SOME IMMEDIATE PROBLEMS, POSSIBILITIES AND EXPERIMENTAL APPROACHES—ARECANUT

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The exclusively seed propagated nature of the crop, its outbreeding and perennial habits and the time lag involved in the study of progenies are the major barriers in undertaking genetic and breeding investigations in arecanut. Use of conventional methods such as recurrent selection, reciprocal recurrent selection etc. adopted for seed propagated, cross fertilised, annual crops are extremely difficult to pursue due to the extensive area that will be required to raise successive generations of the large number of crosses and the time involved in their study. The possibility of using techniques such as mutation breeding is also thus very limited.

METHODS PRESENTLY EMPLOYED

Investigations have been in progress at the Central Arecanut Research Station, Vittal, during the last three years for finding out suitable techniques for achieving genetic improvement of yield. Spotting out of potential yielders at the nursery stage or culling out plants which are likely to be unproductive in the initial stages of the plantation can considerably contribute to yield. Thus, selection of planting material in plantation crops has a special significance unlike in the annuals. Keeping this in view correlation (both phenotypic and genotypic) of seedling characters at various stages of growth was worked out with yield. The results showed that among the various characters examined, selection for number of leaves at the time of planting, girth at collar one year after planting and number of nodes two years after planting can improve the yield of the plantation by 20% for a given standard of selection (Bavappa and Ramachander, 1967 a, b).

Whatever may be the breeding system of a plant, knowledge about the heritability of a character can be directly used in selection. Heritability of yield and yield components and other characters correlated with yield was, therefore, worked out. It was observed that heritability of yield in arecanut is relatively low (0.20). Of the 10 yield components examined, percentage of set alone had a high correlation with yield with a heritability of 0.33. Much success could not thus be achieved in this direction. Among the other characters examined, age at first bearing had a heritability of 0.72 and also a high significant negative correlation

with yield (Bavappa and Ramachander, 1968). It was estimated that by confining seednut selection to palms yielding in the fifth year an increase in yield of 8 to 15 per cent. depending upon the extent of cross pollination can be obtained.

Harland (1957) indicated the existence of differential transmitting ability for yield in coconut and cacao and had suggested collection of seeds from such "prepotent" mother plants. Based on yield performance of 3,000 progenies belonging to 41 mother palms a few prepotent palms were isolated.

The impact of any genetic improvement on increasing production will depend upon the extent of availability of genetically improved material. This calls for large scale production of such superior planting material. The "Mass-pedigree selection" system (Harland, 1949 a, b) which makes the full use of the principle of progeny testing, and is at the same time designed to preserve genetic variability through the use of large number of lines and a broad adaptation base by propagating massed lines under varying seasonal and other environmental conditions, was critically studied for finding out its suitability for adoption in arecanut. After suitable modification and superimposition of indirect selection for yield, using characters of high heritability a "mass-pedigree selection" system on the following lines was formulated for arecanut.

1. Gardens grown under average conditions were selected and palms yielding more than 60 % of the garden mean were marked out for collection of seednuts as mother palms.
2. Plants numbering 2966 belonging to 41 such mother palms were grown under uniform conditions.
3. A norm of 30 % above the mean yield of the progeny garden was fixed and families screened. Three families out of the 41 which satisfied the above norm (Bulk norm test) were selected.
4. All the palms of the selected three families were screened for yield using a norm of 30% above the mean of that particular family. They were also screened for their age at first bearing (5 years after transplanting) and for the established selection criteria of seedlings. Twenty palms which were found to satisfy these standards were selected.
5. Seedlings from the above palms are being grown in adequately replicated progeny rows along with two controls : (a) phenotypically high yielding mother palms (original selection) and (b) phenotypically high yielding mother palms (first generation) for assessing the improvement achieved. Seedlings will be subjected to the standard selection procedures at planting and in subsequent two years except in control plots.

6. The bulk norm test will be applied to eliminate undesirable families.
7. The seeds from families passing the norm test will be bulked after eliminating such of those plants whose yields fall below the family mean/whole population mean of lines.
8. Direct distribution of the seeds as well as simultaneous multiplication in isolation with regular emasculation of palms yielding less than garden mean will be taken up.

The above selection programme which has entered the second generation is expected to give improved planting material in sufficiently large quantities.

