YIELD CAPACITY AND TRANSMITTING POWER OF MOTHER PALMS IN COCONUT

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The tall variety of the coconut palm is the one that is most extensively cultivated on a plantation scale in all the coconut producing countries of the world. It is a highly heterozygous crop with pan tropical distribution. Because it is largely cross pollinated in nature considerable variability occurs within the tall variety itself forming diverse panmictic populations.

Range of yield and frequency distribution

A casual observation of a stand of tall coconut palms reveals that the proportion of high yielders we select as mother palms in a plantation is very small. However the sizable part of the yield of the plantation is contributed by these high yielders. In Malaysia, Jack (1929) concluded from a study of yields of 471 palms that 19 per cent of the palms were not profitable and 15.5 per cent of the palms produced 24.5 per cent of the crop. Murray (1950) analysing the yield records of 600 trees of an estate in Trinidad found that 9 per cent of the trees comprising the high yielders gave 21 per cent of the total crop while 19 per cent comprising the worst trees yielded only 3 per cent. In Java, Cramer (*Private communication*, 1951) based on the data of 244 trees presented by Van der Elst in his report *The Coconut palm and its products* (1930-31) found that 50 per cent poorest trees produced 33.4 per cent of the total crop, the other half composed of the best yielders produced 66.6 per cent of the total crop. In Srilanka, analysis of the yields of 296 palms of Bandirippuwa Estate (Ceylon) in 1949 showed that 70 per cent of the total crop derived from 55 per cent of the population and that nearly half the number accounted for only 30 per cent of the harvest (Menon and Pandalai, 1958). In India, the results of an investigation carried out in a plantation consisting of 1400 palms at Kasaragod indicate that a smaller percentage of the trees accounts for a relatively larger percentage of the yield. High yielders which formed only 8.6 per cent of the trees gave 15.8 per cent of the total crops while poor yielders which formed 32 per cent of the population had only a share of 17.3 per cent (Menon and Pandalai, 1958). Results of another investigation carried out on 4347 palms at CPCRI, Kasaragod also on the West Coast of India have indicated the same trend (Jacob Mathew *et al*, 1978). Venkateswaran *et al* (1975) reported from a study of coconut plantation in Tamil Nadu on the East Coast that 5.9 of the palms comprising the high yields gave 18.5 per cent of the total crop. Kannan (1982) has reported that in a well maintained block of 150 trees at Pilicode, Kerala a total of 29.33 per cent of the palms yield only less than 40 nuts per palm per year and 54.00 per cent yield less than 60 nuts and only 16.67 per cent of the palms give an annual yield of over 80 nuts. In Phillippines and East Africa also the percentage of high yielders in a population is low (Table-1).

