COCONUT SEED GARDENS: A REVIEW

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ABSTRACT

Coconut Seed Gardens are necessary for the mass production of improved coconut cultivars.They will play a dominant role in dvelopment programmes until tissue culture creates new plants.

Models of seed gardens developed in Sri Lanka, Indonesia and Ivory Coast are outlined. The differences between them with regard to structure and management are enumerated.

1. The necessity for seed gardens

The coconut palm (*Cocos nucifera* L) has a single growing point, which contributes to the elongation of the stem and the formulative of leaves. The axillary buds generally develop into inflorescences without branching. Hence, asexual propagation is not possible under normal conditions.

A selected palm produces about 50 nuts per year with artificial pollination. If a million seed coconuts are required, 20,000 palms have to be pollinated; a very expensive and nearly impossible task.

Therefore, the concept of seed gardens was developed for mass production of seed. It is a special coconut plantation, carrying palms of known identify for the production, carrying palms of known identify for the production of particular types of seed. It should have an isolation barrier, suficiently wide to prevent cross-pollination of palms within the seed garden with those in the neighbourhood. A large quantity of seed could be collected from the seed gardens under natural pollination (Liyanage, 1953; 1960).

2. The Sri Lankan Model (SLM)

The objective of the first coconut seed garden developed in Sri Lanka beginning in 1955 was the mass production of seed of an improved cultivar of the Sri Lankan Tall (SLT) palm.

SLT is largely cross-pollinated. The principal agent of pollination was considered to be the honey bee (Apis *indica)* then. Wind pollination was negligible.

Based on these factors, the concept was to grow an improved cultivar of SLT in an isolated block. The cultivar was the offspring of selected SLT x SLf crosses. It was considered that a forest barrier 800 m wide all round the block, would prevent cross-pollination of palms within the block with those outside. This forms an isolated coconut seed garden.

Initially, a 40-ha. block of land from a forest reserve with the required isolation barrier was acquired to establish the seed garden. The block was planted with offspring of SLT x SLT. The parents were selected on a basis of high yield of copra and desirable morphological characters. Eventually, the seed garden was enlarged to 125 ha.

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When the palms in the isolated seed garden flower, natural cross-pollination takes place between them. Emasculation of inflorescences is not necessary. The resulting seednuts are SLT x SLT of a high quality and a high degree of legitimacy. Although the seed garden is situated in a marginal area for coconut cultivation with about two consecutive months of drought occuring twice a year, production under rainfed conditions has been high. The data given in Table 1, show how the crop has fluctuated between 11,000 to 25,100 nuts ha/yr depending on the rainfall.

Table 1.
Yield of nuts of the seed garden

Year	1982	1983	1984	1985	1986	Mean
Nuts per ha	18,200	17,500	11,100	25,100	17,800	17,900
Total rainfall mm	1,236	1,209	2,389	1,305	1,014	1,431
No. of wet days	110	105	134	110	90	110

Deftitions: Sri Lankan Tall (SLT) - var typica form *typica*
Green Dwarf (GD) - var *nana* form *pumila*
Yellow Dwarf (YD) - var *nana* form *eburnea*

In the year 1985, production exceeded 25,000 nuts per ha as the rainfa and distribution during the previous year were satisfactory. In 1984, yield dropped to l1,l00 nuts per ha due to adverse climatic conditions prevalent in 1983.

Thus, it could be expected, that plantations raised from seed of the isolated seed garden, would give about 18,000 nuts ha/yr under rainfed conditions and over 25,000 nuts ha/yr with irrigation.

Under satisfactory environmental conditions, one hectare of seed garden will provide seed to plant in 50 ha of land, assuming 20% seed rejection, 30% rejection in the nursery and 185 seedlings per ha. The ratio with irrigation is 1:75.

The Coconut Research Institute, Sri Lanka has established two more seed gardens at Makandura (58 ha) in 1985 and Maduruoya (85 ha) in 1986 to produce an improved cultivar of SLT. Both of them are based on the Indonesian model (see section 4).

The SLM of seed gardens was designed initially for the mass production of an improved cultivar of *SLT* palms. It was subsequently modified to produce, in addition, Green Dwarf (GD) x SLT hybrid seed.

In November 1959, a block (3 ha) within the seed garden was planted with GD. The inflorescences of the GD were split open phor to their natural opening and emasculated, so that pollen of this form does not contaminate the seed garden. The seed collected from GD is a result of natural crossing with SLT.

If the purpose of the seed garden is for the production of hybrid seed only, the number of *SLT* male parents should be minimal. A ratio of 81 seed parents to a 9 pollen parents is a satisfactory combination for the production of hybrid seed (Manthriratne, 1983).

It is possible to improve further the quality of seednuts derived from the SLM seed gardens by restricting the pollen parent to selected supezior palms only.

3. The Indonesian Model (IM)

The objectives of the seed gardens developed in Indonesia by the author under the UNDP/FAO Coconut Development Project were two fold: mass production of hybrid seed and also seed of improved cultivars of the Indonesian Tall (IT) palms.

Four varieties/cultivars of coconut were identified after carrying out a germplasin survey in Indonesia. They were found in uniformly high-yielding blocks with the following population characteristics (Liyanage and Corputty, 1975).

