THE COPRA INDUSTRY:

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PART I.

Although the present copra situation has been the subject of much serious consideration and discussion, no real solution to the problem appears to have yet been evolved. Coupled with any solution, there are many difficulties although none which are insurmountable. In this article a scheme for the improved and more substantial establishment of the copra industry is suggested. The scheme is designed not only to relieve the present situation but to prevent its future recurrence. Only an outline of the scheme is presented in this article but at a later date it is proposed to deal in greater detail with particular aspects, especially plant and production costs.

The basis of the scheme is—

(1) The cheaper supply of coco-nut oil.
(2) The marketing of the oil in three distinct grades—an "edible grade", a "soap grade" and a "fuel grade".

The Cheaper Supply of Coco-nut Oil.

This can be brought about by—

(1) Carrying out the extraction locally.
(2) Employing the most efficient and cheapest possible means of extraction without regard to the nature of the by-products produced.

The local extraction of oil will no doubt meet with much opposition from shipping companies and those manufacturers of soap and margarine who have dealt with our copra in the past. Such opposition, however, will be of less consequence now than in normal times, and can be overcome.

1. The chief advantages of extracting oil locally are enumerated below:

(*a*) *Cheaper Methods of Extraction.*—The plant required for the extraction of coco-nut oil is most expensive and when once installed is generally required to remain in use for many years before any thought is given to its replacement by more modern means of extraction. As this plant becomes worn and out of date, the cost of extraction continually increases in comparison with the cost of extraction for the most up to date plants equipped with all kinds of automatic devices. This is the state of affairs with regard to the plants which treat much of New Guinea's copra.

If copra were milled locally, only the latest plant would be installed and either a slightly higher price could be paid for copra or, which is more important at the present time, a cheaper product could be marketed.

(*b*) *Cheap Labour.*—In New Guinea, native labour may be obtained for about 6s. per week per man. The hours worked per day are long and there is no loss of time due to daily "smokos" or strikes.

The amount of work performed by a native labourer is not equivalent to that performed by a white man and depends largely upon the kind of work required. Consequently the subject can be dealt with more conveniently under "Production Costs" where the number of men required for each portion of the process will be discussed.

For clerical or more important positions in the mill, Chinese or Malays can be employed for £2 to £3 per week.

(*c*) *A Better Quality Product.*—The quality and value of coco-nut oil depends largely upon the condition of the copra at the time of milling, the highest grade oil being obtained from fresh, well-dried copra. Thus, if copra were milled locally, when it is still fresh, a higher grade oil would result than if it were milled some months later, after shipment overseas.

Copra which has not been dried sufficiently becomes mouldy on standing. The moulds tend to decompose or hydrolize the fats in the copra with the result that the oil, after expression contains free fatty acids, becomes rancid quickly and acquires a dark yellow colour and bad odour. Coco-nut oil, containing free fatty acids which increase in amount when the oil is stored, has to be refined before it is suitable for the manufacture of edible products and this entails additional expense. Furthermore, it has been stated (Walker, The Philippines) that an oil which has been rancid and later refined becomes rancid again more readily than oil that has never shown rancidity. Hence, it is seen that a better quality oil will be obtained from copra which tends to be underdried, if it is milled shortly after it is made and not allowed to remain in storage for some weeks or months in a warm, moist atmosphere prior to and during transport overseas. However, the intentional underdrying of copra should not be tolerated.

In order to obtain a high quality oil suitable for use as food, the copra should not be subjected to any preliminary steam heating before extraction. In places outside the tropics, coco-nut oil is normally in a solid or semi-solid state, and when the copra is pressed or expelled without preliminary heating, the yield of oil is small. The meal is then generally steam heated, after which it is again subjected to further treatment, when the bulk of the oil is obtained. The first oil is of much higher quality than the second fraction.

In New Guinea, coco-nut oil is always in the liquid state and if the oil were extracted locally, the total quantity of high quality oil obtainable in the first treatment would be much higher than if the extraction were carried out in a temperate climate where the oil is in a solid or semi-solid state. Furthermore, less steam would be required, less material would need rehandling and there would be a general reduction in the cost of extraction.

