COCOS, (1986), 4,01–10
Printed in Sri Lanka.

Coconut Breeding in Indonesia – I

D. V. LIYANAGE*, T. MANKEY+, H. LUNTUNGAN+, A. DJISBAR+, and S. SUFIANI

ABSTRACT

The Coconut breeding work done in Indonesia from 1973 to 1983 under the auspices of the UNDP/FAO Coconut Development Project is outlined.

In 1972, the Government was anxious to have improved coconut varieties and seed in large quantities within a short period, for the coconut development programme which had already commenced. Hence a bold and imaginative programme, based on the long experience of the senior author, was initiated to produce improved varieties and seed within 10 years as against the usual 20 years.

Four varieties/cultivars suitable for use in the breeding programme were identified from the germplasm survey carried out in 11 provinces in Indonesia. They were: Nias Yellow Dwarf (NYD), Tenga Tall (TT), Palu Tall (PT) and Bali Tall (BT).

NYD was crossed with the three Tall forms to study the performance of the first generation progenies. Simultaneously, seed gardens were established using NYD as the female parent and the three Tall forms as the male. They were capable of producing NYD × TT, NYD × BT and NTD × PT seed. The seed gardens were developed according to a new concept.

By 1982, the F_1 palms of NYD × TT, NYD × BT and NYD × PT proved their superiority to the ordinary Tall with respect to precocity for bearing and high production of copra. In 1983 over 2 million seednuts of the improved varieties were available.

INTRODUCTION

Coconut breeding in Indonesia could be divided into three phases. Phase I, the work done by P. H. L. Tammes from about 1920 to 1935; Phase II, the work done by A. F. Innes from 1950 to 1960 and Phase III the work done by the authors of this article from 1973 to 1983. Unfortunately, breeding has not been a continuous operation due to various difficulties. However, work accomplished in each phase is of considerable importance.

Phase I: Tammes selected mother palms of the Tall variety from smallholdings in North Sulawesi and planted 1400 open-pollinated progenies derived from 43 mother palms at Mapanget, North Sulawesi. Selfed progenies of some of these selected palms have been planted at the same station in 1933 (Tammes 1958, Toar 1973). The seed parents of these progenies cannot be traced now and their identity is not known. Thus valuable information that would have been useful for the development of improved varieties is lost (Liyanage 1978).

Phase II: Innes planted open-pollinated progenies of 13 palms from Mapanget at Kayuwatu in 1957 and 1958 in three groups, each with three replications. Out of 3470 palms planted, 2242 remained in 1975. This trial is of considerable importance to determine prepotency as the female parents of the progenies are known (Liyanage 1975, Toar 1973).

*Project Manager/Breeder, UNDP/FAO Coconut Development Project Indonesia, 1973 to 1983.
+Coconut Breeder, Lembaga Panelition Tanman Industry, Bogor and Manado, Indonesia.

A number of trials have been planted at Kima Atas Experimental Station near Manado between 1957 and 1959. They include F_1 progenies of sibmatings, paired and reciprocal crosses of palms at Mapanget.

Phase III: The UNDP/FAO Coconut Development Project was initiated in 1972 and the breeding work done from 1973 to 1983 is outlined in this paper.

THE BREEDING PROGRAMME

The Government directed that improved coconut varieties should be developed and seed of these varieties produced in large quantities quickly to meet the requirements of the development plans already initiated to improve the coconut industry. That was a dilemma and a challenge. Breeding and testing a variety takes 12 years: three years for selection of parents, crossing them and seed collection, one year in the nursery, and eight years for field testing. Multiplication of seed of proved varieties through the technique of seed gardens will require another 8 years. Thus, from the start of a coconut breeding programme to mass production of seed, at least 20 years are required. The Government was not prepared to wait that long. Hence a bold, non-conventional coconut breeding programme was carried out as the germplasm survey in Indonesia indicated the availability of good genotypes.

