THE AGRICULTURAL ASPECT OF THE COCO-NUT INDUSTRY IN THE MANDATED TERRITORY OF NEW GUINEA

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Introduction.

The staple agricultural industry in the Mandated Territory of New Guinea is the cultivation of coco-nuts, and the manufacture of coco-nut products such as copra, desiccated coco-nut, and coir fibre; the equity in the numerous plantations being considerable.

It will be shown in the course of this paper, that the outlook at present, relative to the future maintenance of production, will apparently depend to a large extent on the development of new areas.

That the period when the output must decrease as a whole, should be governed by the availability and suitability of virgin areas gives cause for alarm. Obviously, there must be a limit to the suitable areas and the resources of the planter for new development. It might be argued that thousands of hectares still remain undeveloped, but when consideration is given to the area planted in the past thirty to forty years, even in the last ten years, it will be realized that the area of suitable land is not so great after all.

Economic conditions throughout the world in recent years have been most unfavorable towards the primary producer. The price of copra has been depressed, and the planter in this Territory has suffered severe financial loss. Therefore, even should he desire to develop new areas he is handicapped through lack of finance.

That New Guinea possesses large mineral resources is beyond doubt, and the present revenue derived from the gold output is considerable. However, mining is invariably only a passing phase in the development of a new country, the real backbone of prosperity being agriculture. Therefore, the immediate problem facing not only the planting interests, but the Territory as a whole, is the maintenance of the chief agricultural industry—coco-nuts.

The object of this paper is threefold—

(1) To outline the products and uses of the coco-nut palm.
(2) To endeavour to present, quite impartially and non-critically, the existing coco-nut position.
(3) To point out the methods possible of adoption for the improvement of bearing estates, reduction in costs, and development of new areas.

It should be realized that in this Territory very little scientific agricultural data are available, and that many of the ideas postulated are open to criticism, and subject to modification when further information does become available. The co-operation of everybody interested in the agricultural welfare of the Territory is sought, and it is hoped that planters and others will assist the industry by tendering their experiences, ideas, theories, &c.

Section No. 1.

THE PRODUCTS AND USES OF THE COCO-NUT PALM.

The palm stems may be used as hollowed trunks for water pipes or as wood for fuel, and in cut lengths for doors, window posts, house supports, &c. In India and Ceylon the outside wood known as "Porcupine Wood" has been successfully polished for interior decorations.

The leaves can be used for the manufacture of roofing materials and walls, such as "bom boms" for native houses, plant nurseries, &c., or made into native baskets, temporary seed baskets for cacao and coffee plants and used as wrapper with many of the purposes of paper. The central ribs of the fronds yield bristles for brooms, while the dried leaves furnish fuel.

In some countries the flower stalks are tapped and the saccharine juice obtained can be used for the production of sugar, or when fermented becomes "Toddy" or "Arrack".

The roots are often used medicinally by natives as an astringent, and according to Watt[13] the fresh fruit has an anthelminthic action, while the "milk" from unripe fruits is recommended as a useful refrigerant in fever and urinary disorders.*

The nuts have a wide variety of uses (dependent on the portion involved) and practically every plant has a commercial value, as even the coco-nut milk can be used as food for pigs.

The husk is used for the extraction of coir fibre by various commercial processes, while in some countries it is purely a cottage industry, with the retting carried out by primitive processes.

Dr. Barker stated[1] "that the fact that coir properly treated resists decay, is not disintegrated by bacteria or harmed by water and can easily be impregnated with bituminous and resinous materials, provides a unique opportunity for exploiting its use in directions untried in commerce and industry". An excellent report by the Empire Marketing Board[5] is available, on the attributes and preparation of coco-nut fibre.

The residues from the fibre extraction may be used as manure, and although the analysis compares somewhat unfavorably with cattle manure, the creation of such manures from waste products on the spot is worthy of consideration.

From the short fibre combined with ionized oil and rubber latex, a very good imitation leather with distinctly promising characteristics, has been obtained. It has also been successfully used in plastic mixtures with pitch or bitumen for pipe and cable coverings. The coir itself is manufactured into yarns, matting, rope, &c., and may be dyed and bleached.

The finest quality mat fibre is used for the manufacture of ropes, twines, and matting. The coarser and thicker quality fibre is employed in the manufacture of brushes and brooms, while the curled fibre of short strands is used for mattresses or for stuffing upholstery, &c.

Coir is very resistant to the action of water, is light in weight and exhibits good elasticity; it is therefore particularly suitable for certain types of ships' ropes, but is inferior in strength to Manila hemp and Sisal hemp.

* Taken to excess it causes a form of gleet.—*Editor.*

The coir has further uses in native villages as fishing net cords, and owing to its property of swelling when saturated with water, combined with its durability, it is found very useful in boat building and caulking.

