

COCONUT AGRONOMY—1954-1958

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Despite the importance of the copra industry to Papua and New Guinea, knowledge of some of the basic agronomic problems of the coconut still lags behind that of the other tree crops of the Territory. The author, the Coconut Agronomist at the Lowlands Agricultural Experiment Station, at Keravat, New Britain, explains that a survey of world coconut literature showed that this situation is international. In this article, Mr. Charles describes the new experimental programme which was undertaken after war damage was cleared up in Papua and New Guinea and the progress made since 1954. The work has proceeded along two major lines—the improvement of existing palm stands and the development of improved seed for new plantings.

DURING the Japanese occupation of Papua and New Guinea, the coconut plantations were left unattended for several years and many suffered damage from bombing and strafing during the hostilities. Consequently, the main task of plantation owners for some years after 1945 was the clearing of scrub growth and general renovation of plantations. However, during the period which this report refers to, increasing attention has been given to the improvement of plantations by the extension of the area planted, replanting old palms and interplanting with cacao.

Most of the experimental material and records of experiments of the Department of Agriculture were destroyed during the war. As a result, it was necessary to start again from the beginning with a new experimental programme.

Two approaches were considered—

- (a) the improvement of existing palm stands; and
- (b) the provision of improved seed for new plantings.

Before concentrating on either approach, all available literature was surveyed so that full advantage could be taken of findings from other parts of the world. This survey was hampered by the fact that much of the literature was out of print and hard to obtain. However, sufficient was obtained to show that there has probably been less scientific study of the coconut than of any other crop plant of comparable importance and much work remains to be done, even on many of the basic agronomic problems.

With cultural practices, experiments in different parts of the world have shown responses to manuring with potash, phosphorus, nitrogen, lime and farmyard manure and yield improvements have also been obtained from ploughing and from forking the soil under certain conditions.

Regarding the provision of improved planting material, from the results of a critical experiment carried out in Ceylon, it seems highly probable that the traditional method of improvement of planting material is quite ineffective. This experiment showed that the use of seed from high-yielding mother palms gave no significant improvement, even where the mother palms had been selected after some years of careful observations. The same experiment showed, however, that improvement could definitely be achieved by nursery selection of seedlings.

The general conclusion from this literature survey was that genetic improvement of planting material would be a very long-term project. At the same time, it was apparent that the condition of existing stands in many parts of the Territory left much to be desired. Many of these are declining in productivity, as well as being of obviously unhealthy appearance. This condition is not usually wholly explicable by the old age of the stands, although old age is commonly a partial cause.

It was therefore decided that in the programme of coconut agronomy the work should be concentrated initially on the improvement of existing palm stands. At the same time, the

problem of providing improved seed has been given some attention and the first stages of a breeding programme have been commenced.

Personnel

Agronomist A. E. Charles was assigned to coconut work in February, 1954, and Agronomist P. L. Stallwood was appointed in November, 1957. Both these agronomists are based at the Lowlands Agricultural Experiment Station, Keravat. Much research work on coconuts has also been carried out by other officers of the Department, but this report will be restricted almost entirely to the work of the agronomists.

Surveys

Over the last four years, the coconut agronomist has visited plantations throughout most of the major producing areas in the Territory and impressions of palm condition in these areas are summarized below. Most of these visits have not taken the form of a detailed survey, as the amount of attention given to each area has been determined largely by the nature of the problems encountered.

A.—New Ireland

This is one of the main problem areas and has received first priority in the agronomy programme. However, the New Ireland work has already been fully described in this Journal (Vol. 11, No. 4) and no further reference will be made to it here.

B.—Papua

Although the general standard of plantations on the south coast of Papua is good, most of them have patches of poor-yielding palms. Experiments by British New Guinea Development Company had shown that some response could be obtained from fertilizing, so it was decided to make a survey of the area with a view to laying down critical trials.

In 1956, the coconut agronomist visited most of the plantations on the south coast of Papua between Hisiu Beach in the west and Mullins Harbour in the east. This covered an area of more than 13,000 acres of coconuts.