POSSIBLE EXPERIMENTAL APPROACHES

Correlation Studies: Characters having high phenotypic and genotypic correlations with yield are of direct use for selection. All possible characters starting with seed weight, germination date, seedling characters at various stages of growth, chemical characteristics such as C/N ratio (Heslop-Harrison, 1957) should be correlated with yield. For those characters which have high genotypic and phenotypic correlation with yield variability of the character in question should also be studied and appropriate selection standards fixed based on the extent of gain one may like to have. Practical considerations of plantation management such as the extent of rejection of seedlings, gap filling that may have to be taken up in the field etc. may also have to be kept in view while fixing the selection standards for different characters.

Heritability and Index Selection: While correlation studies are useful for obtaining improvement in yield in the population in which selection is exercised, improvement in the genetic potential of a given material can be achieved only by selection based on heritable characters having correlation with yield. This will mean that every measurable character of a plant including those enumerated above should be studied for heritability as well as correlation with yield and selection made accordingly. It will be an added advantage in case the seedling characters correlated with yield are also highly heritable since the plantation thus raised will be a better seed source.

The selection index technique is designed to determine the heritability of each of the characters considered to contribute to the yield of a single plant progeny, and to so combine the estimates of heritability as to provide a single estimate of net worth on which the progenies can be selected. Hence it may be regarded as the limit of refinement of selection methods. In cotton a yield increase of the order of 4% per generation has been achieved over eight generations without any evidence of a decline in the rate of advance (Hutchinson, 1959). A selection programme based on selection index can thus pay high dividends.

Exploitation of Prepotency : The existing method of identifying prepotent palms is only by progeny testing. This requires both considerable time as well as resources and has thus to be rather slow. To exploit prepotency there should be quick methods of identifying such palms. The genetics of prepotency will have to be studied and characters associated with prepotent palms, if any, identified. This will alone make the exploitation practicable. It is important that evaluation of mother palms for prepotency, by whatever method it may be, is done when the plants are young, so that when once such plants are identified they are available for collection of planting material for a number of years.

Modified "Mass-Pedigree" Selection : The modified "Mass-pedigree selection" programme adopted for arecanut can probably be further improved. In addition to screening of the individual plants for characters of high heritability and correlation with yield, screening for prepotency and screening of individuals and families for yield on a relative norm (due to the perennial nature of the crop) as already adopted for arecanut, screening of plants for any other desirable characters such as disease and pest resistance, quality, height of plant etc., screening based on a selection index, as well as effecting controlled pollination between selected palms can probably be superimposed with advantage. However, it is necessary that while taking up the crossing, adequate thought is given to the possible effects of differential combining ability, intra-varietal incompatibility and the advantage or otherwise of preserving heterozygous loci for certain genes for vigour.

Other Approaches : Even though the methods discussed above are aimed at increasing genetic gain either for yield or any other character, it is likely that certain limitations on the achievement of the expected advantage is imposed by the antagonism that may exist between certain characters. For example, in arecanut there is a negative relation between number of nuts in the bunch and weight of nuts. But the reduction in the weight of nut was not so rapid as to bring down the total yield at any stage, thus indicating the absence of a threshold value. Under such a circumstance selection for number of nuts will be advantageous. However, in coconut, there seems to exist a threshold value for number of female flowers and set, which limits the scope of selection for female flowers (Patel, 1938).

The analysis of dispersion studies taken up in the recent past, has already opened up new vistas for exploiting hybrid vigour in annuals (Murthy, 1965). By extending the above study, if the genetic distance between varieties could be studied and the varieties grouped into constellations, an effective hybridisation programme for exploiting hybrid vigour can be formulated and crossing directly taken up for producing hybrid seeds. This will save considerable time and resources involved in breeding for hybrid vigour, using the conventional methods.

Suitable experiments for evaluating the gain achieved by the different approaches and methods outlined above, will have to be laid out. It may also be possible to combine in these experiments certain basic genetic studies. The methods formulated for arecanut along with modifications suggested above can probably be utilised in the improvement of many other seed propagated, outbred, perennial crops.

SUMMARY

Experimental approaches followed in arecanut and the modifications that can be effected in these methods have been outlined. Selection of planting material and mother plants based on characters correlated with yield and on selection index, exploitation of prepotency, selection through a 'Modified Mass-pedigree system' and exploitation of hybrid vigour using analysis of dispersion have been suggested for achieving genetic gain in yield. The need for evaluating the techniques and taking up related basic genetic studies has been pointed out.

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