The use of the half husk as a scrubber is well known here.

Experimentally it has been found possible to make softened coir which can be used for the production of fabric for sugar bags, and if this could be extended commercially to the production of copra bags, a very important cost in copra production would be reduced by utilizing the waste product.

Bags made of coir yarn, owing to their resistance to decay, are stated to be specially suitable for the carriage of superphosphates and other inorganic fertilizers. Coir bags are understood to be used locally in Ceylon for transporting copra to the oil mills, and carrying coal for loading into ships' bunkers. Coal bags made of coir are also employed to some extent in Europe. When the price of jute is high it is conceivable that coir yarn could be used instead for bag making, but jute is naturally preferred for this purpose and sacks made from coir are much heavier than those made from jute.

The ash derived from the husk is rich in potash and manurial constituents, (*see* section No. 3.).

A local company has commenced in this Territory to manufacture coir fibre and its products on a small scale, but so far only experimental shipments have been made. There is still much room for a study of the natural qualities of the husks and fibres, particularly to find out how the local product compares with that from overseas.

Unless much wider uses are found for the product, so as to make processing more profitable, under the particular conditions obtaining here it is not expected that the industry will expand to any great extent in New Guinea, as coir is easily overproduced. The method of harvesting the nuts, and the labour available, would not assist the industry, unless it was carried out in conjunction with the production of desiccated coco-nut, where the nuts are harvested at an earlier stage of maturity.

As far as is known no coir fibre is spun in Australia, and the coco-nut fibre which eventually is converted into ropes or mats is imported as yarn, chiefly from India.

The average 1935 price of coir fibre is quoted at approximately £7 12s. 8d. Australian per ton, coir yarn is quoted at about £14 4s. 7d. per ton sterling, which at current rates of exchange is equivalent to £18 18s. 6d. In the case of New Guinea fibre the bounty of £3 per ton must be taken into account.

The utilization of the shell, especially by destructive distillation, has not been developed to its maximum extent, and chemical research may prove this a valuable by-product of the industry. Nevertheless the present uses of the shell are extremely diverse.

The products of destructive distillation of the coco-nut shell have been calculated experimentally by Georgi and Buckley,[7] and the amounts of the various products, based on 100 lb. of shells are shown as follow:—

Charcoal	49.0 lb.
Pyroligneous acid	2.88 gals.
Tar	0.26 gals.
Acetic acid (calc.)	4.68 lb.
Methyl alcohol	0.07 gals.
Crude creosote oil	0.13 gals.

The value of pure vegetable charcoal is well known for its uses in medicinal filters, explosive manufacture, &c.

According to Georgi and Buckley[7] there is only a limited demand for charcoal from copra apart from its use as fuel in suction gas engines, where special scrubbers have to be provided to use it efficiently. It has two other main uses, viz. decolourizing agent for fluids and absorbents for noxious gases, and during the great war coco-nut shell charcoal was used on an enormous scale in the filling of gas respirators.

The coco-nut shells may form a valuable source of supply for acetic acid, creosote for wood preservation, and wood spirit (naphtha) for use either as a denaturant for alcohol or in the preparation of pure methyl alcohol.

According to Barker[1] a still was designed capable of yielding five gallons of pyroligneous acid per day. There is a small sale for this acid in the meat trade, where it is used as a substitute for the smoking process.

The wood tar from coco-nuts finds a limited industrial use, either as an insulating compound, or as a rope lubricant, but needs a good deal of refining. The percentages of acetic acid and acetone obtained from the brown aqueous distillate, known as pryoligneous acid, are considerable and a wide commercial use for these products is assured, though plenty of other sources are available.

A sample of tarry distillate produced and submitted for analysis by a local planter gave results comparable with the above.

The shell itself provides sources for fuel for copra driers, &c., and could be used as a source of power in gas engines. The hard shell has a variety of uses for the natives, and may be used as food and drinking vessels, lamps, spoons, and in some countries as cups for rubber latex collection.

Copra.

Copra is prepared from the dried kernel of the coco-nut, usually when it is fully matured and after it has been cut open and the husk, and usually the shell, removed.

Copra drying is carried out by various methods, either by taking advantage of natural sun or using smoke, machine and hot air driers. This subject is discussed elsewhere in a previous article[9] and will be the subject of future publications.

Copra is employed exclusively in the manufacture of coco-nut oil, the quality of which depends on the quality of the copra crushed. Good copra produces an oil with a minimum amount of free fatty acid, suitable when refined for edible

purposes, whereas oil expressed from lower grade copra is mostly used for soap making. Under modern conditions rather inferior copra can be deodorized and neutralized for edible purposes.

Coco-nut Oil—Preparation.