Two main soil types are found on these plantations. On the coast and extending to about half a mile inland are soils derived from black sands. These cover an area of about 4,500 acres. Typically the soil has a black,

humic, loamy sand surface horizon, 6 to 12 inches deep, underlain by sand. Texture of the soil is usually fairly fine, but in patches it varies to a coarse sand and sometimes even to a coarse gravel. On one plantation, poor condition of palms appeared to be associated with coarseness of the parent material. On several plantations, there were patches of very poor palms planted on old grassland country, where repeated burning had no doubt exhausted most of the plant nutrients. However, palm stands generally on these soils are tall (60 to 80 feet) and healthy, yielding about half a ton of copra per acre per annum. Most of the palms are between 40 and 50 years old. There were also, on most plantations, patches of poorer-looking palms which could not be related to any obvious feature of the soil and it was considered that such an area would be a good location for a fertilizer trial.

A variation of this soil type found on two plantations has a black, sticky surface soil, probably due to formation under swamp conditions and a continuing tendency to water-logging. Nevertheless palms are fairly healthy.

In the Hisiu Beach area, with annual rainfall of only 50 inches and a well-marked dry season, copra production fluctuates considerably, but this is almost certainly an effect of water relations rather than of nutrient supply.

The second major soil type is an alluvial brown loam, which makes up about 6,500 acres of the planted area. Typically this soil is a friable, well-drained brown loam, with no marked horizon differentiation, but a gradual paling in colour over the first 18 inches. There is a tendency for the soil texture to grow sandier with depth, and in some places the loam merges into a fine sand at about 24 inches depth.

Palms on this soil also are mostly about 40 to 50 years old, well-grown (60 to 80 feet and taller on some plantations) and productive. However, there are some large areas of poor palms on most of the plantations. It was considered probable that in many cases this was a result of poor drainage rather than nutrient deficiency as all the areas are flat and low-lying, so that drainage is quite a problem. In view of this observation, it was decided not to place a fertilizer trial on one of these poor patches, but to choose a more or less average stand of palms for the soil type.

There are other soil types on these plantations, but it was considered that the small areas involved did not warrant the laying down of detailed trials at this stage.

C.—Gazelle Peninsula

No detailed survey has been made of plantations in this area, but several have been visited by the coconut agronomist. The main problems in this area are entomological and will not be discussed here.

The main agronomic problem is senility. Some of the plantations are very old. However, as many of the older palms are still carrying good crops, there can be little doubt that the soils are good enough for the old palms to be replaced without any fertility problem. Many plantations have dense kunai (*Imperata*) ground cover, which cannot improve the soil and certainly does not help in the finding of nuts. However, establishment of leguminous cover crops is a problem because of the giant snail.

Very large areas of coconuts in the Gazelle Peninsula are interplanted with cacao and, where these have been adequately maintained, both crops are doing well. However, the drain on soil nutrients from two crops in full bearing must be heavy, and there are some indications of possible nutrient deficiency on interplanted cacao that has been bearing for several years. Consequently, a fertilizer trial has recently been commenced on one such area. There are minor areas on the Gazelle Peninsula where palms are not doing well, but as yet it has not been possible to make any detailed investigations.

D.—Bougainville

This area has not been surveyed in detail, but the coconut agronomist visited several plantations in 1954-55. Soil types were varied, including coral-derived, alluvial and volcanic soils. Apart from a few areas where water relations were obviously unfavourable, the general impression was that the plantations were doing well and that there were no problems requiring urgent attention.

E.—Madang District

Several plantations along the mainland coast between Madang and Dylup (a distance of 45 miles), and plantations on Karkar Island, were visited in 1956.

Most of the coastline plantation area is on soil developed over koranas (loose decaying coral), though there are some patches of alluvium and other soils. Rainfall ranges from 140 to 170 inches per annum. A typical plantation has a fairly flat strip along the coastline, 100 to 500 yards deep, and behind this ridges rise sharply, so that most of the plantation is rough country with steep gullies. Generally there is about 12 inches of black, friable loam overlying koranas. Where the soil is deeper the surface loam changes to a sticky clay at 15 to 18 inches depth. Palms on the flats are productive and look healthy, but in the back area the palms are variable and are usually poor on the steep slopes. The shallow soil and uneven relief probably provide an adequate explanation.