Gemplasm Survey

A survey of coconut germplasm in selected areas of 11 provinces was carried out. Twentyfive samples that represented a wide spectrum of populations, some exposed to selection pressure, were studied. These revealed 4 varieties/cultivars with desirable characteristics for breeding (Liyanage & Corputty, 1975). They are:

Yellow Dwarf (NYD) growing in Nias island. The population is homogeneous, palms are early flowering giving 188g of copra per unselected nut.

Tenga Tall (TT) cultivar from North Sulawesi. Copra per unselected nut 296g.

Bali Tall (BT) from Central Java. Copra per unselected nut 340g.

Palu Tall (PT) cultivar from Central Sulawesi. Copra per unselected nut 354g.

The palms of the selected TT, BT and PT populations were homogeneously high-yielding giving about 3500kg copra/ha/yr. The weight of fruit components and the ratios between them are given in Tables 1 and 2. Sample size varied from 30 to 40 nuts taken at random from heaps of nuts.

Table 1. *Weight of fruit and its components*

Variety/Cultivar	*Fruit*		*Husk*		*Nut*		*Endosperm*		*Shell*		*Endosperm thickness*
	Wt. g	CV %	Wt. g	CV %	Wt. g	CV %	Wt. g	CV %	Wt. g	CV %	(mm)
Nias Yellow Dwarf (NYD)	1339	1·9	540	32·6	796	13·0	342	9·8	152	13·4	11·3
Tenga Tall (TT) ...	1842	14·1	633	29·6	1209	15·3	538	13·5	250	13·4	12·8
Bali Tall (BT) ...	1862	13·3	477	20·6	1385	13·1	619	12·7	282	12·8	13·3
Palu Tall (PT) ...	2005	16·0	438	24·6	1567	16.8	644	14·1	311	15·3	12·2
Typical Tall ...	1430	23·2	668	33·8	762	23·0	342	20·3	203	20·4	12·4

Table 2 *Ratios between fruit components*

Variety/cultivar	*Husk/Fruit*	*Nut/Fruit*	*Endosperm/ Fruit* Percent	*Endosperm/ Nut*	*Shell/Nut*
NY D ...	40·3	59·5	25·6	43·0	19·1
T T ...	34·4	65·6	29·2	44·5	20·7
BT ...	25·6	74·4	33·2	44·7	20·4
PT ...	21·9	78·2	32·1	41·1	19·9
Typical Tall ...	46·7	53·3	23·9	44·9	26·6

The Programme

Having selected the varieties/cultivars the following programme was formulated.

Conventional method (period in years)	*Item*	*Project programme method (period in years)*
1	Selection of germplsm and parents	1
2	Crossing selected parents and seed collection ...	2
1	Raising seedlings	1
8	Testing varieties and selection of varieties ...	8
8	Seed production in seed gardens	
20	Total	12

In the project programme testing varieties and the establishment of seed gardens with the parents likely to give good offspring were carried out simultaneously, thus saving 8 years.

The objective of the breeding programme was to produce a variety showing precocity for bearing and high-yield. Hence NYD was selected as the female parent and TT, BT and PT as the male parents.

A new concept for seed gardens

Hitherto, in the production of Dwarf x Tall hybrid seed, the practice has been to plant the female parent (Dwarf) in isolated blocks situated far away from existing coconut palms. The idea is to produce seed without contamination from unknown palms. Therefore, each inflorescence produced in the Dwarf palms is emasculated and the female flowers are pollinated artificially with pollen collected from the desired Tall parents to produce Dwarf x Tall hybrid seed. Emasculation and pollination have to be carried out practically every 24 to 28 days throughout the year.