The natives of tropical countries prepare coco-nut oil by primitive methods, such as cutting the kernel in small pieces and exposing these in heaps to the sun, when the oil melts and runs off. Another method is to crush the kernels to pulp in wooden mortars and place the pulp in perforated vessels in the sun, the oil which exudes being collected. A simple and more efficient method consists in first drying the kernels either in the sun or over a fire, pounding the dried material, and pressing in wooden presses. Oil of good quality may also be obtained by throwing the pounded kernels into boiling water and skimming off the oil as it rises to the surface.

Modern methods of copra crushing and extraction of coco-nut oil are outside the scope of this article, but modern milling machinery is becoming more efficient and less complicated every year. Thus the new type expellers, such as as are manufactured by Rosedowns, England, require less power than formerly and are said to be capable of being adjusted to deal with several types of oil bearing seeds and kernels.

The usual method of oil extraction is briefly described as follows:—

The copra is properly milled, the resultant meal being steamed and fashioned into large square cakes. The oil is expressed or squeezed from these cakes by submitting them to a hydraulic pressure of several tons to the square inch.

Properties of Coco-nut Oil.

Coco-nut oil in Europe is a solid, white fat, but it is a liquid oil at the high temperature prevailing in tropical countries. It has a pleasant taste and the peculiar and not unpleasant odour of the coco-nut. It has a specific gravity ranging from .873 to .926 according to the temperature and a melting point of 24 degrees centigrade. It closely resembles palm kernel oil in appearance and composition. It is a complete mixture of the glycerides of fatty acids, consisting principally of trilaurin and trimyrstin together with smaller quantities of tripalmutin, tristearin and triolein, and also glycerides of the volatile caproic, caprylic, and capric acids.

When carefully prepared, coco-nut oil does not turn rancid rapidly, but oil prepared in the tropics by primitive methods, and also oil prepared in the large importing countries from copra of poor quality, contains not only free fatty acid, but also other products, probably formed by the action of fungi or of enzymes on the kernels, which give the oil an unpleasant taste.

Uses of Coco-nut Oil.

Snodgrass[10] comments as follows:—

"The chemical composition of the oil is such that when refined it has excellent keeping qualities. It is also of bland flavour and has a consistency very similar to animal fats. So far it has not been widely used as a cooking fat because if combined with other oils and fats it foams when heated.

Only coco-nut oil of high grade, or oil from the highest grade copra which contains a minimum of fatty acids, is employed in the preparation of vegetable butters (margarine), &c. To render it suitable for this purpose, the free fatty acids and substances of unpleasant

odours are eliminated. A portion of the liquid glycerides is frequently removed by expression, the object being to prepare a fat of firmer consistency and higher melting point. The "coco-nut olein" which is removed, is employed in soap manufacture while glycerine is liberated as a by-product.

Coco-nut stearins of varying melting points can be prepared by removing from 50-80 per cent. of the 'olein', and when prepared from high grade oil the 'stearin' is employed as a chocolate fat, and as a substitute for the more expensive cocoa butter derived from cacao beans which has great use in confectionery manufacture."

Coco-nut "stearin" derived from lower grade copra oils is used for candle manufacture, the olein being made into soap. Again, according to Snodgrass[11] "the adaptability of coco-nut oil in making vegetable margarine, arises from various of its characteristics of which its melting point is probably the most important, and no other oil has proved as satisfactory in making this product on a commercial scale."

The aim is to obtain a material of about the same hardness as butter, with a consistency of "feeling to the tongue" that is similar, and a keeping quality as great. Coco-nut oil has a slightly lower melting point than butter, but remains sweet over long periods.

The relative absence of Vitamins A and D from ordinary margarine, is perhaps the most serious criticism which can be levelled against its use to replace butter. Not only has this difficulty been overcome, but an advance of some importance has been made in the development of a butter like aroma in margarine. It is based on the discovery that the characteristic aroma of freshly made butter is due in the main to an extremely small portion of diacetal.

Coco-nut oil being a non-drying oil is unsuitable for paint, and similar lines of manufacture, nor is it so adaptable as mineral oils for use as lubricants, nor as useful as certain vegetable and animal fats in the treatment of leather. The ease with which its soaps lather, and certain other qualities which the oil possesses, make it specially adaptable for soap making. It is light in colour, and for that reason desirable both for toilet and household uses. It has the almost unique property of lathering in salt water, besides holding an unusually large amount of water, and is therefore the principal fat used in marine soaps.

Coco-nut oil produces a higher rate of by-product glycerine in the process of soap making than most other oils and fats.

Appreciable quantities of coco-nut oil are used in cosmetics of various sorts, shampoos, perfumes and facial creams; fillings for sweets and cakes, and to some extent for salad dressings and lard compounds. A small amount is used for lubricating machinery, and new uses are being continually discovered.

The by-product glycerine has a great variety of uses in chemical and pharmaceutical preparations. It is stated to have use as anti-freeze in the automobile industry and is a valuable component of explosives, where trinitro-glycerine, dynamite and gelignite are evolved.