The general impression of this area was that the plantations are up to the Territory average particularly for coral-derived soils. There are not the same problems as in New Ireland as there appears to be little development of the deep acid clay soils on which the worst decline has occurred in New Ireland.

Karkar is an island of volcanic origin, about 10 miles in diameter and about 40 miles distant from Madang. There is a coastal fringe sloping gently down to the sea. The soil is uniform, loose and loamy with numerous fragments of stone. Rainfall is in the range of 150 to 200 inches. There are about 15 plantations around the island with a total area of about 4,000 to 5,000 acres.

According to figures given by plantation managers, the average yield is about 14 to 16 cwt./acre/annum. This high yield is largely attributable to the uniformity of bearing throughout the plantations. Individual palms carry a good, but not exceptional, number of nuts. Nut size also is more uniform than is usual in the Territory and nuts are also bigger than average, with a copra out-turn of about 4,500 to 4,800 nuts per ton. It is considered that few agronomic problems are likely to be encountered on this island.

F.—Markham District

This district was visited mainly for the study of the Markham type of palm, which will be discussed elsewhere. It is not an important coconut area, but two commercial plantations, a number of village groves and some new plant-

ings were visited. All these are on alluvial soils, which vary from sands to loams and coarse gravels. Palm-stands also vary. Some areas are very poor, although most are good. The variation is almost certainly related to the variation in soil texture, but because of the limited area concerned, other more important problems have taken precedence in the experimental programme. No detailed study has been made in this area.

IMPROVEMENT OF EXISTING STANDS—FIELD EXPERIMENTS

A. Fertilizer Trials.

1.—*Sole Coconuts*

Comprehensive fertilizer trials were laid down on coconut plantations in New Ireland in 1955 and in Papua in 1957. The former trials have already been described in detail in this journal (Vol. 11, No. 4).

The Papuan trials are slightly different from those in New Ireland. Gypsum has been used instead of lime as a source of calcium. The soils are not acid and lime is not needed to sweeten them. Details of fertilizers and rates of application are as follows:—

Fertilizer.	Amount per acre.
Gypsum	4 cwt.
Sulphate of ammonia	4 cwt.
Muriate of potash	2 cwt.
Disodium phosphate	2 cwt.
Magnesium sulphate	2 cwt.
Copper sulphate	14 lb.
Zinc sulphate	14 lb.
Sodium molybdate	1 lb.
Trace element mixture comprising—	
Sulphate of iron	56 lb.
Manganese sulphate	28 lb.
Cobalt sulphate	2 lb.
Borax	28 lb.

The rates given are for a dressing to be repeated at two-yearly intervals. However, the sulphate of ammonia is applied more frequently, at the rate of 1 cwt./acre every six months. The use of materials such as disodium phosphate is simply for the sake of experimental purity. In normal practice, superphosphate would probably be used.

The design of the trial is of a complex nature but is arranged so that the effects of all fertilizers, individually and in their important combinations, can be accurately assessed. A total of 128 palms

is included in the trial and each receives a different fertilizer combination. The arrangement is such that, for instance, the effect of sulphate of ammonia is assessed by a comparison of the performance of 64 palms which received dressings of sulphate of ammonia with 64 which did not receive sulphate of ammonia. The same is true for each fertilizer tested. In technical terms, the design is a factorial, a quarter replicate of 2^9 , with eight sub-blocks of 16 trees each.

Two of these trials have been commenced on typical examples of the two main soil types described:—

(a) *Black Sand.*

The area selected carried tall, well-grown palms, most of them producing well. However, many of the palms showed pronounced yellowing of the foliage, while on the same plantation there were patches of this soil where the palms were in an advanced state of decline. Initial yield of the area was estimated at about 11 cwt./acre/annum, with a copra out-turn of about 4,900 nuts/ton.

Fertilizer was applied in October, 1957. It is too early yet for any response to be definitely detected.

