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A new technique for establishing coconut seed gardens

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ABSTRACT

Four coconut seed gardens, covering an area of 510 ha, have been developed at four locations in Indonesia. Two of them are situated amidst coconut plantations. A barrier, 12 coconut rows deep, planted with the Tall strains used within the gardens, reduced contamination. Dwarf x Tall seeds were produced with high degree of legitimacy and the rate of contamination was 2.6%.

The high degree of legitimacy achieved is attributed to the mechanism of pollination of coconut flowers by the honey bee and its behaviour, the main agent for pollination, but not to its flight range. The ritual movements and the bodily jerks of the bee when it visits a female flower ensure that pollen grains and mites loaded with pollen, sticking to the bee, are not carried far from the sources of their origin. Wind pollination is negligible.

The female and male parents are planted within the garden and seed is produced by natural pollination, thereby eliminating assisted pollination. Two types of seed are produced: Dwarf x Tall and Tall x Tall.

The Indonesian model of seed gardens reduces the cost of seed production due to a number of factors: location of the garden within the seed distribution area, rather than in isolation, reduces expenditure on transport of seed outwards and on supplies required for the maintenance of the garden inwards; elimination of expensive and tedious pollen processing and labour involved in assisted pollination; easier supervision and administration of the seed garden.

INTRODUCTION

Coconut seed gardens have been established in a number of countries for mass production of Dwarf x Tall seed. Their development and design vary. In one type, the Dwarf palms to be used as the female parents and the Tall palms to be used as the male parents are planted in two separate spatially isolated blocks. Seeds are produced by assisted pollination of emasculated Dwarf palms with p[illegible] processed from the Tall palm block. In another system both the fe[illegible] and [illegible] parents, in certain proportions are planted within the same block [illegible] tion from other coconut palms. The Dwarf palms are emasculated and [illegible] pollination [illegible] the Tall palms is allowed to occur [illegible]

Previously, the minimum distance separating a seed garden from other coconut groves was decided on the flight range of the honey bee and the distance wind can carry the pollen. A 80 hectare coconut seed garden established in Sri Lanka in 1955 had a spatial isolation barrier of 1.3 km of forest. This distance was based on the flight range of *Apis indica,* the principal agent of pollination, which was considered then to be about 1.0 km (Liyanage, 1955). Subsequently, it has been shown that an isolation barrier of 300 m is sufficient to assure satisfactory legitimacy of seed (Nuce de Lamothe, *et al* 1975). Coconut pollen is not carried through a thick jungle belt of about 320m even when winds are favourable (Manthiiratna, 1965). Still the tendency is to establish seed gardens in isolated places far away from existing coconut groves. This paper describes some improved techniques used for developing seed gardens in Indonesia.

The Indonesian Model of seed gardens

Four seed gardens, comprising a total area of 510 ha, situated in Aceh, West Java, South Sulawesi and North Sulawesi provinces have been planted between 1976 and 1978. The yellow form of the Dwarf variety from Nias island is used as the only female parent and three selected local Tall variety strains, *viz* Tenga, Bali and Palu, as the male parents.

The Tall strains used as male parents were derived from uniformly high-yielding blocks under small holder management. Their population characteristics were (Liyanage and Corputty, 1975):

Variety	*Ratios between fruit components (percent)*			*Copra/nut*	*Estimate copra/ha/yr*
	Husk/ fruit	*Nut/ fruit*	*Endosperm/ nut*	*(g)*	*(kg)*
Tenga Tall	34.4	65.6	44.5	296	3500
Bali Tall	25.6	74.4	44.7	340	3500
Palu Tall	21.9	78.2	41.1	354	3600
Yellow Dwarf	40.3	59.6	43.0	188	—

The following design is employed in each seed garden. Four rows of Dwarf palms are followed by a single row comprised of the three Tall strains. In the Tall rows, single palms of the strains Tenga, Bali and Palu are repeated serially maintaining that order. Thus every fifth row of the garden consists of Tall palms, with the order of palms being Tenga, Bali, Palu, Tenga, Bali, Palu, Tenga, etc. Surrounding each garden, there are 8 to 12 rows planted with the selected Tall strains. These form a barrier between the effective seed garden and the adjacent coconut groves and minimize unwanted pollinations of the Dwarf palms within the garden with the Tall variety- palms outside the barrier. In two seed gardens, 8 rows only of Tall palms form the barrier as coconut holdings are not within the immediate vicinity, but in the other two, 12 rows are used as village coconut groves are adjacent to them.