Soap and candle industries of Australia use approximately 900,000 to 1,000,000 lb. of coco-nut oil annually, from which over 1,000,000 lb. of soap are made. In 1928-29, 70,000 lb. of candles were manufactured but this dropped to 50,000 lb. in 1930-31. The value of total production of soap and candle factories in Australia ranges from approximately £1,500,000 per year.

In the United States vegetable oil margarine is manufactured almost exclusively, but in Europe and in other countries margarine made from hardened and refined animal fats is in direct competition with it.

Coco-nut Cake and Meal [4].

These are residual products of the crushing and extraction respectively of coco-nut oil from copra. The residue is a valuable concentrated cattle food containing a large percentage of oil, and is exported in considerable quantities from those copra-producing areas which also produce coco-nut oil on a large scale, such as the Philippine Islands, Dutch East Indies and Ceylon. The copra crushing countries, outside the copra producing areas, utilize almost the whole of this residual product for their livestock.

Utilization of Coco-nut Cake (Poonac).

The residual cake left after expression of the greater part of the oil, contains about 7 to 10 per cent. fat and forms a fairly nutritious cattle food for which purpose it is employed, both in the temperate zones and in the tropics.

The following table of analysis compares coco-nut cake with some of the oil seed cakes, commonly employed as feeding cakes:—

TABLE No. 1.[12]

Average Composition percentage by analysis.	Coco-nut cake.	Cotton seed cake.	Groundnut cake.	Linseed cake.
	%	%	%	%
Dry matter	89	88	90	89
Protein	20	23	50	31
Oil	10	5	8	10
Carbohyd. Sol... ..	41	32	22	32
Carbohyd. Fibre	12	21	5	9
Ash	6	5	5	6

Feeding tests in England have shown that the butter from cows fed on coco-nut cake is of good quality, and possesses better keeping qualities than that from the milk of cows fed on linseed cake or cotton seed cake.

The price of coco-nut cake (ex mill) during November, 1935, ranged from £6 to £7 per ton, and over a series of years usually varies from £6 to £10.

In Australia coco-nut cake has a wide use, particularly in periods of drought; it is popular on the Continent of Europe and in America.

Henry and Morrison[8] state in their book on *Feeds and Feeding* that the residue derived from the manufacture of oil from coco-nut is lower in crude protein than most other oil meals, but higher than in wheat bran. When fed to dairy cattle using about 3-4 lb. per head daily, the butter produced is of good quality and firmness. It may also be fed with success to horses, sheep, and pigs.

Coco-nut meal, especially that high in fat content, has a tendency to turn rancid in hot weather.

The following table (No. 2) gives particulars of the digestible nutrients per cent. of coco-nut cake:—

TABLE No. 2.[12]

Crude Protein.	Pure Protein.	Oil.	Carbohyd. Soluble.	Carbohyd. Fibre.	Nutritive ratio Approx. 1 to
15	15	9	34	8	4

The nutritive ratio can be defined as the ratio between the nitrogenous substances (crude protein) and the non-nitrogenous substances in the food [carbohydrates, i.e., sugars and starches + (fat × 2.25)]. This varies considerably in different classes of foods and here represents a relatively nitrogenous food with a "narrow" nutritive ratio.

The fertilizing constituents in 1,000 lb. of oil cake are roughly as follows:—

Nitrogen	33 lb.
Phosphoric acid	12.4 lb.
Potash	23.6 lb.

It is seen that the manurial value of residual oil cake is considerable, but it usually has more value as a feeding stuff.

Production of Shredded and Desiccated Coco-nut.

The use of these products in the production of confectionery, cakes and foods is too well known to require elaboration.

According to Eaton [3] the three principle products on the American market are—

(1) Fresh grated coco-nut canned in its own milk or water.

(2) Moist sweetened coco-nut with the milk, in cans.

(3) Dried shredded coco-nut prepared with sugar, in cardboard packages.

It is essential to use only fresh ripe nuts for the purpose, and it is estimated that about 5,000 to 7,000 nuts are required to produce 1 ton of desiccated coco-nut.

The nuts are first husked, then sterilized by steaming for an hour or two in a kiln under low pressure steam, which has the effect of loosening the kernel and admits of loosening the shell easily.[3] The brown skin is then pared off, the milk drained and the white meat shredded and dried immediately. Drying is done in several ways, and the shredded nut is stirred until quite dry.

The preparation of desiccated and shredded coco-nut entails the following operations:—

Husking, removal of the shell, removal of the skin or testa (usually done by hand), cutting and shredding by machine, drying and desiccation in suitable artificial driers. The dried product is then sifted in a "machine sifter," which together with grating machines can be regulated to produce a more granular product. This is then packed in lead lined cases for shipment.