In the new model developed in Indonesia, seed gardens are established within coconut plantations and not in isolated places. The Dwarf (NYD) and the male parents (TT, BT and PT) were planted in the seed garden. Four rows of Dwarfs were followed by a row of Talls. In the latter TT, BT and PT were planted. A barrier consisting of 8 to 12 rows of the three selected Tall cultivars surrounded the seed garden. This barrier prevents contamination of palms within the seed garden with those in the neighbourhood during the process of pollination. The contamination rate was less than 3 % with a twelve-row barrier. A total of 510 ha of seed gardens were planted at four locations in Indonesia between 1976 and 1978 based on this model (Liyanage and Hasman Aziz, 1983).

The purpose of planting three Tall selections in the seed garden is as a precautionary measure. If the varietal tests conducted simultaneously show that a particular male parent

does not combine well with the female Dwarf, then that parent could be removed from the seed garden without affecting the quality of seed to be produced.

Testing hybrids

A crossing programme was carried out from 1975 to 1977, using NYD as the female parent and TT, BT and PT as the males. Five comparative variety trials were planted at five locations between 1977 and 1980 on a randomized block layout using F_1 progeny of the above crosses. The varieties studied were NYD × TT, NYD × BT, NYD × PT and open-pollinated progenies of NYD, TT, BT and PT..

3. RESULTS

The Indonesian Hybrids

Sufficient yield data were available only from the variety trials No. I and II planted in January and December 1977 at Parungkuda, W. Java and Mapanget, N. Sulawesi respectively at the completion of the UNDP/FAO project in 1983. These have been fully utilized in the present analysis. Mapanget has ideal conditions for coconut cultivation, but those at Parungkuda were less favourable. The variations are reflected on the growth and yield of the palms.

Leaf production

Leaf production data of the five trials when the palms were 12 and 24 months old from the date of sprouting of seednuts are given in Table 3.

NYD has produced more leaves** than the hybrids and Talls. The hybrids show dominance in leaf production and have produced more leaves** than the Talls.

Table 3. *Leaf production in 5 Variety Trials*

Treatment/ Trial No.	*No. of leaves produced per plant from sprouting*								
	To 12 mth age					*To 24 mth age*			
	I	II	III	IV	V	I	II	III	IV
NYD x TT	10·0	10·7	13·8	11·2	8·1	20·6	24·7	24·5	20·8
NYD x BT	10·5	10·5	10·5	10·2	8·2	21·9	23·0	20·6	19·4
NYD x PT	10·7	10·1	—	10·5	9·6	21·9	23·5	—	20·3
NYD x WAT	—	—	—	—	8·4	—	—	—	—
NYD x WAT	—	—	11·7	9·4	8·1	—	—	21·7	19·1
TT op	7·1	10·8	—	10·1	—	15·9	20·8	—	18·2
BT op	9·5	—	11·3	—	—	18·7	—	20·2	—
PT op	8·0	11·3	—	—	—	17·6	21·9	—	—
NYD op	11·4	—	—	—	—	24·9	—	—	—
LSD(0·05)	0·8	0·7	0·6	0·4	0·9	1·1	2·0	1·3	1·0
LSD(0·01)	1·9	1·0	0·7	0·6	1·1	1·4	2·7	1·6	1.2

Trial I at Pakuwon, W. Java
Trial II at Mapanget, N. Sulawesi
Trial III at Gunung Anaga, W. Java
Trial IV at Sukareja, W. Java
Trial V at Segayung, C. Java

*Significant at P = 0.05
**Significant at P = 0.01

Leaf and stem characters

Table 4 gives eight measurements of the leaf characters of the 14th leaf and two of the stem made on palms in Trial No. 1 in order to study the differences between the varieties.

NYD characters, except stem length had the lowest values. Stem length was longer** than that of the three Tall varieties and shorter* than the 3 hybrids.

There were no significant differences between the male parents with respect to all the characters, except stem girth, where PT had a narrower* girth than BT.

Among the hybrids, NYD × PT has the lowest number of leaflets, less than NYD × TT** and NYD × BT*; differences between the others were negligible.

