the size of segregating progeny needed to recover a desirable recombinant is large whereas the probability of finding such a recombinant is very low.

Population improvement using a recurrent selection scheme is a systematic approach to the problems in breeding for simultaneous fixation of several characters. The process involves release of maximum variability by recombination upon which selection can be exercised. Eventually the resultant population will be enriched with a higher frequency of desirable recombinants.

With the development of rapid hand crossing techniques and discovery of simply inherited genetic male sterility in cowpeas, a large number of crosses can be made under field conditions in a relatively short time at minimal expense. Moreover, natural crossing on the male sterile plants by insect pollinators (bees, Apis mellifera)at IITA appears to be high, provided proper care is taken in spraying insecticides. Results on natural out crossing on male sterile plants during the first season of 1974 indicated absence of flower color preference by the bees. Thus, large scale random mating between male sterile and fertile plants of cowpeas is feasible.

The population improvement program for cowpeas utilizing genetic male sterility functions according to the following procedural cycle:



Operational features and details of methodology are described below:

Population Synthesis

Synthesis of the basic population was initiated in second season 1973. A total of 669 crosses were made between male sterile plants segregating from 12 F_2 progenies and heterozygous fertiles from crosses among IITA elite lines, University of Ife improved cultivars and large, white seeded types.

The F_1 plants were grown during the dry season. Equal number of F_2 seeds were harvested from these plants and were grown during the first season 1974.

Hand crossing involving 43 new materials with desired growth habit, good seed quality and multiple disease resistance were made on the male sterile plants. Natural pollination with the help of bees resulted in 13,827 crosses. Three subpopulations with the specific objectives of multiple disease resistance, virus resistance and insect tolerance were also created. A total of over 19,000 crosses was attained. The crosses were grown during the second season 1974 and the subsequent dry season and intermating between the steriles and fertiles was maneuvered by hand crossing. At present, over 9,000 fertiles will be crossed onto about 2.500 male sterile plants. Several cycles of intermating are essential to break up linkages before selection is initiated.

Selection

Selection in a crop species for the lowland tropics must consider the role of the crop in farming systems and also consumer preferences. In broad terms, cowpeas are grown as a major component in relay cropping in plantations of oil-palm and cocoa. White and tan seeds with rough or smooth testa are generally acceptable by consumers.

In 1975 second season, seeds harvested from the male sterile plants during the first season will be grown and populations combining necessary plant types with acceptable seed types will be grouped as follows:

Plant Growth Habit	Seed Color	Use
(1) Acute Erect and Erect	White Tan	Relay or sole crop
(2) Semi-erect	White Tan	Mixed crop
(3) Indeterminate	White Tan	Cover crop

The allele for rough testa is recessive to smooth and hence will be easy to pick up at any stage of development. Seeds from the selected fertile and male sterile plants will be bulked according to the groupings mentioned above and tested for disease susceptibility and yield in the subsequent two seasons.

Because progeny from each male sterile plant will constitute a half-sib family, progress can be enhanced by first selecting among families and then using mass selection with the superior half-sib families.

Recombination

Selected elite material with high yield and disease resistance will carry ms_2 gene and controlled crossing on the male steriles can be performed. For natural pollination by bees there appears to be a location-season effect. However, hand crossing can be equally effective if performed on a large scale during the growing season.