(b) *Alluvial Brown Loam.*

Palms on the site chosen were well grown and healthy in appearance, as was typical on this type of soil. Initial yield of the area was estimated at about 12 cwt./acre/annum, with copra out-turn of about 5,200 nuts/ton.

Fertilizer was applied in March, 1957, but as yet there are no clear indications of response to any treatment. Comparing this result with that of the trial in New Ireland on yellow-brown clay, where a response to potash showed quite clearly after 18 months, it appears likely that there are no major deficiencies in this type of soil. Further yield records will be necessary to confirm this.

2.—*Coconuts Interplanted with Cacao*

As has already been stated, a trial is being carried out in the Gazelle Peninsula on a stand of mature cacao (10 years old) interplanted under coconuts, with no additional permanent shade.

The fertile soils of this area are normally well supplied with plant nutrients. However, an experiment on sole cacao at Keravat showed a

slight response to nitrogen and it is considered likely that any deficiency of this element would be accentuated under interplanting conditions, where there is no legume cover crop or shade tree. Chemical analysis of the soil also suggests that phosphorus could be low. Consequently both nitrogen (as sulphate of ammonia) and phosphorous (as superphosphate) have been used in this trial. Sulphate of ammonia was applied at two rates (1 and 2 cwt./acre/annum) and superphosphate at one rate (1 cwt./acre/annum).

The design of the trial is a 2 by 3 factorial with three replications. Plot size is nominally 16 coconut palms (4 by 4) but several palms are missing and spacing is somewhat irregular in places. Hence the actual number of palms a plot averages only 12.5. The numbers of cacao trees are also variable, ranging from 40 to 52.

Preliminary yield recording (counting of nuts on the palms as six-monthly intervals and counting cacao pods at each harvest) was commenced in January, 1958, and the fertilizer was applied in August. Some results may be evident, at least in respect of cacao yields, within the next 12 months.

B. Cultivation Trials.

The practice of cultivation in coconut plantations has never appealed to Territory planters, although there have been some definite reports from overseas of benefits from the practice. One good reason for the lack of interest in this country is the fear that under the high rainfall conditions in most areas the soil would become vulnerable to erosion.

Since in most soils the bulk of the palm's roots are to be found close to the surface, there can be little doubt that intensive cultivation, whatever its long-term results, would severely set back the palm at first by cutting a large proportion of its roots. Two treatments were therefore used in experiments—strip ploughing and disc harrowing. Strips 10 to 15 feet wide were ploughed down the centre of alternate rows and the treatment was repeated as yearly intervals, alternating the rows which were worked. This treatment should have achieved the moderate "root pruning" which some authorities claimed to be beneficial. The aim of the disc harrowing was simply to break up any surface crust on the soil and to turn the cover crop in as a green manure. This treatment was repeated every six months.

One such trial, laid down in New Ireland in 1956, has already been described in this Journal (Vol. 11, No. 4). A similar trial was commenced on the Government Plantation at Baibara, Papua, in March, 1957. This trial is located on a typical brown alluvial loam soil. Cattle are grazed in the area, which has a predominantly grass cover. As there is both a lighter soil and a lighter cover crop, the operations have been more successful than in New Ireland. Ploughing has been satisfactory, but the harrows do little more than scratch the surface. It has been noticed, however, that kunai (*Imperata*) grass, which previously was scattered through the area, has been very much reduced by the harrowing.

On this experiment, the nuts are being collected and counted after falling, instead of on the palms. Consequently any response to the treatments will be slower in showing up. Analysis of yield records up to October, 1958, shows no response evident as yet. Yield in the first 12 months was about 12 cwt./acre.

C. Maintenance Trial.

This trial, located at Baibara, is designed to assess the comparative costs of three different methods of cover maintenance, as well as to observe how effective each method is from the point of view of finding nuts and of eliminating undesirable plant species.

The three methods compared are cattle grazing, tractor and drag, and handslashing (this last being the most common method used through most of the Territory). Each method is being tested on blocks of approximately 35 acres.