The rows of palms are 7 m apart in each seed garden. Along the rows, th Dwarf palms are spaced 7 m and the Tall 9.25 m. Square planting, 7m x 7i is too wide a spacing for Dwarfs, yet this system has been adapted to reduc their height in order to facilitate emasculation work. There are 9,068 Dwarf paln and 6,901 Tall variety palms including those in the 12-row barrier, in the 1C hectare seed garden in North Sulawesi.

Efficiency of the 12*–row barrier of palms*

Out of the four gardens, the Paniki seed garden (PSG) in North Sulawe is the one most exposed to foreign pollen, as there are coconut groves adjacei to all its boundaries. It has 12 rows of the selected Tall strains as the barrie Most of the Dwarf palms have flowered, but none of the Tall variety. The are six blocks. Block I, exposed to village groves on two sides, was selected f a trial to test the efficiency of the 12-row barrier. The Dwarf palms in flow in this block were emasculated at intervals as necessary. This was done by splittir the spathes open one to two days prior to their natural opening. The spadic in all the other five blocks were cut. Emasculations were carried out for fi consecutive months. During that period, there was no pollen emanating from t palms within the seed garden, subject to the efficiency of emasculation, but plen of pollen was available from the Tall variety palms in the village groves adjacei to the 12-row barrier of palms.

The control was a block of Nias Yellow Dwarf palms of the same age those of the trial area and situated outside PSG amidst a coconut plantatio Natural setting of female flowers was allowed to occur without emasculation. palms were recorded.

The numbers of female flowers and fruits developing after 8 weeks fro the date of emasculation in each inflorescence were recorded. Results were follows:

		Trial area in PSG	*Control*
Total number of inflorescences	:	1244	166
Total number of female flowers	:	9738	1845
Total number of fruit developing	:	404	460
Setting (fruits developing) in all the inflorescences (%)		4.1	24.9
Setting leaving out the first 5 inflorescences (%)	:	4.7	31.4

In the trial area in PSG, 4.1% of the female flowers developed into frui against 24.9 in the control. Generally, the first few inflorescences produced young coconut palms, carry only a small number of female flowers and if th is setting, the percentage will not be within the normal range. Therefore, setti was calculated leaving out the first five inflorescences borne on each palm order to get over this bias. They produced an average of 17 and 21 fem flowers, with a setting of 4.7% and 31.4% in the trial and control respective The very low setting of female flowers in the trial, can be attributed to lack fertilization in the absence of pollen. This indicates that the 12-row barrier palms is quite efficient for protection of the PSG from unwanted pollen from palms in the neighbourhood.

...ing of fruits after emasculation in the trial can be attributed to three ...causes: (a) faulty emasculation resulting in leaving out a few male ..., (b) pollination with the Tall variety palms outside the seed garden, and ...haps (c) to parthenocarpy.

In order to test the parthenocarpy theory, 12 palms that produced some fruits after emasculation were selected. Two inflorescences in each of these palms were emasculated and covered with a bag. Since there cannot be pollination from ... outside source, any fruit development should be attributed to parthenocarpy None of the 431 female flowers developed into fruits. Thus, parthenocarpy can be ruled out.

Whether the 4.7% fruits produced in the trial are due to faulty emasculation or the result of cross pollination with palms outside the barrier, can be determined by germinating them. The colour of the leaf stalks of the germinating seed will give an indication: yellow due to faulty emasculation (true to the mother type) and any other colour due to pollination with palms outside the barrier.

Of the 93 fruits that were developing in the 6th to 9th inflorescences, 65 nuts were harvested, the balance having dropped prematurely. These nuts were planted in a nursery, and 4 seedlings were identified as Dwarf, 22 as hybrids and the remaining 39 nuts did not germinate – the endosperm of each nut had rotted inspite of harvesting ripe nuts. In order to make a correction for the fruits that did not germinate, assume that 95% of 65 fruits will germinate and that the ratio of hybrids: Dwarf will be 22 : 4. Then 52 seedings out of the 65 fruits/ 1973 female flowers will turn out to be hybrids, equivalent to a contamination rate of 2.6%. Thus, production of illegitimate seed is negligible.

