THE USE OF ISOLATED SEED GARDENS FOR COCONUT SEED PRODUCTION*

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INTRODUCTION

The *typica* variety of coconut palms (*Cocos nucifera* L.), which is grown principally on a plantation scale in different countries is predominantly out-breeding and therefore highly heterozygous. Consequently, variations between palms with respect to shape, size and colour of nut, quantity of copra per nut, number of nuts per palm and vegetative characters are considerable. Hitherto, mass selection has been practised extensively, *i.e.* open-pollinated seednuts have been collected from phenotypically superior palms.

In order to meet the national new planting and replanting programmes of Ceylon, 3,000,000 (approx.) seednuts are required yearly. This quantity of seed is collected from selected palms within selected high-yielding blocks. Initially, high-yielding blocks giving at least 15 cwts. of copra per acre per year are selected and from these blocks, high-yielding palms with desirable agronomic characters are selected. Seed collection is restricted to these palms only. In the selection of both blocks and palms, considerable care is taken to exclude high-yield due to a favourable environment.

The response to selection for any character will, to a large extent depend on variations present in the population, and on its heritability. The genetic diversity between palms is considerable, but the heritability has been estimated only for a few characters. The measurement of the efficiency of any selection programme has to await evaluation of heritability estimates. Progress due to selection would be necessarily slow, as the life cycle of the coconut palm is long.

GENETIC PROGRESS DUE TO SELECTION

The genetic variances of certain characters of the coconut palm are high. The heritability values of components of yield, such as number of bunches produced per year, number of nuts per bunch, and weight per husked-nut are 0.47, 0.52, 0.95 respectively. The number of nuts per bunch is related to female flower production and percentage of setting, which have heritability estimates of 0.52 and 0.81 respectively. These estimates are either high or intermediate in value, and consequently, selection of seed parents using some of these criteria, particularly yield of copra and weight per husked-nut is efficient.

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TABLE I

Genetic and environmental correlations (Liyanage and Sakai, 1960)

	Genetic correlation, r_G	Environmental correlation, r_E
Yield of nuts × yield of copra ..	0.79	0.96
,, ,, ,, × weight per husked-nut ..	-0.22	-0.23
,, ,, ,, × flowering-period ..	-0.72	-0.11
,, ,, copra × weight per husked-nut ..	0.43	-0.07
,, ,, ,, × flowering-period ..	-0.81	0.12
Weight per husked-nut × flowering-period ..	-0.25	0.62

The genetic correlations between the different productive traits of the coconut palm are of considerable importance in selection. Since the yield of nuts and copra are highly correlated positively ($r_G = 0.79$), and the flowering-period and yield of nuts are highly correlated negatively ($r_G = -0.72$), and the flowering-period and yield of copra are highly correlated negatively ($r_G = -0.81$), selection of seed parents on early flowering and number of nuts will tend to increase the yield of the progeny with respect to copra production.

The relative importance of the four characters, (i) yield of copra, (ii) yield of nuts, (iii) weight per husked-nut and (iv) flowering-period, with respect to genetic progress expected in the yield of copra of the progenies was found to be more, if the seed parent was selected on high-yield of copra and nuts rather than on the other two criteria. But from the stand point of practice, it is necessary to consider other characters as well, and it would be generally useful to construct selection indices (Liyanage and Sakai, 1960).

A selection index I, using three criteria has been computed as follows:

$$I = x_1 - 14.70x_2 - 4.47x_3$$

where

x_1 = number of nuts per palm per year

x_2 = weight per husked-nut (lb.)

x_3 = flowering-period of palm (month).

It is necessary to construct a number of selection indices using different criteria and ascertain the most efficient index by determining expected genetic progress.

PREPOTENCY

The variations in yield of copra between families of open-pollinated progenies are indicated in Table II. The differences in yield between families are highly significant. Family IV has given significantly higher yields than all the other families, except XLIII and XXII. The increase in yield per progeny of family IV, over the general mean of the population is 35.8 per cent; and 81.8 per cent of the progenies have given high yields of more than 36 lbs. of copra per palm per year.