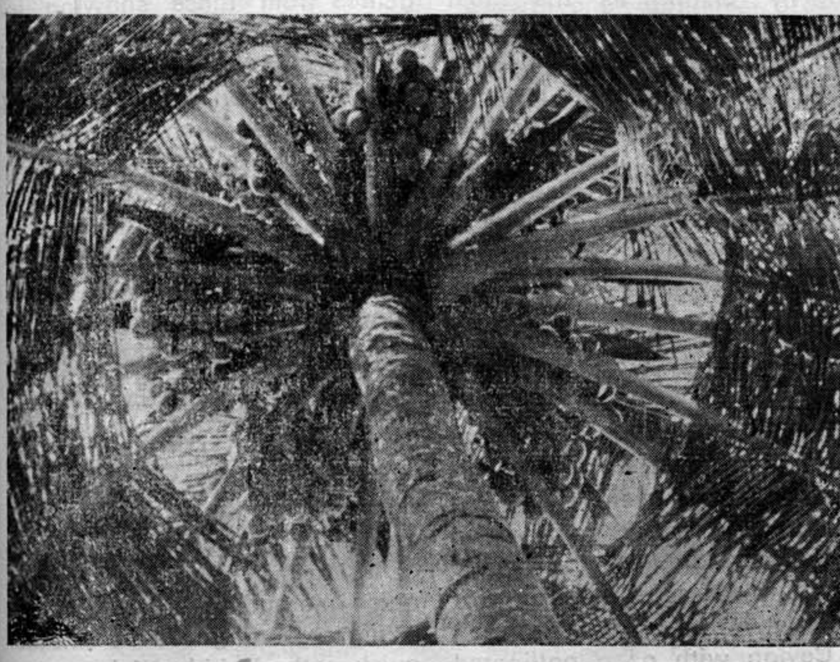
Observations on the distribution of 4347 palms at CPCRI, Kasaragod on the basis of yield groups as high yielders for those yielding over 80 nuts per palm per annum, medium yielders for those yielding between 40 and 80 nuts per palm per annum and low yielders for those yielding less than 40 nuts per palm per annum indicate that 31.3 per cent of the low yielders account for 17.2 per cent of the total yield, 60.3 per cent of medium yielders account for 67.6 per cent of the total yield and 8.4 per cent of the high yielders account for 15.3 per cent of the total yield (Table-1). Data on the yield of palms in different blocks at Kasaragod has shown that the percentage of palms in the high yield group is low in all the blocks, the percentage varying from 5.6 to 10.5 whereas the percentage of medium yielders vary from 53.6 to 75.1 per cent and low yielders account for 15.5 to 38.0 per cent of the total population. The mean yield of the different blocks are 47.9 in South and North Blocks and 57.5 in the East Block. It is 52.4 in the Main and Central Blocks. The mean yield of all the blocks is 50.7 (Table-2). If the yield of palms in each field is taken into consideration the percentage of high yielders in the 19 fields which form the five blocks, varies from 2 to 17 per cent and accounts for 3 to 27.2 per cent of the yield (Table-3). This is the situation which we can expect in the normal course of cultivation with random-bred material and even with normal manuring. Seednuts obtained from such high yielding palms from a field are utilised for raising seedlings for planting out in the field. If all high yielding palms transmit their high yielding character to their progeny, this type of selection would have changed the present position in the coconut situation of India today. It would have registered considerable improvement in the production of coconut and its allied products like copra and oil. But the situation in coconut seems to be different.

Yield as basis for selection of mother palms

Palms which satisfy the criteria of selection in a garden are selected as mother palms. The main basis on which selection of palms is made is the yield of nuts. This method of selection has its own defects. Here the male parent is unknown and the female parent is itself heterozygous and the high productivity of the mother palm may be transmissible or not to the progenies. The high yielding capacity of a palm may be due to mainly two reasons. It may be due to favourable environment or due to inherent capacity of the palms. Unless selection of mother palms in a field is made on the basis of genetical superiority, we cannot expect that the seedlings obtained from all regular heavy bearers will behave like the mother parent in their performance. By the type of selection practised at present it is possible that palms which are genetically superior but located in an unfavourable environment may get eliminated and those with poor inherent capacity but high yielding due to favourable environment may get selected.

Heritability of yield in coconut

Research workers on coconut who have studied the question of heritability in coconut have attached more importance to heredity and not to environment. The heritability of yield of nuts in coconut is found to be low and hence selection on the basis of yield of nuts alone is not likely to be of desired advantage. Work done on other crops has also indicated that all phenotypic high yielders do not transmit their high yielding character to their progenies and selection based on phenotypic characters alone is not expected to produce substantial results. According to Harland (1957) if in a field of maize all the inferior plants are eliminated and the resulting elite progenies are allowed to intercross freely, the yield obtained from such a field shows practically no advantage over that from an unselected mixed population. Harland's experiments in open pollinated cacao trees have also shown that they differ in their power of transmitting high yield to their progenies. Some transmit strongly probably through the possession of an especially favourable combination of dominant genes i. e. they are prepotents while others give progeny no better than average (Harland, 1957).