The original cover was a dense mixture of grasses, mainly kunai (*Imperata*), thurston (*Paspalum conjugatum*), couch (*Cynodon* sp.) and *Paspalum paniculatum*; sensitive plant (*Mimosa pudica*); "clover" (*Desmodium heterophyllum*); *Centrosema pubescens* and scattered clumps of fern. Some changes in the botanical composition have occurred under the different treatments.

Cattle grazing has reduced the *Imperata* and *Paspalum paniculatum* but the amount of fern has increased. With dragging, the *P. paniculatum* has greatly increased and in patches it completely dominates the other grasses, while *Centrosema* has also become more prominent in other places. The handslashing has caused little change, although there may have been some increase again in *P. paniculatum*.

Concerning effectiveness of the treatments, cattle grazing, if sufficiently intense, will keep the pasture very short so that nuts can be found with the greatest of ease. However, the bulk of pasture growth is much greater in the wet season than in the dry, so that the number of cattle which could be carried in the dry season would not be able to handle the wet season flush of growth. It would probably, therefore, be essential to cut the cover by hand or machine at least once a year. The drag also helps in finding nuts, as it collects all that lie in its path and carries them along for some distance before finally lifting over them and leaving them in a heap. However, there appears to be some tendency for the building up of a dense mat of organic matter on the surface which is very slow to decompose.

Costing of grass maintenance by cattle grazing is fairly complicated and has not yet been calculated. Handslashing, with the usual task of 40 rooms per labourer per day, costs 8s. to 10s. per acre per operation. Cost of dragging at Baibara varies from about 7s. to 12s. per acre per operation, depending on weather conditions, as control of this type of cover requires the use of a heavy drag (a heavy hardwood log squared and faced with angle iron on the leading edge). When the ground is wet and sticky the operation is inefficient. Thus on Baibara cost of mechanical maintenance is similar to that of handslashing, since both operations need to be repeated at about the same intervals. It may be noted, however, that on plantations with a good legume cover crop, a lighter drag would give satisfactory control and thus lower costs.

D. Replanting Trial.

Some Territory plantations have now reached the stage where productivity is declining because of old age, and many more are approaching that stage. Consequently, if overall productivity is to be maintained, many old stands will have to be replanted within the next 10 to 20 years.

In an attempt to minimize costs of replanting, a technique is being used in Ceylon where some of the old palms are left standing until the replants come into bearing. As yet no very definite results have been published on this work and in any case labour conditions are so different in Ceylon that their findings would not apply directly to the Territory.

Consequently, experiments are being commenced to determine the usefulness of this system for our local conditions. The method is to plant seedlings in the centre of the rooms between the old palms and to thin out the old palms to some extent to allow light to enter and to reduce root competition. In the experiment, different degrees of thinning are being used with the following proportion of palms being removed—0, 25, 50, 75 and 100 per cent. To gain accurate results a large area has to be used. The trial involves a block of 2,000 palms, of which approximately 1,000 have been cut out. The trial is a simple randomized block design, with four replications of the five treatments. Plot size is 36 palms (6 by 6) with a double guard row receiving the same treatment, thus bringing the plots to 10 by 10.

The trial was marked out at Baibara in April, 1958. Yield records are to be kept of some palms in all plots, as it is anticipated that there will be some increase in yield of the remaining palms where the stand has been thinned and this should compensate to some extent for the reduction of palm numbers. Felling of the old palms and planting of the new seedlings was carried out in September-October, 1958. Final results from this trial will probably not be obtained for at least ten years, but it is anticipated that differences in growth rate of the seedlings under different levels of thinning will show up quite early.

One point which already emerges from this trial is that by far the greatest expense in the replanting programme comes from the cost of disposal of the old palms. These must, of course, be destroyed or they will provide breeding sites for insect pests. The palm trunk does not burn readily and has to be cut into lengths, split and stacked to dry before it can readily be disposed of. This is likely to prove almost as expensive as the clearing of virgin bush, and planters might be well advised to consider carrying out replanting over a long period and offsetting these costs by using the palm trunks as drier fuel.

A similar type of trial, but on a smaller scale, is being carried out in New Ireland, the area having been marked out in June, 1958. The palms on this site are not as healthy as those at Baibara, and therefore do not throw so dense a shade. It is to be expected, therefore, that

the two trials will give somewhat different results, but together they should provide information applicable to most types of palm stands in the Territory.