DISCUSSION

Insect Pollination

Interesting work on the pollination of the Dwarf variety of coconut has been done in Indonesia (Jesmandt, *et al.* 1975 and Moeso, 1979), According to these authors:

> Many insects visit the coconut flowers, but not all of them are pollinators, some being predators. Honey bee (*Apis indica*) and mites are important agents for pollination.
>
> Mites (*Neocypholaelaps ampulula*) appear in newly opened spadices but vanish from them subsequently. The honey bees transport the mites from palm to palm. When a bee visits a coconut inflorescence at the end of its male phase, hundreds of mites crawl up its legs and rest on the dorsal part of the thorax. The bee then visits another inflorescence, makes specific vibrating movements and during that process the mites crawl down to the flowers.

The mites are loaded with pollen grains. The bee also carries pollen stickin to the legs outside the pollen sacs. When it next visits a female flowe the mites and extra pollen sticking to its legs are shed on the flower durin the ritual rotations around the stigma. Thus, a honey bee cannot carr pollen grains of one tree beyond two or three subsequent trees which visits.

It is clear from these observations that the honey bee and the mites (ind rectly) play an important role in pollination of the Dwarf variety palms in Indo nesia. The flight range of a local honey bee is large, up to 1.6 km, but when i search of pollen or nectar it makes short flight landings on palms one after anoth in close proximity. The ritual movements that a bee performs after landing on female flower ensures that pollen grains and mites sticking to its legs are n carried far from their source of origin (Moeso, 1979). Thus, the spatial isolatio of a seed garden need not be related to the flight range of a honey bee. T very low setting of female flowers after emasculation, referred to above, substa tiates this point.

Wind Pollination

Wind is often referred to as another agent for pollination of coconut palm Just outside 120 m from the situation of Dwarf palms in the Paniki seed gard there are hundreds of coconut palms releasing pollen daily. But only 2.6% se has been produced on the emasculated Dwarf palms with pollen derived fro the palms outside the barrier. These data indicate that wind pollination of cocon palms is negligible – at least in Indonesia.

Natural Vs Assisted Pollination

The advantages of natural pollination in seed gardens are:

Hand pollination of female flowers is not necessary during any time the year, thereby making it unnecessary to process pollen. Elemination of bo these procedures considerably reduces the cost of seed production. Two types seed are available: Dwarf x Tall and Tall x Tall. Currently, production of sat factorily high-yielding coconut planting material requiring low inputs a suitable for growing under small holder conditions is gaining ground. Tall Tall seeds are likely to meet this requirement.

On the other hand advantages of assisted pollination are attributed to:

Flexibility, *ie* different male parents can be used to pollinate the Dw palms in the seed garden, periodically. This depends on progress of resear directed to identify male parents that combine well with Dwarf (as female) to g higher yielding progenies than at present. After all, research during the l 30 years has produced only about 3 to 4 high-yielding Dwarf x Tall hybrid var ties. Differences between them cannot be evaluated in the absence of comparat trials. Since breeding new strains is a slow process in a perennial crop like conut, this type of flexibility is not so advantageous.

Location of Seed Gardens

A distinct advantage of the Indonesian model of seed garden is that they can be situated in coconut areas. One seed garden could be established in each province. The size would depend on the demand for seed, but it should preferably be not less than 100 ha. This system reduces the expenditure involved in transporting seed to the growers and also for transporting the supplies required for the maintenance of the garden from the main city compared to seed gardens located in isolated places. Further, supervision and administration are much easier. These factors contribute to a considerable reduction in cost of seed production.

Choice of the Male Parents

The Indonesian coconut breeding programme is unique in that variety trials are carried on simultaneously with the establishment of seed gardens. This is largely to save time. By the time the performance of the Dwarf x Tall progenies are evaluated from the variety trials, a large quantity of seed will be available from the seed gardens for distribution. The Tall strains have to be selected very judiciously. Indications from the trials are that the three types of hybrid – Dwarf x Tenga Tall, Dwarf x Bali Tall and Dwarf x Palu Tall – show precocity for early bearing and have a good potential for yield. Their total production of copra per hectare will be practically the same, but there will be differences in copra per nut. However, if any particular Tall strain produces hybrids with a lower yield, that could be removed from the seed garden without any detrimental effects.

If a genetically uniform variety is grown throughout large areas, the risks due to pest and disease damage are likely to be more than when hybrids of greater genetic diversity are planted. Seed gardens with more than one male parental type, will produce progenies of different genotypes, that will be adaptable to a wider range of environmental conditions, as is the case with the Indonesian model.

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