COCONUT RESEARCH IN MALAYA*

UP to the time of the formation of the Rubber Research Institute of Malaya, the main activities of most of the research divisions of the Malayan Department of Agriculture were necessarily confined to the investigation of rubber problems. Coconut investigations, however, formed a main line in the Divisions of Economic Botany and Entomology long before the inauguration of the Rubber Research Institute and since 1920 much work has been done on coconut research by the officers of these Divisions. When the rubber work of the Department was taken over by the Rubber Research Institute, other Divisions devoted more time to coconut problems, so that at the present time this crop is receiving a considerable amount of attention as regards research necessities.

In 1920, the Division of Economic Botany commenced taking individual yield records with a view to studying variation in individual palms. In 1922, an Experimental Coconut Plantation of 50 acres was started between Klang and Port Swettenham and planted up with seed nuts of known origin.

The study of variability in coconuts by the Division of Economic Botany up to date has shown that as regards fruiting qualities, the co-efficient of variation in the number of nuts produced per annum is as high as 34% of the mean production per palm under average estate conditions. The study of variation has also revealed the fact that 19% of the palms on the average estate are unprofitable. Fruiting characters of individual palms have been found to be definitely constant over a period of eight years and no doubt this constancy also exists as regards the oil content of copra from individual palms within the range of seasonal variation. Investigations on this point are already in hand by the Chemical Division.

The entomological work from 1920 onwards included investigations into the life history of the more important pests of coconut palms and the following special bulletins have been issued:

(1) The Two-coloured Coconut Beetle (*Plesispa reichei*).

(2) Red-Stripe Weevil of Coconut (*Rhynchophorus schach*).

Further considerable work on the Black Beetle (*Oryctes rhinoceros*) and the influence of *Tirathaba rufivena* (Greater Spike Moth) on immature nut-fall has been undertaken.

The study of diseases of coconut palms was under investigation during the days of intensive rubber work but after 1926 this work was considerably accelerated. The work was mainly concentrated on the elucidation of the so-called "Bud-Rot" problem. In 1922, a paper was published in the Annals of Botany describing inoculation experiments which led to the conclusion that the problem had not been finally settled and that, as far as Malaya was concerned, the whole subject needed reinvestigation. Numerous articles on coconut diseases have since been published and in 1928 a special double number of *The Malayan Agricultural Journal* was published giving the results of the work up to date. The important results may be summarised as follows:

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* By A. Sharples in *The Malayan Agricultural Journal*, Vol. XVIII, No. 2, February 1930.

(1) No evidence has been found to support the suggestion that a form of epidemic Bud-Rot, caused by parasitic organisms, exists in Malaya.

(2) That Lightning is of primary importance in the question of so-called Malayan Bud-Rot and probably of other affections.

(3) That *Merasmius palmivorous n.s.* plays a rôle of some importance in so-called Bud-Rot manifestations in Malaya.

In 1928, a report entitled Copra Manufacture, by H. C. Sampson, was received in which he reviewed the present Empire position with regard to quality of copra and the possibility of improving the quality, with suggestions as to the relevant lines of research and the place where the work could be best undertaken. The report suggested *inter alia* that "Malaya seems to offer the best scope for carrying out this work for not only is copra becoming of increasing importance as an export from there, but the country probably has better facilities in the way of staff and equipment than is possessed by other colonies interested in this matter. It would be a much better country than Ceylon since the climatic conditions in the main coconut growing districts of that island much more closely resemble those of the West Coast of India where sundrying is largely practised.

As the matter was of considerable (Imperial) importance economically, the Empire Marketing Board, after consultation, expressed their willingness to provide a contribution towards the cost of the Research, an offer which the local administration accepted. The more immediate work on copra research obviously demanded study from the chemical point of view, and arrangements for the special appointment of an Assistant Chemist for Copra Research were made on the initiative of the Empire Marketing Board. The appointment was filled, and this officer assumed duties in October, 1929.

The question of the appointment of a Copra Research Chemist was under discussion when the Director of Agriculture arrived in Malaya in 1929. The Director of Agriculture suggested the formation of a Departmental Copra Research Committee, with the object of correlating the various lines of work in progress, and making suggestions for its extension on properly co-ordinated lines, the Head of Divisions to sit as members with the Government Mycologist as Chairman. This Committee held its first meeting on April 14th, 1929, and made a number of recommendations relative to the desirability of collecting information on the subject of copra manufacture in Ceylon and the marketing of copra in England. As a result, the Government on the recommendation of the Director of Agriculture approved :

(a) Of an officer being deputed to obtain informaton as to the market standards required by copra dealers in England and data concerning other factors in influencing the price of copra on the English markets. A report on this subject has been lately submitted by the officer in question (Mr. D. H. Grist, Agricultural Economist).