A high yielding palm

Work on coconut and its scope

Early workers on coconut have recorded a similar situation in coconut. According to Smith (1933) it is necessary to study nursery results of the selected mother palms in view of the fact that certain palms persistently yield nuts of low germination percentage and poor growth characteristics. He is of the view that seed from high yielding palm is useless if it refuses to germinate or having done so, produces progeny unfit to plant. Dwyer (1938) has stated that some palms will tend to produce much stronger seedlings than others. In his view there is a tendency for the nuts from some palms and even from some localities to germinate badly and this variable characteristic is probably more often transmitted than not. He has stated that a perusal of the data given by Smith (loc. cit) has shown that some populations produce no good plants whatsoever, though the germination was 100 per cent, others produce a large proportion with malformed shoots while others give 100 per cent germination all of which progeny were strong and evenly grown. The data on classification of seedlings of high yielding palms on the basis of yield of nuts presented by Van der Elst (1930-31) in his report *The Coconut palm and its products* (private communication from Prof. Cramer, 1951) also indicate that out of 244 seedlings of high yielders planted during 1911-12, 78 trees gave less than 40 nuts, 118 trees gave an yield between 40 and 79 nuts and only 48 trees gave an yield of 80 nuts and above during 1922-28 indicating that all of them were not high yielders. Harland (1957) considered that the same situation encountered in maize and cacao with regard to selection holds good with coconut and if the progenies of high yielding mothers are identifiable it should be possible within a few years to pick out the yield transmitters and use them for propagation and intercrossing with one another. According to him, selected seedlings of high yielding palms are very little better than those from low yielding ones based on the data available from an experiment laid out in Ceylon. He felt that it is apparent from the results that high yield is not transmitted by a mixed group of offsprings from high yielding mother palms exposed to natural crossing and suggested identification of prepotent high yielders by comparison of large number of open pollinated progenies. Harland considers that a high yielder may owe its high yield to a variety of causes and even when high yielders associated with unusually favourable environments are eliminated, the others which may be considered to have genetic superiority are of two types, the first having a favourable combination of genes in the heterozygous condition or hybrid phase and the second which are sufficiently possessed of dominant yield genes to ensure that their progeny are also high yielding. These high yielders which continue to maintain significantly high progeny values irrespective of the type of pollinating male are no doubt inherently superior and may be regarded to have sufficient load of dominant factors to be called prepotents in Harland's sense. Hence the success of mother palm selection lies in the identification of trees among high yielders which yield seedlings of superior characters. Charles (1961) evaluated the potentiality of mother palm selection and produced experimental evidence to indicate that the technique is ineffective probably because of low yield. He has recommended progeny testing as the most reliable method of detecting prepotent palms. Recently Kannan (1982) has suggested progeny row tests for quick identification of prepotent palms which can be used for paired crosses or for pollinating phenotypically superior females. Thus the early effective method of selecting mother palms would appear to be by progeny testing.

