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# METHOD OF BREEDING OF COCONUT PALMS

A Comment on "The Improvement of the Coconut Palm  
by Breeding and Selection" of Dr. S. C. Harland

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DR. S. C. HARLAND has extended a comprehensive discussion on the method of breeding of the coconut palm, suggesting a number of research problems to be conducted in relation to the improvement of the plant (Harland, 1957). Among them, is the use of the paired crosses for the purpose of selecting genetical high yielders. He recommends it in place of the selection of phenotypically superior mother plants in a coconut palm population. The ground for this argument is that the data collected by the Coconut Research Institute of Ceylon show that there are no significant differences in yield of progenies whether they are derived from selected high-yielding or low-yielding mother palms. He concludes that "high yield is not transmitted by a mixed group of offspring from high yielding mother palms exposed to natural crossing".

It will be a matter of vital importance to the coconut breeders, whether the selection of mother palms on the basis of phenotypic characters should really be replaced by the paired crossings. That is because the paired cross method recommended by Harland would require a great deal of labour and, in addition, they would have to wait another ten or more years for the detection of genetical high yielders.

In 1958, I had an opportunity to visit the Coconut Research Institute of Ceylon. Then I went through the original data and found that Harland's understanding was not correct because of the two reasons to follow :

(1) The data actually show that the yield of progeny of the "high-yielding" mother palms was not much different from that of the "low-yielding" ones. However, the "high-yielding" mother palms and the "low-yielding" ones were not selected from the same population. The selection for high yield had been made in an estate at Kirime-tiyana, while that for low yield in another estate at Bandirippuwa. Perhaps, if Harland was aware of this, he would never have drawn the conclusion as he did. It would be needless to say that the effect of selection cannot be compared, if it was made in different populations.

(2) Most of those palms which have been evaluated as low yielders at the time of selection were later found to be not really low-yielding. Yield of those plants was not low in comparison with other remaining plants of the same population in later years. It means that selection for low yield had never been actually made.

That Harland unfortunately misinterpreted the selection experiment of the Coconut Research Institute of Ceylon can be shown by the following data which show comparatively the yield of nuts of progenies of high yielding mother palms and selected heap-nut from the same estate (Table 1).

Table 1—Mean Yield per Palm per Year of Progenies of Selected High-yielding Palms and Heap-nuts

(Unpublished data of Coconut Research Institute of Ceylon, kindly supplied by Dr. D. V. Liyanage)

	11th to 14th year		15th to 18th year	
	Nuts	Husked Nuts (lb.)	Nuts	Husked Nuts (lb.)
Progenies of selected palms (A)	.. 57.6	.. 87.6	.. 75.7	.. 120.4
Progenies of heap nuts (B)	.. 46.0	.. 71.7	.. 64.1	.. 107.6
Percentage increase of (A) over (B)	.. 25.2	.. 22.2	.. 18.1	.. 11.9

From Table 1, we find that selection of mother palms would not be ineffective in improving yield capacity of coconut palms. Then, what will be the effectiveness of mother palm selection for yield in coconuts and how to attain our aims of improving yield of the plant?

Dr. Liyanage and I co-operated in re-examining the data from the progeny trials, which have accumulated for a number of years in the Coconut Research Institute of Ceylon. The details of this analysis will be published before long (Liyanage and Sakai, 1960), and it will be satisfactory to describe only the summarized results in this paper.

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Four characters which are supposed to be more or less related to the yield of copra were investigated for their heritability and the genetic correlations amongst them. The four characters are : flowering-period, i.e. number of months from planting seedling to the appearance of first inflorescence, number of nuts and total weight of copra produced from a single tree per year, and weight of a husked-nut. Heritability values and genetic correlations are presented in Table 2.

Table 2—Heritability (in bold face) and Genetic Correlations (In italics) for Four Characters of the Coconut Palm

		<i>Flowering period</i>	<i>Number of Nuts*</i>	<i>Total wt. of Copra*</i>	<i>Nut weight*</i>
Flowering-period	..	<b>0.23</b>	.. —	.. —	.. —
Number of nuts *	..	<i>0.72</i>	<b>0.48</b>	.. —	.. —
Total weight of Copra	..	<i>0.81</i>	<i>0.79</i>	<b>0.67</b>	.. —
Nut weight *	..	<i>0.25</i>	<i>0.22</i>	.. —	<b>0.95</b>

\* Average value of the harvests gathered during the four years, 16th to 19th years after planting.