TABLE II

Mean yield per palm per year of families of open-pollinated progenies (Liyanage and Sakai, 1960)

Family No.	*No. of Progenies*	*Weight of husked-nuts (lb.)*	*S.D.*	*Yield per cent*
IV	11	126.7	27.86	135.8
XLIII	10	116.4	22.51	124.8
XXII	12	107.0	27.34	114.7
VI	22	100.5	16.20	107.7
I	57	99.3	28.63	106.4
XXVI	42	91.6	25.97	98.2
XVII	64	88.7	26.65	95.1
XXIII	41	79.4	28.37	85.1
XVI	19	75.8	23.59	81.2
Mean	—	93.3	—	100.0

It is possible that the seed parent No. IV can transmit the character high-yield of copra to the progenies, inspite of the fact that they have been derived from randomly pollinated nuts. Such palms are classified as *prepotent*.

The term *prepotency* has been used considerably in animal breeding work to imply, 'The ability of an animal to impress characteristics upon its offspring to such an extent that they resemble that parent to each other more closely than is usual' (Lush, 1946). Harland (1957) has used the same term relative to coconuts to imply almost the same definition: a palm that is able to transmit the character high yield of copra to the offspring, inspite of random pollination.

The genetic basis for prepotency, has been described by Lush, to depend on the degree of dominance, homozygosity, and in certain instances on linkage and epistasis. As a quantitative character is involved in coconuts, prepotency may be due to the high additive genetic value and/or the general combining ability, besides the genetic causes given above.

As coconuts are monoecious, prepotency may be either on the female or male side and the terms *female transmitter* or *male transmitter* may be conveniently used. It is not known whether a female transmitter would behave equally efficiently as a male transmitter. Harland (1957) considers that, 'Just as the progeny of a single mother palm may be superior, whatever the nature of the male parent, it is evident that the reverse situation also holds good, *viz*. that once female transmitters are identified, their pollen can be used on phenotypically high-yielding mothers, thus making a very large quantity of good planting material available in a very short time'.

ISOLATED SEED GARDENS

How far could the principles outlined so far on breeding value and prepotency of coconuts be used to raise large quantities of seed to meet the national demands? There are many difficulties in the large scale production of quality seed coconuts. Even if male transmitters are identified, ultimate seed production has to be by hand pollination. Since pollination of coconuts is a laborious process, it is physically impossible to raise large quantities of seed by that method. Seed Gardens may be usefully adopted to overcome this difficulty.

In Swedish forestry management, use of Isolated Seed Gardens is a standard practice in seed collection. Larsen (1956) states, 'This is our trump card in forest tree breeding. It is the means for the growing of seed through controlled pollination in any desired quantity'. They have the advantage of clonal multiplication.

The Coconut Research Institute, Ceylon has already established an Isolated Seed Garden in the centre of a crown forest reserve (Liyanage, 1955). The first step is the opening up of a spatially isolated plantation with seedlings of known parentage. Isolation is necessary to protect the palms within the garden from contamination with pollen from other coconut palms. The agents of pollination of coconuts are largely insects (chiefly *Apis indica*) and wind. The foraging area of the Ceylon honey bee (*Apis indica*), has been shown to be not more than 750 yards from the beehive in open country (Lindauer, 1955 unpublished). Forest vegetation to a depth of 350 yards has been found to give sufficient protection from coconut pollen carried by wind. Thus, an isolation belt of forest vegetation about 880 yards wide is sufficient to protect the seed garden from unwanted pollen grains.

The next step is the identification of a sufficient number of male transmitters from the palms within the seed garden. The genetic merit of each palm should be estimated by the use of selection indices and those with low values should be rogued. All the remaining palms, except those identified as male transmitters should be emasculated regularly. Thus, seed collected from the palms in the Seed Garden will be the result of natural cross pollination between female parents of high breeding value and male transmitters. A large quantity of quality seed could be collected in this manner. The whole process of establishing a plantation and identifying male transmitters will take about 20 years.

ABSTRACT

The present situation regarding the breeding and selection of Coconut palms (*Cocos nucifera* L.) is reviewed. Estimates of heritability and genetic correlations between different productive traits and the efficiency of some of these characters for selection are outlined.

Methods of production of seed with particular reference to the difficulties involved in large scale production of quality seed are discussed. Although, controlled pollination is desirable, only a limited quantity of seed could be raised in that manner, and that would be hardly sufficient to meet any extensive national programme of planting. This difficulty may be overcome by the use of Isolated Seed Gardens.

Spatially isolated gardens are planted with palms of known parentage. Within the garden palms with high breeding value are used as the female parents and the pollen source is limited only to known male transmitters (or prepotents), thereby ensuring that the seed to be collected is the result of crossing between desirable palms, one of which at least is a proved parent.

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