(b) Of an officer being deputed to visit Ceylon with a view to obtaining information relative to manufacture of copra in Ceylon, for purposes of comparative study. Subsequently, a schedule was submitted by the Committee to the Director of Agriculture indicating various additional lines of work which appeared to offer prospects of yielding useful information.

A considerable amount of useful research work on copra had already been achieved by the Chemical Division. This work comprised particularly :

(a) Analytical comparison of the composition of Malayan copra with Ceylon and Malabar copra.

(b) Studies of variations in oil content of copra from selected palms. This work was being carried on in collaboration with the Economic Botanist.

With reference to (a) the work so far performed appears to indicate that commercial Malayan copra is of lower oil content than copra from Ceylon and Malabar, but this result required confirmation by further analyses. In the opinion of the Acting Agricultural Chemist the alleged inferiority of Malayan copra may be largely due to climatic causes. Efforts, will, therefore, be made to obtain further information on this point by importing seed nuts from Ceylon and Malabar, and by making enquiries in this country to ascertain whether any seed nuts have ever been imported from Ceylon, in addition to those at Klang Experimental Station, the trees from which are not yet in bearing. As a result, a provisional outline programme of work on copra research was formulated as follows. This programme may be subject to modification as experience is gained.

(a) The Assistant Chemist for Copra Research on arrival in Malaya should in the first place undertake a series of tours through the Malayan coconut districts with the object of obtaining a general knowledge of the various conditions associated with the coconut industry. These have already been commenced.

(b) After the preliminary survey, a detailed study of the production of copra stage by stage would be commenced. The following items indicate the more important lines to be followed:

1. Systematic comparative analysis of native and estate copra from different districts in Malaya, Borneo and Sarawak.
2. Examination of further samples of copra from other countries, *e.g.*, Ceylon and Malabar and a detailed comparison of actual nuts from Ceylon, Malabar and Malaya . . . also microscopic comparison.
3. Laboratory experiments on the colour of soap produced, and the bleaching properties of coconut oil derived from copra from different sources . . . these tests are used in the soap and edible oil industry for grading oils.
4. Structural examination, radially and tangentially, of nuts of various shapes, sizes and states of ripeness in order to determine the best sampling position to be adopted in the succeeding work.
5. An elaborated examination including tangentially sectioning of under-ripe, ripe and over-ripe nuts derived from two high-yielding and two low-yielding palms.
6. The same from a palm yielding uniformly small nuts, and one yielding uniformly large nuts.
7. The same from palms of different ages, and also of different types. . . in conjunction with chemical analysis of soils and fruits.
8. Thinning out the flowers or young fruit to note the effect on the yield and oil per cent. of copra.
9. A study of tapping for toddy, noting its effects on yield and oil per cent. of copra.
10. An elaborated study of the structure and growth of coconuts obtained by dating individual nuts, immediately the spathe opens, and by picking individual nuts daily between 200 days and until natural nut fall commences, including microscopic examination and free fatty acid determination.

The basis of comparison between the individual nuts will be the "ripeness factor" or "total oil per unit area of meat." (Oil % Wet × Thickness of Meat × Sp. Gr. Meat) which will, it is anticipated, effectively overcome individual differences in shape, size, meat thickness and erratic development of the nuts examined. In this connection, neither total oil nor oil percentage (dry) is considered here an effective method for studying nut development.

11. Bulk determination of the total oil derived from 100 ripe ungerminated nuts and 100 partially germinated nuts and 100 young nuts, and the same for nuts kept one, two and four months longer before opening.
12. The preparation of a comparative statement of the picking systems in vogue on different plantations and the copra obtained (quality copra and oil yield per 1,000 nuts).
13. An examination of the working costs of different methods of collection and estate transport and the effect, if any, on the copra obtained.
14. The preparation of a comparative statement of the Capital Cost, Maintenance and Repair Charges, Life of Plant, Labour Costs, Capacity, Speed and Efficiency of existing driers and of the proprietary driers at present on the market.
15. A comparison of the working temperature and humidity conditions; and of the colour, structure and quality of the copra obtained by the existing methods: Sun-drying, smoke-drying, simple hot air drying, and chulu drying and also of perfect copra obtained on a small scale under laboratory conditions.
16. The effect of washing the meat in water, 2% formaldehyde, hypochlorite or sulphurous acid before drying.
17. The effect of 'sulphuring' during drying.
18. The effect of the size of coconut meat on the rate of drying and subsequent mould formation.
19. Small-scale experiments in burning coconut shell, using forced draught . . . consideration of the use of a gas producer as a source of heat.
20. Small-scale laboratory experiments under varying conditions of drying, noting structure and physical condition of resulting copra.
21. The effect on mould formation, of chopping the copra after drying.
22. A study of the storage of the different types of copra from different sources under warehouse conditions, noting variation in oil, free fatty acid and moisture.
23. A study of the maintenance of low moisture content, or its fluctuation under conditions of varying humidity for copra of different physical structure.
24. A study of mould, free fatty acid formation and insect attack under varied conditions of temperature and humidity.
25. A comparison of clean and mouldy copra from the same source.
26. The effect of mixing (on a 25%, 50% and 75% basis) of estate with native copra, noting results.
27. A study of the temperature and humidity conditions in a copra cargo boat with a view to possible improvements.