The by-products are the rejected nuts, and the parings and tailings from the factory, all of which may be processed on the spot or exported as a source of oil.

The Fresh Coco-nut.

The use of the fresh coco-nut as an article of food by the natives, and the contained milk or water of the young nut (Kulau), by Europeans and natives as a refreshing beverage is a common feature of the life in New Guinea and other tropical countries.

SECTION No. 2.

THE EXISTING COCO-NUT POSITION.

Mainland of New Guinea.

The mainland of New Guinea, which is divided into three main districts, (Madang, Aitape/Sepik, Morobe), has an area of 70,000 square miles. There are few good harbours, the best being probably those of Madang, Vanimo, Alexishafen, Matzfeldt, Monumba, Finschhafen, Salamaua, and Morobe. Agricultural development of this huge tract of country is confined solely to the coastal belt.

MADANG DISTRICT.

The Madang district is a large district which has 56 plantations, containing about 12,600 hectares under coco-nuts, of which 10,000 hectares are in bearing. In many instances the growth of the palms is not satisfactory, especially in those areas where the soil, though rich, is shallow overlying limestone. In other places hilly areas are going back in production.

Several of the earliest planted properties show very little new planting since German days, some are over 40 years old and decreasing in yield, whilst others are just holding their own.

Between 60 and 70 per cent. of the estates have incraesed their yields since 1924, but in the majority of instances this may be attributed to new areas coming into bearing, or sections reaching full bearing.

On Kar-kar Island (Dampier Is.), the production shows rapid increase, many areas yielding over 1½ tons of copra per hectare.

There are approximately 700 hectares of recent plantings, while a number of palms are just coming into bearing. The land is fertile and has abundant underground water coming from the mountains in the centre of the island; the climate is equable, and the rainfall well distributed.

It is anticipated that many of the expropriated properties on the Madang coast will probably give reduced yields in the future; in fact a proportion of the plantation areas already appear to be going back, or have little future ahead of them. The newly planted areas will, however, balance the production on the poorer sections.

Up to the present most of the suitable areas with the best anchorages have been selected. There still remains probably 50,000 hectares more or less fit for planting, which is in the virgin state. Some of the areas along the coast have good anchorages, but there are some instances where large expanses of swamp are interspersed with the good land.

SEPIK/AITAPE DISTRICT.

There has been little agricultural development in this district, only about 2,600 hectares being under cultivation on the eighteen plantations. Included in these are several old properties controlled by the Expropriation Board, and island properties such as Seleo and Wallis islands.

Generally speaking this district will maintain its production, although very few new areas have been planted.

The Aitape coast is practically an open roadstead, anchorages are few, and loading is so difficult that it is often impossible for vessels to load or discharge cargo.

It is anticipated that little new planting of coco-nuts will occur here, owing mainly to the lack of anchorages and because more suitable areas are available in other districts.

Morobe District.

The Morobe district has yet to be developed agriculturally, the twelve plantations owned by Europeans comprising only about 1,400 hectares of coco-nuts.

There are few good anchorages along the mainland coast, Finschhafen, Salamaua, and Morobe being perhaps the best.

The Mission properties should maintain their present production as soil is good and they are well worked, although one property situated in the Huon Gulf is decreasing. The Government and other plantations will probably decrease in yield.

In the Siassi Island group, Sexava has been troublesome but the planted areas are young and the yield will increase slightly.

Generally speaking, the district as a whole can be expected to decrease unless new areas are planted, or the existing estates are improved.

New Britain.

The island of New Britain is the largest and most important island of the Bismarck Archipelago. It is 300 miles long, and average breadth of 50 miles, and has an area of 13,000 square miles [14].

A high rugged mountain range runs throughout the length of the island, and volcanic action is still very evident. Mount Ulamon ("the Father") (7,500 ft.) is the highest peak and an active volcano.

New Britain possesses several good harbours, Simpsons Harbour, Passage-Man-O-War, Powell Harbour, Rein Bay, and Talasea Harbour, being perhaps the best. There are also numerous anchorages suitable for schooners and small inter-island steamers.

For the purpose of this paper New Britain has been divided into the following districts:—Rabaul/Kokopo, Duke of York, Baining, Talasea, and Gasmata.

Rabaul/Kokopo District.

In this area there are 58 plantations, comprising 14,274 hectares, of which 10,663 hectares are bearing. Approximately 2,000 hectares have been planted in recent years or are in the process of being planted, whilst further plantings are intended.

About twelve or thirteen early plantings should maintain their present level of production for a considerable period, whilst a number of estates are expected to decrease in output, in some cases very much in the near future. The majority of these properties are situated in the pumice belt, where in many instances not more than 5 or 6 cwt. of copra are produced to the hectare per annum. The output, however, is apparently maintained to a large extent by extensive trading in native grown coco-nuts.