When extraction is not carried out by pressure or expulsion, the physical state of the oil is not so important.

(*d*) *Reduction in Shipping Costs.*—Copra contains about 65 per cent. oil, and to bag one ton there are required 14.5 bags weighing approximately 36 lb. Hence, to export one ton of oil as copra the total weight of material to be shipped and the amount of shipping space required is—

$$\left.\begin{array}{l}\text{Total weight to be shipped} = 1\tfrac{1}{2} \text{ tons} \\ \text{Shipping space required} = 117 \text{ c. feet}\end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

If the oil were extracted in New Guinea, and shipped in 44-gallon oil drums each weighing approximately 50 lb., then to export one ton of oil the total weight of material to be shipped and the amount of shipping space required would be—

Total weight to be shipped = $1\frac{1}{8}$ tons
Shipping space required = 53 c. feet ..... (2)

If the oil were shipped in bulk,* to export one ton of oil, the total weight of material to be shipped and the amount of shipping space required would be—

Total weight to be shipped = 1 ton
Shipping space required = 39 c. feet ..... (3)

By comparing (2) and (3) with (1), the reduction in weight, capacity and hence shipping costs when oil is shipped in preference to copra is seen to be most marked.

To export one ton of oil as copra, 22 copra sacks at a pre-war value of 15s. are required. To export one ton of oil in 44-gallon drums, $5\frac{1}{2}$ drums at a pre-war value of £5 are required. Thus the cost of containers for exporting oil as copra is less than when the oil is exported in drums, but it must be remembered that the drums can be used over and over again and have a high resale value whereas second-hand copra sacks are of scarcely any value except, perhaps, within the Territory. Copra sacks will always be required for inter-territorial use and for this purpose bags may be used over and over again until they are worn out.

If oil were exported in drums, and oil for edible purposes would probably have to be exported in this manner, many thousands of oil drums would be required. It would be expensive importing empty drums for this purpose and the number of drums which could be imported full (i.e., containing petrol, &c.) is limited. However, it has been stated that there are large iron deposits on the mainland of New Guinea and New Britain. If this is so, a small industry might even be developed for the local production of oil drums.

It may be argued that when copra is exported its value depends not only on its oil content but also on the copra cake it contains. It will be shown later, however, that under present conditions, copra cake has a higher value as a fertilizer within the Territory than as copra cake on an overseas market.

(*e*) *No impoverishment of the Soil.*—In normal times, the amount of copra exported from this Territory annually is approximately 75,000 tons, and of this amount 26,250 tons are used in the manufacture of copra cake. This copra cake would contain approximately—

Nitrogen	500 tons.
Potash	250 tons.
Phosphoric Acid	125 tons.

Now 75,000 tons of copra = dry meat from 380,000,000 nuts;
= annual yield from 9,500,000 palms;
= annual yield from 200,000 acres, approximately.

(According to Dwyer, *Gazette*, Vol. 2, No. 2, there are 198,051 acres under coco-nuts in New Guinea.)

* The greater proportion of coco-nut oil shipped from the Philippines to the United States, Japan and Europe is sent in bulk. As coco-nut oil solidifies at about 70° F., it is necessary to provide heating pipes in the tanks of the steamers, in the steel storage tanks at the docks and in tank lorries used for distributing the oil, for the purpose of heating the oil before removal.

There is thus an annual drain on plantation soils of approximately—

Nitrogen	$5\frac{1}{2}$ lb. per acre
Potash	$2\frac{3}{4}$ „ „ „
Phosphoric Acid	$1\frac{1}{2}$ „ „ „

due to the amount of copra cake exported (losses due to loss of shell and husk on some plantations are not taken into account). Coco-nut soils in New Guinea are not very rich soils, an average analysis giving—

Nitrogen	.25 per cent.
Potash	.13 „ „
Phosphoric Acid	.15 „ „

and their impoverishment due to the copra cake (coco-nut oil does not impoverish the soil) exported is a matter of vital importance, as proved by the fact that, although little over 40 years old, many plantations in this Territory are already showing a decline in yield. This state of affairs can only be remedied by returning to the soil the nutrients which have been taken from it. It would be expensive to import fertilizers for this purpose, but if the copra were treated within the Territory it would be a simple matter to return to each planter approximately 1 ton of copra cake for every 3 tons of copra treated, and thus arrest further impoverishment of the soil.