Based on the suggestion made by Harland (1957) research workers have been trying to identify prepotent palms based on progeny performance. Liyanage (1961) discussed the results of a progeny trial planted in 1934 in Ceylon with open pollinated seednuts of 9 selected high yielders and identified one of the seed parent which can transmit the character of high yield of copra to the progenies as prepotent. He (1967) identified one palm out of 104 palms in a progeny trial planted in 1948 as a prepotent based on phenotypic and breeding values classifying only one per cent of the palms in the trial as prepotent. As it takes for a tall palm 7 to 10 years to come into bearing, progeny testing to identify prepotent palms will be a long process. Nursery selection which is being practised everywhere should be done on a sound basis on a true correlation of seedling and adult characters. Ninan and Pankajakshan (1961) studied the seedling characters of the open pollinated progenies and hybrids of some high yielders of West Coast Tall variety and came to the conclusion that on the basis of seedling performance it is possible to isolate high yielders which yield superior progenies from those showing inferior progeny performance. Ninan *et al* (1964) found from their studies on growth rate and vigour of seedling that, differences between families in vigour and growth rate were highly significant in comparison with the variation within families indicating the possibility of identifying prepotent palms on the basis of progeny performance in the nursery. Liyanage (1967) reported that there is a positive and significant correlation between total number of leaves produced during the first 40 months and yield of copra at the age of 13 to 14 years indicating a quick method of isolating palms of high breeding value. Another quick method of identifying palms of high breeding value suggested by Liyanage (1969) is by selfing and studying the depression in endosperm and embryo weight relative to those of open pollinated nuts from the same palm. Satyabalan *et al* (1975) studied the seedling characters like collar girth and leaf production, which are reported to be genetically correlated with the yield of adult palms (Nampoothiri *et al* 1975), of open pollinated progenies of some high yielding palms and compared them with their performance as adult palms and reported on the possibility of identifying prepotent palms based on seedling performance in the nursery. Monthly correlations on growth rate and seedling vigour as measured by collar girth and leaf production from the time of germination of open pollinated progenies of high yielding families from the first month to the ninth month with those of the tenth month showed that correlation was high and positive from the fifth month. This indicated the possibility to identify palms of superior genetic value even from the fifth month based on these two growth characters of the progeny, (Satyabalan and Jacob Mathew, 1976). Further studies done to test the prepotency of palms identified earlier by studying the performance of progeny obtained from nuts harvested during the different months of the seednut season on the West Coast of India (January to May) and of those germinated during the different months July to November after they were planted in the nursery in June, have shown that in the case of the palms identified as prepotents in whichever month from January to May the seednuts were harvested and in whichever month the seednut germinated from July to November, the growth of the seedlings was more vigourous than those of other palms. In the two palms identified as prepotents out of 16 palms studied, more than 80 per cent of the progenies have growth characters–leaf production and collar girth above the general mean of 599 seedlings indicating that they can be fixed as prepotents. The phenotypic and genetic correlations worked out were high and positive (Satyabalan and Jacob Mathew). Prepotency studies on West Coast Tall conducted on 20 progenies each of 15 palms from Kuttiadi centre at Nileshwar have indicated that only two families out of fifteen have recorded high yields (Anon. 1977) showing thereby that progenies of all high yielders may not turn out to be high yielders. All these investigations indicate that the percentage of high yielders in a population is low and that all the high yielders are not likely to yield progenies of high yielding nature. Hence to improve the overall yield of coconut plantations, open pollinated progenies of genetically superior high yielding mother palms have to be planted. The planting of progenies of such genetically superior palms (prepotents) only will go a long way to augment the production of coconuts in our country.

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Table - I

Distribution of palms according to yield in some coconut growing countries

Countries	No. of palms studied	Yield group	Percentage of palms in the group	Percentage contribut-ion to to-tal yield	Reference
SRI LANKA					
Bandirippuwa Estate	296		45.0	30.0	Menon, K. P. V. & Pandalai, K. M. (1958)
		High	55.0	70.0	
MALAYSIA	388	35	23.2	11.1	Jack, H. W. (1929)
		35-85	57.7	59.4	
		85	19.1	29.5	
PHILIPPINES					
Laguna	4703	40	90.7	NA	Rodrigo, P. A. *et. al* (1962)
		40-80	9.3		
		80	0.0		
Quezon	5149	40	40.9	NA	" "
		40-80	55.0		
		80	4.1		
Quezon	2316	40	17.8	NA	" "
		40-80	51.9		
		80	30.3		
INDONESIA Java	244	40	31.9	NA	Cramer, P. J. S. (1951)
		40-80	48.5		
		80	19.6		
WEST INDIES Trinidad	600	Low	19.0	3.0	Murray. D. E. (1950)
		Medium	72.0	76.0	
		High	9.0	21.0	
E. AFRICA Chambezi	278	80	89.6	NA	Kasembe,J. N. R. & Currah, I. A (1968)
		80	10.4		
INDIA Kasaragod Kerala	1400	40	32.0	17.3	Menon, K. P. V. & Pandalai, K. M. (1958)
		40-80	59.4	66.9	
		80	8.6	15.8	
Kasaragod Kerala	4347	40	31.3	17.2	Jacob Mathew *et. al.* (1978)
		40-80	60.3	67.6	
		80	8.4	15.3	
Pilicode Kerala	150	40	29.3		Kannan, K. (1982)
		40-80	54.0		
		80	16.7		
Veppankulam Tamil Nadu	1668	40	66.9	34.1	Venkateswaran, A. N. *et al* (1975)
		40-80	27.2	47.4	
		80	5.9	18.5	