Promecotheca sp., has been fairly bad on three or four plantations, the severity of the attack appearing to be more pronounced where the soil is evidently exhausted of its chemical constituents, which in itself has led to decreased vigour and dying back of fronds. On other plantations decreased vigour following soil exhaustion has resulted in a certain amount of premature nut-fall.

Taking the plantations in this district as a whole, notwithstanding some very poor estates, the yearly output of copra will be maintained.

Duke of York District.

This district consists of thirteen islands. The island of Mioko, which is 1 mile long and ¾ mile wide, has a large, deep, protected harbour, and is the principal settlement. There are four plantations comprising 524 hectares of coco-nuts of which 513 hectares are in bearing.

Production in this district should increase with the young areas coming into bearing.

Baining District.

In this district there are 22 plantations, comprising 4,977 hectares of coco-nuts, with 4,025 hectares in bearing.

There are five plantations that appear to be decreasing in yield, (one has already decreased), five others have newly planted areas, and the remaining estates should maintain their production for many years. It is believed that although the original plantings will probably decrease in yield, the output of the whole district will increase as the young areas come into bearing.

So far as suitable land for future development is concerned, there are 1,872 hectares on New Massava plantation, but only limited areas elsewhere, although there is quite a large area of land in the Keravat valley which could be reconnoitred.

Talasea District (including Witu and Bali Islands).

In this district there are fourteen plantations, comprising 3,404 hectares of coco-nuts, of which 2,657 are in bearing. On the mainland, production is bound to increase as the properties are young and the soil fertile, although certain estates have suffered considerably from Promecotheca infestation.

There is scope for development in this area, the rich soil derived from volcanic sand, scoriae, tuffs, and pumice, being deep and well drained, and although there are only one or two good harbours nevertheless small anchorages are to be found which are suitable for schooners.

The properties on Witu and Bali islands will either maintain their present level of production or increase. Some of the plantations yield exceptionally well, the production being slightly under 2 tons per hectare of copra per annum. One old estate on Witu Island has a large area of palms turning yellow, being planted on the hills, but owing to new plantings even this property will maintain its present production.

Gasmata District.

In the Gasmata district there are nine plantations, comprising 2,439 hectares of coco-nuts, of which 1,431 hectares are in bearing. On two or three plantations Sexava has been serious, and considerably reduced the yields. In several other areas, notably the Government Plantation, Promecotheca has been prevalent and yields have suffered greatly.

Except for those plantations where yields have been decreased by pests, it is anticipated that three plantations will maintain their production, whilst the remainder will increase. Control of pests in the badly infested areas should bring production back to normal.

The properties on which production will increase are all young, some of them just commencing to bear. On one large property that is barely holding its output the frontage is badly planted, the spacing being 20 ft. x 20 ft.

The soil in the Gasmata district is quite suitable for coco-nuts, although in certain areas there are outcrops of soap-stone, or a soap-stone layer just below the surface. There are areas available for future planting, but owing to pests and a rather excessive rainfall, other districts would probably prove more suitable for expansion.

Several fairly good harbours are to be found along the Gasmata coast, and there are many anchorages suitable for small craft.

Manus District.

This is an island district with a total area of about 1,000 square miles. The island of Manus, which is approximately 55 miles long by 16 miles wide, is the administrative centre.

Manus island is rugged and mountainous in the centre, fairly fertile, densely wooded, and together with several smaller islands adjacent to it, constitutes the Admiralty Group. Several useful harbours provide good anchorages for shipping purposes. There are 36 plantations, with about 8,400 hectares under coco-nuts.

Serious outbreaks of Sexava and Promecoteca have occurred in the Admiralty Group, and on estates that are free at present, infestation is liable to take place at any time. Sexava has been responsible for decreased production on certain plantations, and this pest plus poor sandy coral soils has caused a reduction in yield of about 28 per cent. on five small islands in the group.

Purdy Island, which has phosphate deposits, should maintain its present level of production, but on Alim Island the encroachment of the sea will cause a decrease. New areas coming into bearing should enable Pak Island to maintain its output in spite of Sexava.

Taking the plantations in the Admiralty Group as a whole, five should maintain their present level of production, three can be expected to decrease, and the remainder should increase on the present figures.

Situated to the north-west of the Admiralty Group and included in the Manus district, are a number of islands known as the Ninigo, Hermit, and Anchorite groups, which together form the Western Islands. With the exception of Allison Island, where phosphate deposits exist (and where one area of 22 hectares is giving the remarkable yield of 7 tons of copra per month), the production is decreasing despite certain new areas coming into bearing. Factors contributing to the general decrease in yield are poor sandy soil, bad drainage and swampy conditions prevailing in many instances, the large number of palms planted closely and haphazardly by the natives in the early days, and damage due to Sexava and *Aspidiotus destructor*.