From Table 2, we find that weight of a husked-nut has the highest heritability, while the flowering-period the lowest of the four. Total weight of copra and number of nuts are intermediate regarding heritability. Needless to say, the number of nuts, total weight of copra or nut weight produced from a single plant may vary from year to year. Accordingly, heritability of the same character may vary according to different number of years involved in the study. The correlation between number of nuts harvested from a single plant in different years has been computed by means of the intra-class correlation. The correlation or the repeatability of number of nuts is,

$$r(a) = 0.2179$$

$$r(b) = 0.4605$$

where  $r(a)$  stands for the repeatability of the actual number of nuts harvested each year, while  $r(b)$  for the repeatability of number of nuts harvested, the effect of years on actual number of nuts, however, being removed.

Again from Table 2, we find that total weight of copra is positively highly correlated with the number of nuts and to some extent with the weight of a husked-nut but negatively highly correlated with the flowering-period. Thus, it is expected that the yield of copra would be improved by selecting plants which bear either larger number of nuts or heavier nuts. Selection of palms in respect of early flowering might also bring about improvement in the yield capacity of their offspring. Selection of mother palms can also be conducted taking into consideration all of the four characters. In the latter case, construction of a selection index combining all the four characters in such

a way as to make the correlation between the value of the index and the genotypic value of individual palm in respect of yield capacity maximum. The selection indexes worked out for the above population of the coconut palms for the improvement of the yield of copra are as follows :

$I(\Delta) = C - 1.07 N - 38.38 W - 0.23 F$ , for population A where  $C$  = yield (lb.) of copra,  $N$  = Number of nuts,  $W$  = weight. (lb.) of a nut and  $F$  = flowering period (month). It is surprising to find that the weight factor for the number of nuts becomes negative in this formula, in spite of its high positive correlation with the yield of copra.

Now, let us compare the efficiency of selection of mother palms on different criteria. Assume that we select 5 per cent. of most superior individuals with regard to a given criterion in the population of the coconut palms with the purpose of improving yield of copra. The selection can be made for any one character : flowering-period, weight of a husked-nut, number of nuts and yield of copra. The selection index will be another criterion for mother palm selection. The genetic progress theoretically expected by these selections is presented in Table 3.

Table 3—Expected genetic progress in yield of Copra by selection of Seed parents on different criteria in Coconuts

<i>Selection criteria of seed parents</i>				<i>Genetic progress in yield of copra</i>
Weight of a husked-nut	..	..	..	16.0 lb.
Flowering-period	..	..	..	14.6
Number of nuts	..	..	..	21.7
Yield of copra	..	..	..	30.4
Selection index	..	..	..	42.6

It is found in Table 3, that the use of the selection index would be the most effective in improving the yield capacity of the coconut palm. Among the four single characters, the yield of copra would be most useful and weight of a husked-nut or the flowering-period the least for the purpose of the breeding.

Strictly speaking, values of heritability, as well as the extent of genetic correlation, should differ with changes in environmental conditions, such as locality, year, etc., and especially changes in the genetic constitution of populations. Therefore, it may not be quite correct to generalize on the results of this investigation and insist on their applicability to other countries, other populations, and so on. It is desirable that similar studies be made on different environments. However, a study of this kind will require a certain number of years,

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because it is necessary to grow families from a number of mother palms. On the assumption that genotype-environment interaction would be negligible, and the genetic constitution of different populations of the coconut palm would not be very different from each other, we may not be very wrong in accepting that selection could be conducted along the lines just mentioned.

As stated at the beginning of this paper, Harland recommended the use of the paired crosses for the purpose of detecting genetically high yielding seed parents. However, I have to state here that at least under the present circumstances, the improvement of the coconut palm in respect of yield of copra would be attained better by the selection of mother palms through the use of a selection index, than the use of paired crosses.

### SUMMARY

Studies on heritability and genetic correlation of four characters, which are more or less related to yield capacity of coconut palms, suggest that selection of mother palms in an open-pollinated population would be effective. The selection on the basis of copra yield would be more effective than the selection on the basis of any one of other characters such as flowering-period, number of nuts or weight of a husked nut. Most effective would be the use of the selection index.

The method of paired crosses as recommended by S. C. Harland would not be very useful from the standpoint of practical coconut breeding, because it will require a great deal of labour and a certain number of years, say more than ten, for detecting genetical high yielders above.

### LITERATURE CITED

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