Copra cake for use as a fertilizer should contain a minimum amount of oil and such a cake is produced when extraction is carried out by the solvent process.

2. The extraction of coco-nut oil involves two essential phases:—

(1) the disintegration of the copra or fresh meat,

(2) the separation of the oil.

Modern methods of disintegrating copra vary little in principle, but there are five distinct processes for the separation of the oil. In the last two, fresh meat may replace copra when a water-white oil of exceptionally high quality is obtained. The processes are as follows:—

1. *By Primitive Native Methods.*—The commonest of these methods have been described by Copeland in "The Coco-nut".

2. *By Hydraulic Presses.*—Until recently, the common method of extracting oil was by means of large, powerful, hydraulic presses. Generally there is first a cold pressure to produce oil of the best quality suitable for edible purposes, and then a second pressure after the oil has been treated with steam. Sometimes the disintegrated copra is subjected to a preliminary heating before both extractions. Details of this process are given in Volume 5, Number 1, Page 32 of this *Gazette*.

3. *By Expellers.*—A more recent method of oil extraction is by means of expellers. Working with presses, there is an interruption as often as a fresh charge is required, but the action of an expeller is continuous. The expellers have not been made to effect as perfect an expulsion of the oil as a press, and frequently the meal is pressed after it leaves the expeller. Details of this process are also given in the above mentioned issue of the *Gazette*.

4. *By Bacterial Action.*—The compression process of recovering oil from copra tends to be wasteful and inefficient. However good the compression a proportion of the oil-containing cells always remains unbroken. A more efficient method would be to dissolve or decompose the cell walls and thereby liberate the oil. A bacterium, *Bacillus delbrueckia*, which can be obtained from brewer's malt, has been used for this purpose. It has the advantage of being hardy, vigorous, anaerobic and thermophilic. It decomposes carbohydrates, forming lactic acid and an enzyme which hydrolyses proteins into water-soluble amino acids, but it has no action on fats.

The copra is disintegrated, mixed with ground limestone and a little water to form a mush and a culture of the organism is added. The mixture is kept at a temperature of 50° C. in a container from which all air is excluded. Carbon dioxide is evolved and lactic acid, which is immediately converted to calcium lactate, is formed by the action of the organism on the cell walls. The process is complete in about six days when fermentation ceases. The liberated oil is separated from the residue by filtration.

The chief disadvantage to the method appears to be the length of time required for the process, necessitating a very large incubator space. Nevertheless, it is claimed that the plant is cheaper to erect and maintain than those required for the compression processes.

The solid and aqueous residues from the filter presses are generally converted into cattle feed. The former is dried and the latter evaporated to dryness and the two residues combined. The cake contains approximately 5 per cent. fat.

(5) *By Solvents.*—Perhaps the most efficient and cheapest means of extracting oil by means of solvents. There have been many late developments in the process and these will be dealt with in detail at a later date. It will also be shown that the solvent process has certain advantages over the other methods.

At the present time, most coco-nut oil is obtained by means of hydraulic presses or expellers. This is partly because the bacterial process is of recent introduction and partly because the by-product obtained from compression processes is a valuable cattle feed, whereas the by-product from oil obtained by the solvent process may be of doubtful value as a feed. On the other hand, extraction by the solvent process produces a by-product more suitable for use as a fertilizer than the by-product produced by hydraulic presses or expellers. Despite the fact that copra cake has a higher commercial value as a cattle, pig or poultry feed than as a fertilizer, it is considered a sounder proposition, under present circumstances, to return the cake to the individual plantations for fertilization purposes. It may be returned to the soil directly or it may possibly be manufactured into compost or it may even be used satisfactorily as a cattle feed and returned to the soil as dung, but its use for this latter purpose would depend upon the solvent which had been used. The bacterial method of extraction has much to recommend it but, as already pointed out, the copra cake contains 5 per cent. oil which lowers its value as a fertilizer.

Marketing Coco-nut Oil.