So far as the Manus district is concerned, the Admiralty Group should maintain its present output, providing serious pest invasions do not constantly recur. In the Western Islands there will be a decrease in production.

New Ireland.

This district embraces the main islands of New Ireland and New Hanover, and the adjacent island groups of Tabar, Tanga, Lihir, Anir, Djaul, and Tsoi.

New Ireland lies close to, and runs practically at right angles to the northern end of New Britain. It is 200 miles long, with a mean width of 20 miles; is very mountainous, with a good deal of uplifted coral limestone formation, outcrops of limestone being found in the centre of the island at a height of approximately 3,000 feet. Geologically it is much older than New Britain, hence its volcanic activity has practically ceased. In the Namatanai area material resembling brown coal is to be found, and is used by the natives as fuel.

The coast line is fairly regular, with good harbours at Kavieng, Namatanai, Muliama, Labom, and Kalili; schooner anchorages are more or less confined to the west coast and central east coast, but are not numerous.

A large part of the island, particularly on the east coast, is under cultivation, there being many large European owned plantations. On the west coast of Namatanai, between Bom and Gil-Gil, are many small Asiatic plantations. The extreme northern end of the island, on the western side, is inclined to be swampy, and the southern end is very mountainous and rugged.

In June, 1935, on the 134 plantations there were about 27,060 hectares of coco-nuts in cultivation, of which 19,298 hectares are in bearing.

In the Kavieng section about five properties on the east coast are expected to decrease in yield. Most of the plantations on the west coast, however, should maintain or increase their output, as the palms are relatively young and new areas have been planted. There is still a certain amount of virgin land suitable for planting in this section, but the frontages are possibly the only areas worth developing, as land away from the beach is rather broken, and in some instances there are high limestone cliffs.

There are a number of good plantations in the Namatanai area from Karu to Maritzoan (east coast), which compare favorably with those in the northern end of Bougainville. On the west coast one rather large property is expected to decrease in yield.

In Namatanai there is little suitable virgin land available for planting owing to the lack of anchorage or loading sites. In some instances where there are anchorages, the land is unsuitable as the hills are far too steep. Portions of Namatanai have been subjected to a Sexava attack, and in the New Ireland district as a whole a suspected virus disease known as "head droop," "cabbaging," or "corkscrewing" is rather prevalent.

New Hanover.

This is a large, mountainous, well watered island about 40 miles by 20 miles in extent, lying north-west of New Ireland. The soil is mostly unsuitable for coco-nuts being heavy and clayey, although it should suit other crops quite well. Of the eleven properties on the island, few are yielding really well, and it might

be said that some estates should never have been planted as they are on some of the worst soil for coco-nuts in the territory. The average yield is only about 6 cwt. of copra per hectare, and in addition to unsuitable soil conditions, Sexava has also assisted in decreasing the yields in recent years.

Portland Islands.

These islands also appear unsuitable for coco-nuts, some thousands of palms having completely lost their crown, and the output must decrease.

Tanga and Waramung Islands.

The production should increase in these islands. In the former, 300 to 400 hectares of virgin land are available for planting.

Anir and Lihir Islands.

The production in these islands should increase by 75 per cent., as the areas are new and just coming into bearing. There is, however, only a limited area still available for planting.

Tabar Islands.

In the Tabar islands, considerable areas of the plantations are established on land that is apparently too wet and clayey for coco-nuts, and in two instances high and badly eroded hillsides have been planted. Although small areas have been newly planted, it is anticipated that the output in this group will decrease by possibly 10 per cent.

Djaul Island.

This island is producing well, and with new plantings is likely to increase in production.

Mussau Islands.

The output of this group will probably decrease owing to the presence of large areas of sand, and a very shallow surface soil.

Tsoi Group.

This group of islands may maintain their present level of production, although it is problematical whether the areas that are decreasing will be offset by the newly planted areas.

Generally speaking, the production in the New Ireland district should increase by about 20 per cent. in the future. A number of the older properties should maintain their output, while large areas (about 2,900 hectares) have been planted within recent years.

Kieta District.

The Kieta district, the late German Solomon Islands, has a total area of about 3,400 square miles. The district consists of the islands of Bougainville, Buka, Nissan, Feads, Cartarets, Mortlocks, and Tasmans, and supports 51 European owned plantations, comprising about 10,000 hectares, of which approximately 9,300 hectares have bearing coco-nuts.

Bougainville.

The largest of the Solomon Islands, extends in a north-east, south-west direction. The soil is of volcanic origin, varies in colour from chocolate to red, and is fertile.

An extensive forest-covered mountain range occupies a large proportion of the island, and rises to a height of 10,171 feet (Mt. Balbi), where one of the two active volcanoes is situated.