	Copra per nut (g)	**Estimate of copra ha/yr(kg)**
var *typica*		
Tenga cultivar (TT)	296	3,500
Bali cultivar (BT)	340	3,500
Palu cultivar (PT)	354	3,600
var. *nana*		
Nias Yellow Dwarf (NYD) :	88	

Having selected the four varieties/cultivars, they were planted in a block within an *existing coconut plantation,* taking particular care to minfinize cross-pollination between palms within and outside the block by a special process of isolation (Liyanage and Azis, 1983).

Four rows of NYD followed by a row containing TT, BT and PT were planted. Every fifth row is planted with the latter in the same order. Surrounding the garden are 12 rows planted with the above three tall cultivars to form the barrier, preventing palms inside the garden being pollinated with those outside the barrier.

The NYD palms are emasculated regularly, but not the IT cultivars. The former will be pollinated with pollen from the latter and the IT also will cross between thernselves, ail under nawral conditions without artificial pollination. The types of hybrid nuts gathered from the dwarf palms are: NYD x TT, NYD x BT and NYD x PT; and also six improved cultivars of IT: combinations of crosses between TT, BT and PT.

The three IT cultivars were planted in the seed garden as a safety precaution, as the performance of the hybrid combinations were not known at the time of planting. In the accelerated breeding programme carried out in Indonesia, the variety trials and seed gardens were planted simultaneously. Should anyone of the hybrid combination prove subsequently to be uneconomical, the respective tall cultivar with be removed from the seed garden (Liyanage et al, 1986).

A 100-ha seed garden in which the dwarf palms were planted 7 x 7 m apart and the IT 7 x 9.25 m contains 9,000 dwarf palms and 6,900 IT palms, including those in the barrier. The Research Institute for Industrial Crops, Indonesia planted 510 ha of seed gardens at four locations based, on the IM between 1975 and 1978.

4. Ivory Coast Model (ICM)

Ivory Coast planted seed gardens initially on the SLM basis having the female and the male parents in the saine block with adequate, isolation. The arrangement was to have two rows of

yellow dwarf (YD) followed by a row containing both YD and West African Tall (WAT). Female and male parents were in the ratio 5:1. Isolation barrier was kept at 200 m of forest cover. The dwarf palms were emasculated regularly for the production of hybrid seed (Nuce de, Lamothe and Rognon, 1972).

Subsequently, the above design was changed to carry only the female parents in the garden (ICM). They were emasculated and pollinated with pollen collected from palms growing outside the garden - assisted pollination (Nuce de Lamothe and Rognon, 1975).

They claim that with assisted pollination, several selected coconut cultivars could be used as the male parents at different times to pollinate the YD in the seed garden, to produce different types of hybrid seed.

Assisted pollination requires collection, processing and storage of pollen.

Coconut Seed Gardens have been developed in Ivory Coast, Phlippines and in Jamaica on the ICM, for the exclusive production of dwarf x tall seed.

5. Discussion

Efficiency of parental selections in the IM: The Govermnent of Indonesia required from 1972 large quantities of improved coconut seed for the development of the coconut industry. None was available then. The UNDP and FAO were requested to assist them.

In the absence of coconut variety trials in Indonesia, the author carried out a bold, imaginative and accelerated breeding progranune. Variety trials and seed gardens were established simultaneously, knowing that hybrids between selected palms of dwarf of Malaysian origin and selected tall cultivars; produced earfy bearing and high-yielding offspring. The variety trials proved this assumption 10 years later (1982). Large quantities of hybrid seed were available to the industry then (Liyanage *et al,* 1986).

Efficiency of the barrier of IM: Isolation of the seed garden with coconut palms, rather than with forest trees, was based on some important observations made by Indonesian scientists (Jesmaudt *et al,* 1975). They peointed oit that mites that live on coconut inflorescences axe the real agents of pollination in coconut. They are transported from palm to palm by the honey bee and are shed in the second or third inflorescence that the bee visits.

Thus, when the bees visit the palins in the seed garden, they carry mites and pollen collected from the inner rows of the barrier *ie* from known IT cultivars.

The barrier composed of 12 rows of IT cultivars reduces considerably the inflow of pollen from the palms outside the barrier to the seed garden proper. Contamination was only 2.6%. The IM seed gardens produce NYD x IT and IT x IT seed with a high degree of legitimacy (Liyanage and Azis, 1983).

Comparison between the three models: The three models of seed gardens differ in structure: SLM and IM have both the female and male parents growing within the seed garden, whereas ICM carries only the female parent.

Natural cross-pollination occurs between palms in SLM and IM; artificial pollination has to be carried out in ICM. This involves pollen processing, labour for pollination and supervision which increase the cost of production of nuts.

Two types of seed are available fronr SLM and IM: hybrid and Tall cultivars, whereas ICM gives only hybrid seed.

The advantages of IM in being located in coconut growing areas are numerous :

- inward and outward transport of inputs for the seed garden and seed respectively are cheaper,
- supervision and administration are cheaper and easier.
- the staff attached to the seed garden live near towns where marketing and educational facilities are available, and
- these factors considerably reduce the cost of production of seednuts.

One advantage of ICM over the other two models is that it could produce different types of hybrid seed, provided the female parent remains the yellow dwarf in the new combinations.

If artificial pollination is not carried out at the right time on each palm in ICM, less nuts with be developed compared to natural pollination.

The seed gardens will remain a dominant force for production of coconut seed until tissue culture succeeds creating new plants.

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