When the three hybrids are compared with the Talls, the hybrids have a shorter* rachis and leaf length, narrower** and longer** stem. Leaf stalk girth and width of NYD × BT were smaller* than that of BT, but in the other two hybrids similar to the Talls.

Table 4. *Measurements of leaf and stem characters*

Character/Variety	*NYD*	*TT*	*BT*	*PT*	*Mean value parents*	*Hybrid*	*Hybrid vs*	
							Female	*Male*
1. Stalk length (cm)	135·4	186·8	—	—	161.1	177·8	+ 42.4°	- 9·0
(from node to 1st		—	195·1	—	165·3	181·2	+ 45.8**	-13·9
leaflet)		—	—	183·6	159·5	182·1	+ 46.7**	- 1·5
2. Rachis lenght (cm)	256·3	411·1	—	—	338·2	378·2	+112·9**	−32·9**
(from 1st to last		—	413·4	—	339·4	363·6	+ 98·3**	−49·8**
leaflet)		—	—	427·4	346·6	379·9	+108.6**	−53·5**
3. Leaf length (cm)	480·7	597·9	—	—	499·3	556·0	+155·3**	- 41·9**
(1+2)		—	608·6	—	504.7	546.3	+145.6**	− 62.3**
		—	—	626·0	513·4	556·3	+155·4	−69·9**
4. Stalk width (cm)	6·1	7·5	—	—	6·8	7·4	+ 1·3**	- 0·0**
(flat surface at 1st		—	7·8	—	7·0	7·3	+ 1·2**	− 0·5**
leaflet)		—	—	7·5	6·8	7·3	+ 1·2**	− 0·2
5. Stalk girth (cm)	9·2	12·1	—	—	10·7	11·3.	+ 2·1*	− 0·83
(curved surface		—	12·5	—	10·9	11·3	+ 2·1*	− 1·3**
at 1st leaflet)		—	—	12/1	10·7	11·0	+ 1·8**	1 1**
6. Leaflet length (cm)	103·5	120·4	—	—	112·0	117·0	+ 13·4**	− 3·5**
(longest leaflet)		—	117·9	—	110·7	113·3	+ 9·8*	− 4·6
		—	120·8	—	112·2	116·2	+ 12·7*	− 4·6
7. Leaflet number	137·4	199.3	—	—	168·4	194·9	+ 57·5**	− 4·4
		—	196·2	—	166·8	191·2	+ 53·8**	- 5·0
		—	—	197·6	167·5	187·3	+ 44·9**	−15·3**
8. Leaflet width (cm)	5·2	6·5	—	—	5·0	6·1	+ 1·0**	0·4
(at middle of 6)		—	6·8	—	6·0	6·3	+ 1·1**	0·5*
		—	—	6·7	6·0	6·2	+ 1·0**	0·6
9. Stem girth (cm)	97·4	178·7	—	—	138·1	150·7	+ 53·3**	−28·0**
(1 m above ground)		—	183·9	—	140·7	155·7	+ 58·3**	−28·1**
		—	—	172·2	134·8	150·3	+ 52·9**	−21·9**
10. Stem length (cm)	143·0	93·1	—	—	118·1	170·7	+ 27·8*	+77·7**
(ground level to node		—	95·4	—	119·2	172·1	+ 29·2*	+76·7**
with oldest green leaf)		—		99·5	121·3	180·9	+ 38·0**	+81·5**

*Significant at p = 0·05
**Significant at P = 0·01

It is advantageous to have short leaf stalks and rachis to reduce leaf drooping, larger leaflet area to increase photosynthetic activity and a shorter stem to reduce height of the palm. The three hybrids compared to the Talls have shorter leaves, which is an advantage, and longer stems, a disadvantage, and practically similar leaf area.