The foreshores are of raised coral limestone, the rainfall is heavy but well distributed, and the island is well watered by numerous short, rapid rivers, which however, tend to accumulate in coastal swamps in certain areas. There are some extremely good harbours such as Kieta and Buka Passage, and at nearly all plantations along the coast north of Kieta, good anchorages for small craft are available. It is noted that on the southern side of Kieta, anchorages are scarce.

About fifteen properties on the island will maintain their production, while eleven of these should increase in the future. As far as can be judged, there are few plantations in this area that are likely to decrease.

Buka Island, which is separated from Bougainville Island by a narrow passage, is also of volcanic origin. There are about eight European plantations on the main island, and a few islands in Buka Passage. Two of these plantations should never have been planted, as the land is too wet and swampy; they should, however, retain their small production, although one is already showing signs of going off. Two plantations should retain their yield, and may increase slightly, and one property established on poor badly drained soil will decrease considerably.

The other islands in the Kieta district, with the exception of *Nissan Island* (which contains some excellent coco-nut land with good anchorages inside a lagoon), will probably decrease in production, in fact one group appears to be already on the decline.

On Bougainville Island, there are three large areas of land between Buka Passage and Kieta, that are suitable for planting. The opening of roads, and the construction of bridges over some of the rivers in the Buin-Siwai-Nagovissi areas, would give access to a very large area of native palms which are producing well, and also to some very excellent land for planting. There is little land available on Buka Island.

So far as serious pests are concerned the Kieta district is fairly free, although Thread Blight (corticium penicillatum) is prevalent in the very sheltered areas of most plantations.

PROSPECTS.

In summing up the position for the whole territory, it will be seen that copra production should increase in the future. This increase, however, is due solely to new areas coming into production or reaching full bearing.

Reference is made throughout this section to the older properties. The oldest plantation in New Guinea is said to be 50 years old, but the majority are from 18 to 30 years of age [6]. That many of these plantations are decreasing in yield, or just maintaining production is alarming, when it has been proved that estates with proper management will continue to increase up to 60 years and even longer [2].

There are many island properties, particularly in the Kieta, Manus, and New Island districts that have already decreased in output, or will do so in the near future. On these island plantations there are instances in which adequate foreshore protection has been disregarded, hence recession has occurred. In other cases

the poor type of sandy soil is incapable of supporting economic coco-nut cultivation for any period, and neglect to assist the soils by maintaining the organic matter has materially hastened decrease in yields.

There are examples throughout the territory where coco-nuts have been planted on soils that are too heavy, or too wet and swampy for coco-nuts to thrive; further, steep hills have been planted, and no provision has been made to control erosion. There are instances of close and haphazard planting.

Pests are a problem in certain districts, especially Sexava and Promecotheca spp, and there is a most depressing effect on yields where infestations occur.

In recent years a big increase in new plantings has taken place, and comparatively large areas are still available for planting in some districts. It is most likely, however, that future development will not be so extensive or so rapid as in the past, being influenced by prices offering for the products.

It is contended that too much reliance should not be placed on the development of new areas to maintain output. Every endeavour should be made to increase the production by rehabilitation, newer and better methods of agricultural management, and consideration to pest control.

(To be continued.)

BIBLIOGRAPHY.

1. Barker, Dr. S. G.—*Coir*, Empire Marketing Board Publication, No. 71, September, 1933.
2. Cooke, F. C.—*Investigations on Coco-nuts and Coco-nut Products*, F.M.S. Publication, General Series No. 8, 1932.
3. Eaton, B. J.—"Copra and Coco-nut Products" *Agric. Bulletin*, F.M.S. Vol. VI., No. 12, 1918.
4. E.M.B. No. 61.—"Survey of Oil Seeds and Vegetable Oils", Vol. 2, *Coco-nut Palm Products*, 1932.
5. E.M.B. No. 71.—*Coir*, by Dr. S. G. Barker, September, 1933.
6. Expropriation Board.—Delegate to the Custodian, Private Communication, 1936.
7. Georgi and Buckley.—"Destructive Distillation of Coco-nut Shells and Oil Palm Shells", *Malayan Agric. Jour.*, Vol. XVII., November, 1929.
8. Henry and Morrison.—*Feeds and Feeding*, 4th Edition, 1922.
9. Moody, F. O.—"Copra Drying", *New Guinea Agric. Gazette*, Vol. 2, No. 1, January, 1936.
10. Snodgrass, Katherine.—*Fats and Oil Studies, No. 2*", Food Research Institute, Stanford University, California, April, 1928.
11. Snodgrass, Katherine.—*Margarine as a Butter Substitute, Fats and Oil Studies, No. 4*, Stamford University, California, December, 1928.
12. Wood, R. C.—*A Note Book of Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, 1933.
13. Watt, Sir George.—*The Commercial Products of India.*
14. *Year Book of Pacific Islands*, R. W. Robson, Editor, Sydney, N.S.W., 1932.