E. Interplanting Trial.

In 1955, an experiment was commenced at Keravat to compare the costs of establishment of sole cacao, cacao interplanted under coconuts and sole coconuts. Ultimately the trial would also show the comparative returns from the two crops grown separately and in conjunction.

For interplanting, it is essential that the coco-nuts be well established before the cacao is planted, otherwise the palms would be shaded out by the quicker-growing *Leucaena*. In addition it is desirable to have the coconuts provide a large portion of the shade for the cacao. The actual stage at which interplanting could be commenced would be judged as the trial proceeded, but the coconuts would probably need four to five years' start.

The experiment has been unsuccessful, however, in its first aim at least, because of the very heavy rhinoceros beetle (*Oryctes rhinoceros*) population in this particular locality. Despite daily inspection of the seedlings and insecticidal treatments, a high proportion of the seedlings was killed in the early stages and most of the rest have been severely set back. However, in the last 12 months, those palms which survived the first two years have come away fairly well, and new methods of insecticidal treatment give promise of adequate control of the insect (though probably at costs which would be uneconomic for a commercial grower). The missing palms are being replaced, and it is hoped that the trial may eventually be established satisfactorily. However, the costs will bear no relation to normal expectations.

PROVISION OF IMPROVED PLANTING MATERIAL.

As stated in the introduction of this report, the results of an experiment in Ceylon discount the effectiveness of the traditional method of coconut improvement by mother palm selection. Some alternative method is therefore needed and after careful consideration it has been decided that the most effective approach is by progeny testing.

Progeny Trial

The reason why mother palm selection may be ineffective, is that the performance of a palm is dependent on many factors other than its inherent qualities. The environment in general probably has a considerable influence on the palm's performance as soil conditions and competition with surrounding palms are highly variable and a setback in the first few years of life (as by insect damage) probably influences the whole future performance of the palm. Consequently, palms which we select as high yielding probably owe their superiority to their environmental situation rather than to inherent factors. When it is also remembered that the male parentage of seed from selected palms is unknown, it is not surprising if this seed is only of average quality.

This is a similar problem to that faced by animal breeders and the most effective solution that has been devised is that of progeny testing. The merit of the parent is not judged from its own performance, but from the performance of a large number of its progeny. The same technique can be applied to coconuts, although the disadvantages are a longer waiting period for results and the fact that large areas of land are necessary, since 40 to 50 progeny palms must be used to give a reasonable assessment of the value of the parent. On the other hand there is the advantage of the longer life of the parent palm.

A trial was initiated at Baibara in April, 1957. Twenty palms of representative types, from a single block of the plantation, were marked, and detailed records of their performance are being kept so that it can ultimately be checked whether the parent yields do bear any relation to progeny yield. Nuts from these palms were planted in a nursery, and notes have been made of their germination and early growth. Already differences between progenies, probably inherent, have been observed at the germination stage. The average for the 20 progenies, up to May, 1959, was 77 per cent. germination, but individual progenies varied from 50 per cent. to 96 per cent. Of the 20, nine representative types were chosen for the actual trial. This number is small, but one may expect to find among them two or three above-average parents. The limitation on number is due to the area involved.

With nine progenies, the trial covers 11 acres, and anything larger than this might reduce too greatly the accuracy of the experiment, because of soil variability.

The design of the experiment is a 3 by 3 balanced lattice with four replications. Plots are of 12 palms (4 by 3). To reduce edge effects the trial area is surrounded by a single row of guard palms.

Half the seedlings in the trial were transplanted in May, 1958, but very dry weather in the months that followed set them back and nine per cent. had to be replaced in October. Continuing dry weather prevented the planting of the remaining half, but it is hoped soon to be able to complete planting.

The next step in the programme, after choice of the best parents, has not yet been decided. Obviously two or three palms will not provide enough seed to be of any direct benefit. However, the same inherent qualities are to be found in the pollen as in the nut, and it might be possible to use this to produce seed in moderate quantity by hand pollination. Seed from the proven parents, obtained from controlled pollinations, could be used to plant up an isolated seed garden from which superior seed would ultimately be obtainable in fair quantity.