Leaf axil of the first spadix

The first spadix appeared in the axil of the 30th leaf produced after sprouting of the seed nut in NYD, 46th leaf in the Talls and 35th in the hybrid. The differences within the three hybrids and the three Talls were not significant. More leaves** have to be produced in the hybrids and the Talls to produce the first spadix; the hybrids need fewer** than the Talls and have taken a mid-parental value.

The hybrids are at a distinct advantage over the Tall cultivars with regard to the number of leaves that have to be produced in a young palm to initiate the first spadix.

Precocity for bearing

There are three factors involved in precocity of bearing: initial flowering, splitting of spathe and the first harvest of fruits (Table 5). It is a cycle of events varying between varie-

Table 5. *Initial flowering and harvest data of two Dwarf x Tall trials*

Treatment	*Initial flowering*		*Spliting of spathe*		*First harvest*	
Trial No.	*I*	*II*	*I*	*II*	*I*	*II*
	Months from sprouting of seed nuts					
NYD X TT	45·3	41·2	48·0	43·1	65·1	56·1
NYD X BT	43·8	42·6	46·7	45·0	63·6	59·0
NYD X PT	44·4	42·1	46·8	43·8	64·2	57·8
TT op	63·6	56·0	65·4	57·3	—	—
BT op	59·6	52·0	61·7	54·0	—	—
PT op	60·9	52·6	63·0	54·3	—	—
NYD op	37·2	—	40·9	—	—	—
LSD (0·05)	3·67	5·78	4·32	6·11	—	—
(0·01)	4·55	7·16	5·35	7·57	—	—
CV %	3·1	5·3	3·4	5·4	—	—

ties, a shorter period for each phase being advantageous. The duration of these phases are recorded from the date of sprouting seed nuts, but the relative data in published literature is given from the date of planting seedlings in the field. To convert the data presented here into the latter system, deduct 8 months from the mean value of each figure.

Initial flowering-period of the three hybrids was 42.0 months (average) from sprouting of seed nuts in Trial II and 2.5 months later in Trial I. The differences between them at each location are not significant. They have taken a shorter period** than the Talls, but longer** than NYD. The Talls have averaged 53.5 and 61.4 months to flower at the two locations, the difference between them at each place being negligible. NYD has taken only 37.2 months, a much shorter period** than the hybrids and the Talls.

The hybrids show precocity for flowering compared to the Tall cultivars.

First spathe to split is not necessarily the first one produced as the initial ones sometimes abort. Therefore, the period taken for the splitting of the first spathe is a better index than the flowering period. The hybrids in Trial II have taken 44 months, *ie.* 2 months after noticing the first flower, and in the other trials 47 months. The differences between them at each location are not significant. The behaviour of the Talls is similar, which is unusual and probably a result of efficient selection.

Again the hybrids are at an advantage over the Tall cultivars.

The bearing-age of a palm, *ie.* the period taken to harvest the first bunch of fruits, is a more important economic factor than those discussed in the two previous sections, as one or more spathes produced initially do not carry female flowers or the few produced are shed pre-maturely. This data for the hybrids only are given in Table 5 as harvesting from some of the Talls had not started. The data is presented below as mean values.

	Trial I	*Trial II*
	(months from sprouting)	
Flowering-period of hybrids	45	42
Opening of 1st spadix of hybrids	47	44
First harvest of hybrids	64	58

Yield of Fruits and Copra

Yield data for 3 years for Trial I (5th, 6th and 7th years after planting seedlings) and for 2 years for Trial II (5th and 6th years) are given in Table 6. Unfortunately these two trials went through a severe drought and its effect is reflected on the yield.

The cumulative yield data per ha of 147 palms is given below, for the 5th, 6th and 7th years for Trial I and 5th and 6th years for Trial II.