The uses to which coco-nut oil may be put are divisable into three groups:—

(1) For the manufacture of edible products.
(2) For the manufacture of soap, pharmaceutical products, candles, glycerine, &c.
(3) For use as a liquid fuel.*

The use to which the oil is to be put would determine the quality to be supplied and the selling price. For instance, edible oil would be of the highest

* The value of coco-nut oil as a liquid fuel is not widely recognized although other vegetable oils have been in use for this purpose for many years. Its fuel value was first demonstrated in the Philippines nearly 10 years ago. As a result of tests carried out over long periods in this Territory, coco-nut oil is claimed to be quite as satisfactory as a liquid fuel as imported crude mineral oil. Recent experiments carried out in Fiji confirm this.

For use in an ordinary crude oil engine, the oil should be purified by boiling it with water for about fifteen minutes. Purification is unnecessary for some engines such as the "Drott" and the "Robey" Semi-Diesel Crude Oil Engine in which there are no valves to become clogged up.

If the oil were to be exported as a fuel to colder countries, solidification could be prevented by the addition of a little kerosene or some such substance. Possibly the substance could be so chosen as not only to prevent solidification but also to neutralize any acidity which might be present and to generally enhance the value of the oil as a fuel. The author is already experimenting with such a substance.

grade ("edible-grade"), oil for the manufacture of soap, glycerine, &c., would be of a slightly lower grade ("soap-grade") whilst oil for use as a fuel would consist of the lowest grade oil ("fuel-grade"). Also the edible-grade would be sold at a higher price than the soap-grade, whilst the price of fuel-grade oil would depend to a large extent upon the cost of production and the current price of crude mineral oil.

In order that the soap-grade oil could not be bought at the cheaper price and used as edible-grade oil, a denaturant, which would prevent its use for this purpose, would have to be added. Similarly, some substance would have to be added to the fuel-grade oil to prevent its use as an edible or soap-grade oil. At present, experiments are being conducted by the author in an endeavour to find the most suitable substance for addition to soap and fuel-grade oils.

When a market exists for edible oils, obviously the bulk of the oil produced should be sold as edible-grade. However, it may not be economical or desirable to refine lower-grade oils for sale as edible-grade. In the first place, the additional price obtainable may not compensate for the extra cost of refining and secondly, it would probably be desirable to keep open a small market at all times for all grades pending the time when one or two of the markets should wholly or partly collapse. It is unlikely that the market for fuel oil will ever collapse but, on the contrary, will increase as the supplies of mineral oils decrease.

The Present Position.

When the bulk of the oil produced is fuel-grade oil (which would be the position at the present time), transport, milling and overhead expenses would have to be reduced to an absolute minimum in order to produce this oil at a price comparable with that of crude mineral oil and in order to pay planters a fair price for their copra or fresh meat. Fresh meat could only be considered when it is possible to deliver it at the mill a day or so after it is cut. On some plantations copra can be produced for £3 per ton, while on others it costs as much as £7 10s. The average price, however, seems to be about £5 per ton, that is, 1 ton of oil, as copra, can be produced for about £7 10s.

The price which could be paid for copra at the mill would depend essentially on the amounts of each of the three grades of oil produced. If the production of edible and soap-grade oil was high then the price which could be paid for copra would rise far above £5 per ton, but, if it were low, which is an extreme case, then the price would also be low. However, as edible-grade oil would be sold for three-four times, and soap-grade for two-three times as much as fuel grade oil, it would not require the sale of large amounts of these grades to raise the price which could be paid for copra. The price of copra would also depend upon its quality. For instance, a ton of third or poor-grade copra would not receive the same price as a ton of first-grade copra, all of which could be used for the production of edible-grade oil if necessary. However, this side of the scheme will be dealt with in greater detail later.

In order for the scheme to be a success, every plantation in the Territory would have to be a unit—the private exportation of copra could not be permitted—and if the scheme could be extended beyond this Territory so much the better. This arrangement might tend to give two or three firms, who own large areas of plantation in this Territory, a controlling influence in the scheme and in order to prevent the private planter from becoming victimized it would be necessary for all concerned, including the Government, to have adequate representation on a controlling board.