TABLE

Proportion of different yield groups and yield accounted for by them in the different blocks

Block	Yield groups per palm/year	No. of palms	Mean annual yield of nuts	Mean annual yield of the block	Percentage of palms in the group	Percentage of total accounted for by the group
Main	Below 40 nuts	318	9609		26.1	15.1
	Between 40-80 nuts	805	45441		66.2	71.2
	Above 80 nuts	94	8728		7.7	13.7
		1217	63778	52.4		
Central	Below 40 nuts	323	8923		29.1	15.4
	Between 40-80 nuts	670	38457		60.4	66.2
	Above 80 nuts	116	10727		10.5	18.4
		1109	58107	52.4		
North	Below 40 nuts	373	9197		37.5	19.3
	Between 40-80 nuts	533	30420		53.6	63.8
	Above 80 nuts	88	8033		8.9	16.9
		994	47650	47.9		
South	Below 40 nuts	317	9375		38.0	23.5
	Between 40-80 nuts	470	26092		56.4	65.3
	Above 80 nuts	47	4499		5.6	11.2
		834	39966	47.9		
East	Below 40 nuts	30	798		15.5	7.2
	Between 40-80 nuts	145	8618		75.1	77.7
	Above 80 nuts	18	1682		9.3	15.2
		193	11098	57.5		
Total of all the blocks	Below 40 nuts	1361	37902		31.3	17.2
	Between 40-80 nuts	2623	149028		60.3	67.6
	Above 80 nuts	363	33669		8.4	15.3
		4347	220599	50.7		

Proportion of different yield groups and yield accounted for by them in the different fields

FIELD	TOTAL No. of palms	Total yield	Mean yield of field	No. of poor yielders and percentage of total		No. of medium yielders and percentage of total		No. of high yielders and percentage of total		Percentage yield of poor yielders of total yield	Percentage yield of medium yielders of total yield	Percentage yield of high yielders of total yield
1	174	9782	56.2	40	23%	109	63%	25	14%	12.5	64.1	23.4
2	203	10827	53.3	45	22%	141	70%	17	8%	12.1	72.9	14.9
3	98	5655	57.6	9	9%	83	85%	6	6%	4.4	86.6	8.9
4	117	5322	45.4	40	34%	75	64%	2	2%	22.4	74.6	3.0
5	140	7428	57.1	32	23%	103	74%	5	3%	13.1	81.1	5.8
6	84	3825	45.5	31	37%	51	61%	2	2%	25.3	70.1	4.5
7	150	7987	53.2	45	30%	86	57%	19	13%	16.8	60.3	22.9
8	163	7432	45.5	63	39%	96	58%	4	3%	25.7	69.6	4.7
9	88	5520	62.7	13	15%	61	69%	14	16%	8.0	67.2	24.8
10	401	20529	51.1	118	29%	253	63%	30	8%	16.1	70.2	13.7
11	539	29647	55.0	127	24%	345	64%	67	12%	12.1	67.4	20.5
12	47	2934	62.4	3	6%	36	77%	8	17%	3.9	68.9	27.2
13	401	22263	55.5	92	23%	254	63%	55	14%	10.4	66.6	23.0
14	155	7892	50.9	55	35%	85	55%	15	10%	20.8	60.5	18.7
15	459	20406	44.4	193	42%	257	56%	9	2%	27.4	68.6	4.0
16	220	11668	53.0	69	31%	128	58%	23	11%	18.3	62.7	19.0
17	122	4997	40.9	75	61%	36	30%	11	9%	38.3	40.2	21.5
18	193	11098	57.5	30	16%	145	75%	18	9%	7.2	77.7	15.1
19	593	25387	42.9	281	47%	279	47%	33	6%	27.1	61.4	11.5
Total	4347	220599	50.7	1361	31.3%	2623	60.3%	363	8.4%	17.2	67.6	15.3