Testing of Local Strains.

Another possibility for improved planting material is that there may exist already in the Territory some coconut strains which are above average. Seed from certain localities or plantations, such as Baibara and Karkar, is reputed to be superior, but no accurate comparisons have been made of the performance of palms from these seed types grown together.

An experiment is now being laid down at Keravat to compare the performance of seed from several important areas through the Territory. Seed for the experiment is collected, completely at random, over a fairly large area of a representative plantation, so that it should be typical of that plantation as a whole. This trial is being planted on a newly cleared block some distance from the main planted area of Keravat and a few hundred feet above sea-level, where it is hoped to escape serious *Oryctes* damage.

Final results of this trial can not be expected in less than ten years, while the progeny trial will probably take much longer. In the meantime, it is recommended that growers should concentrate on nursery selection of seedlings for new plantings.

SEEDLING SELECTION.

It was shown in the Ceylon experiment discussed above that nursery-selected seedlings produce earlier bearing and higher yielding palms than did unselected seedlings. Selection is based on two criteria—earliness of germination, and vigour and appearance at the four-leaf stage (about six months old). At the first stage, all seeds which have not germinated within a reasonable period should be rejected. The actual period cannot be stated precisely since rate of germination is influenced by weather conditions. However, a suitable criterion would be to discard all ungerminated nuts as soon as the first 70 per cent. have germinated. At the four-leaf stage, seedlings are selected on colour, size and number of leaves, leggy or unhealthy looking seedlings being rejected. Up to 50 per cent. of the initial seed may be rejected. This makes the seedlings somewhat expensive, but the expense will be more than justified by future performance. The principle is that vegetative vigour is generally quite closely related to yielding ability and the method of seedling selection is simply an early selection on the basis of vegetative vigour.

PALM TYPE COLLECTION.

A collection of different types of palms from all over the Territory was begun at Keravat in 1954, as a possible source of breeding material and for general genetical research. However, this collection, like the palms in the interplanting trial, has been largely frustrated by the activities of *Oryctes*. Less than half the palms planted initially still survive, and the variable damage inflicted on the palms makes it impossible to compare such characters as time of maturity and vigour of different types.

Markham Type Coconut

The Markham type nut is characterized by a very large fruit. A block of these palms was planted at Keravat pre-war, of which a few still survive. These palms were observed to be

variable, many having only normal-sized nuts, but it was not known whether this was due to variability of the strain or to lack of care in obtaining the original seed.

In 1956 the coconut agronomist visited the Markham Valley to try to determine whether the type of nut is growing anywhere there as a pure variety. One European plantation and many native groves were visited, but although a number of individuals of the type were found, they were nowhere present in a pure stand.

A cytological study was made of one palm at Keravat to determine whether the large size of the fruits might be a result of polyploidy. Chromosomes were counted at meiosis, but the number proved to be the normal diploid ($2n = 32$).

Dwarf x Tall Crosses

Work in both Ceylon and India has shown that there may be some commercial possibilities in the use of hybrid seed obtained by crossing dwarf palms with the ordinary tall variety.

Experiments with such crosses at Keravat are impeded by the lack of any mature dwarf palms on the station, although some should come into

bearing within a year or two. However, we are grateful to Coconut Products Limited for permission to make crosses on dwarf palms, imported from Fiji, growing on Ralabang Plantation. In February, 1957, 13 flowers were pollinated with pollen from a Markham type palm growing at Keravat and four of these reached maturity. These were harvested in January, 1958, but only two have germinated and one of these is extremely weak.

In July and August, 1958, 33 more pollinations were made, again with pollen from Markham palms. From these, eight nuts reached maturity and were planted in August, 1958, in the nursery at Keravat. All eight have germinated and are growing well.

Bubia

A number of progeny rows from Markham type palms growing on a local plantation have been planted at Bubia (near Lae). These are now about four years old, and doing well.

There are also some seedlings, about two years old, from Fiji. These are progeny from hybrid dwarf palms, bred by Mareschal in 1928.