	Trial I		*Trial II*	
	For 3 years		*For 2 years*	
	Nuts	*Copra (Ton)*	*Nuts*	*Copra (Ton)*
NYD × TT	23,681	5.81	15,024	3.04
NYD × BT	17,295	4.92	9,299	2.09
NYD × PT	20,308	5.06	10,505	2.33
TT OP	2,657	0.73	408	0.08
BT OP	2,919	0.79	265	0.07
PT OP	2,595	0.67	798	0.19
NYD OP	24,503	3.91	–	–
LSD 0.05	5,304	1.38	4,008	0.77
LSD 0.01	6,571	1.71	5,069	1.08
CV %...	4.7	18.9	268	26.4

The hybrids have given more fruits** and copra** than the Talls in the initial stages of bearing, differences between the Talls being negligible. In Trial I, the yield of copra between the hybrids are not significant, but in the other trial NYD × TT has given more copra* than NYD × BT.

Effect of drought on the hybrids

A demonstration block planted in East Java in November 1978 consists of the Indonesian hybrids and the ordinary selected cultivar. Each variety was divided into blocks receiving high inputs and farmer's level of inputs. This block was exposed to a prolonged drought in 1982 lasting 6 consecutive months resulting in heavy leaf drooping. The number of broken and dry leaves were counted. The results are summarized below:

Table 6. *Yield data of Trials I and II*

Treatment	Year	Trial I		Trial II	
		Fruits	Copra (ton)	Fruits	Copra (ton)
		per ha		per ha	
NYD X TT	5th	1 635	0·44	8 996	1·99
	6th	11 756	2·98	6 028	1·05
	7th	10 288	2·39	—	—
	Total	23 681	5·81	15 024	3·04
NYD X BT	5th	1 161	0·36	5 615	1·42
	6th	8 034	2·38	3 684	0·67
	7th	8 100	2·18	—	—
	Total	17 295	4·92	9 299	2·09
NYD X PT	5th	1 082	0·27	5 542	1·41
	6th	11 219	2·76	5 013	0·92
	7th	8 007	2.03	—	—
	Total	20 308	5·06	10 555	2·33
NYD	5th	3 339	0·60		
	6th	10 883	1·89		
	7th	10 281	1·42		
	Total	24 503	3·91		
TT op	6th	625	0·17	408	0·08
	7th	2 032	0·56	—	—
	Total	2 657	0·73		
BT op	6th	897	0·23	265	0·07
	7th	2 022	0·56	—	—
	Total	2 919	0·79		
PT op	6th	422	0·11	798	0·19
	7th	2 173	0·56	—	—
	Total	2 595	0·67		

No. of fruits estimated on a basis of 147 palms/ha.
Copra weight is calculated as 50 % of the wet endosperm weight. The weight of the endosperm of a random sample of 10 % of the fruits harvested at each pick from each treatment plot was recorded.

— The hybrids suffered more** than the Talls irrespective of the management system,
— Hybrids in the intensive system suffered more** than the hybrids in the non-intensive,
— Talls with intensive management suffered more than the Talls in the non-intensive, and
— The hybrids with non-intensive management suffered more** than the Talls in the same system.

DISCUSSION

The coconut breeding programme carried out in Indonesia from 1973 to 1983 is non-conventional and unique. At the completion of testing new varieties, during a period of 10 years, seednuts of the improved varieties were available in large quantities. This was the result of implementing the breeding programme and the establishment of seed gardens simultaneously.

The germplasm survey carried out in Indonesia indicated the existence of valuable genotypes to increase copra production. The three selections TT, BT and PT turned out to be useful to produce precocious and productive hybrids in combination with the NYD.

NYD × TT, NYD × BT and NYD × PT bred from intensive selections of indigenous material have grown more vigourously showing precocity for bearing compared to the male parents indicating a heterosis effect. The yield of the hybrids NYD × TT and NYD × PT in the 6th year after planting in Trial I (not exposed to drought) giving over 2.8 tons copra/ha/yr is remarkable.