28. The actual preparation on a large scale of copra containing 72% oil and a comparison between it and that derived from Ceylon and Malabar, and the working oil and copra yield per 1,000 nuts.

In addition to the above, a considerable programme of research work on coconuts is in hand in the various Divisions of the Department. The following may be mentioned:

(a) The selection and breeding of improved strains of coconuts.

(b) Manurial and cultivation experiments.

(c) Pests and diseases of coconuts.

(d) Catch crops and cover crops in coconut cultivation.

The preliminary work on the structure of the coconut fruit has been started and although only a few months have been spent on the work, important subsidiary indications have been obtained.

Variation in oil content has been studied in (a) for different nuts and (b) for different parts of the same nut.

The results for (a) show that a considerable variation exists in oil percentage (D.B. = dry basis) in pieces of meat derived from nuts normally picked on Malayan estates as shown by a range from 45% to 75%. The copra resulting, from which the individual pieces were picked, will probably show the same variation; this indicates that there is considerable room for improvement if a more uniform product with a higher average oil content can be produced.

The results for (b) show considerable difference in oil percentages in pieces of meat from different parts of the same nut, most particularly in nuts not fully ripe. This throws considerable doubt on the utility of any nut sampling which has been done in previous experimental work when the state of ripeness has not been specified and when the sampling has been done at random.

Experiments in the selection of the best sampling position have shown that it is desirable to take samples near the middle of the nut and not from the ends where extreme differences are found. Further, when tangential slices are examined, and oil gradient has been determined, with the lowest oil percentage on the inside face of the meat gradually increasing in value as slices are taken nearer the shell. In these preliminary experiments, the difference in oil percentage of a 1/10 inch slice of meat from the inside face as against a similar piece nearest the shell seems to show a fairly constant difference of 38%-40%. This applies only for a ripe ungerminated nut; the meat from nuts containing a germinating embryo does not show this oil gradient.

The effect of ripeness on oil yield has been studied fairly extensively and the results show that there is an increase in oil percentage as the nuts germinate and become over-ripe. In the samples examined, an average increase in oil percentage was found, from 63% when the nuts were considered to be ripe, up to 72% when the nuts held a germinating embryo 3½ inches in diameter. This result confirms the studies made by analysing tangential and radial slices of meat. This finding may have some significance in the question of the apparent superiority of Malabar and Ceylon as compared with Straits copra, if it is correct that, in Malabar, the nuts are allowed to fall naturally, while in Ceylon there is a longer ripening period and the nuts are kept for a considerable period after plucking. The question of whether the total oil in the nut continues to increase after the nut is considered to be ripe has still to be determined, but it appears that the best plucking age will be an important economic factor, if copra should ever be valued according to oil content.

Further work on copra deterioration has been done and it has been shown that badly deteriorated samples of native manufactured copra may show the remarkably high average oil content of 67·2% which is 2% in excess of the average for large good quality samples of Malayan estate copra.

During deterioration it may be accepted that the total oil content is diminished owing to the degradation of the actual oil containing meat, which will result in a nett loss in weight of copra, by agencies, such as moulds, insects and heat. But it is a fact that such copra when analysed may show a high oil percentage content with usually a high development of free fatty acid.

The preliminary experiments have provided very interesting results and confirmatory and extensional experiments are being carried out.

A comprehensive scheme of research work on coconuts has been proposed in Ceylon, and a special research station for this crop is being organised in that country. Copra research work is also being undertaken at the Biological Station, Slough, attached to the Imperial College of Science and Technology, London, Malaya and these stations. Every effort will be made to maintain touch with all research stations undertaking coconut research work, as lack of such co-operative effort often leads to unnecessary duplication of effort.

It is proposed that a half-yearly report on the progress of the copra research work will be published and so soon as sufficient experience has been obtained and the work of the Copra Research Chemist has become established along sound lines, definite proposals for the erection of one or more experimental driers will be put forward. The results of completed pieces of research will be published as bulletins of the Department of Agriculture, while summaries thereof will appear from time to time in *The Malayan Agricultural Journal.*