Another important character of these hybrids is that copra content per nut is high. From the combined cumulative yield totals for 3 and 2 years of the Trials I and II respectively the weight recorded are as follows:

NYD × TT – 38,705 nuts have given 8,850kg. copra, equivalent to 229g copra/nut.

NYD × BT – 26,594 nuts have given 7,010kg copra, equivalent to 264g copra/nut

NYD × PT – 30,863 nuts have given 7,390kg copra, equivalent to 239g copra/nut.

The copra content per nut is high in each hybrid ranging from 229 to 264g with NYD x BT at an advantage over the other two hybrids. When the copra content per nut is high, the cost production of copra is proportionately less.

There are differences among the three hybrids. However, they could be graded as indicated below considering the characters of economic value from a Breeder's point of view, disregarding statistical significance:

Character	*NYD x TT*	*NYD x BT*	*NYD x PT*
Flowering-period	0	0	0
Harvesting-period	0	0	0
Yield of nuts	2	0	1
Yield of copra	2	0	1
Copra per nut	0	2	1
Appearance of crown	1	0	0
Tolerance to drought	0	0	0
Tolerance to pests and diseases	0	0	0
Total:	5	2	3

0 = no advantage, 1 = at an advantage,
2 = at an extra advantage.

The hybrids fall into the following order of merit according to the data presented in this paper. NYD x TT, NYD x PT, NYD x BT.

There are two unique features about the Indonesian model of coconut seed gardens. The male and female parents are planted within the garden and seed is produced by natural pollination after emasculation eliminating assisted pollination. They are situated within coconut areas and cost of production of seed is low. The inclusion of the three Tall cultivars is as a precaution. If by chance, the variety trials show that a particular male combined with NYD does not produce productive progenies, then that parent would be removed from the seed garden retaining only the parent/s that combine well with the Dwarf female. Futher, seed of high legitimacy is produced: contamination is only 2·6 %.

Another advantage of this model of seed gardens is that Tall x Tall seed of a good quality could be produced in addition to Dwarf x Tall seed. Since the selected Tall variety palms within the seed garden are elite palms, cross pollination between them will produce a progeny far superior to those derived through open-pollination from selected 'mother palms,.

ACKNOWLEDGEMENTS

Prof. Dr. Thojib Hadiwidjaja, Minister of Agriculture and Ir. Hasman Aziz, Director, LPTI, Bogor were interested in this breeding programme and supported it. Had it not been for their foresight and sustained support in the face of severe criticism from vested interests who were against the implementation of this programme, it would have been aborted in the initial stages.

The success of the breeding programme was due to the cooperation received from a number of staff members of the Institute for Industrial Crops (LPTI). Amongst them, our particular thanks are due to Messrs. Ch.P Corputty, A. Abdulla, Deswert, H. Sudasrip, Ausai, D. Sitepu W. A. Baringbim, D. Hideyat, M. Mansur, M. Paliiu, T. Toar and Suchyawan. Also our thanks are due to Prof. T. A. Davis, Coconut Agronomist of the project, particularly for the study on the effect of drought on the palms in an observation plot.

REFERENCES

Liyanage, D. V. (1975). Coconut breeding programme of the UNDP/FAO Coconut Industry Development Project. Document No. 2 (mimeographed).

Liyanage, D. V. (1978). Ibid. Supplement No. 1 (mimeographed).

Liyanage, D. V. and Corputty, Ch.P (1975). Coconut germplasm in Indonesia. Paper presented at the Fourth Session of the FAO Technical Working Party on Coconut Production, Protection and Processing, Kingston, Jamaica.

Liyanage, D. V. and Hasman Azis (1983). A new technique for establishing seed gardens. Cocos 1, 01–06.

Tammes, P. L. H. (1958). Review of coconut selection in Indonesia. Euphytica 4: 17–24.

Toar, T. (1973). Private communication.

Tammes, P. L. H. (1958). Review of coconut selection in Indonesia. Euphytica 4: 17–24.

Toar, T. (1973). Private communication.