DERRIS.

Its Cultural and Economic Possibilities for the Territory of New Guinea.

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The plantation agriculture in the Mandated Territory of New Guinea is devoted mainly to coco-nuts and to a far lesser extent cocoa and coffee. Interest in the two latter crops is rapidly extending, and cultures such as kapok, castor oil, pepper, &c., are now claiming some attention.

The prevailing low price of copra has greatly reflected on the financial position of the plantations devoted to this crop. Local planters naturally believe that the immediate development of suitable auxiliary crops with a short growing period will augment their incomes and alleviate the position to some extent.

A survey of the progress made with the development of new crops was conducted by the author during a recent investigational visit to Java, Malaya and Sumatra. It was observed in all three countries that the choice of new and profitable cultures was decidedly limited.

This is largely due to the prevailing economic position and because prices for all tropical produce have fallen so low as to cause all countries to look for new and profitable avenues in plantation agriculture.

Derris is discussed in this article as a valuable source of insecticidal material receiving much attention throughout all tropical countries owing to its comparatively recent development as a valuable culture crop, and the supply of which does not exceed the demand. This culture has been the subject of many inquiries to this department both inside and outside the Territory. Such inquiries are largly traceable to an article published in the Bulletin of the Imperial Institute,[4] dealing with an analysis of samples of Derris root sent to England by the Director of Agriculture in 1933.

A number of aspects regarding the culture and economic possibilities of Derris, particularly in New Guinea, are presented in this article from sources not usually available to planters and others interested.

The extensive literature and wide interest in this subject is shown by a publication of the United States Department of Agriculture[18] where abstracts of 456 references are quoted, and it is known that many more publications on Derris have appeared since 1931.

Botany of Derris.

Derris elliptica, Derris malaccensis, and related species with insecticidal value, belong to a small sub-tribe—*Lonchocarpinae*—of the well known order *Leguminosae.* The genus Derris also known as *Dequelia* by American botanists, is widely spread throughout all tropical countries. This group also contains a number of species which have little or no insecticidal properties of commercial value.

Most species of Derris are climbing shrubs with short stems which send out numerous long slender branches, and these climb over trees and any surrounding tropical vegetation. In most instances they are shade-loving plants, which grow at low altitudes and require plenty of moisture.

The two species of Derris commercially known as "Tuba Root" in Malaya and surrounding countries and most commonly cultivated for toxic content, are *Derris elliptica* and *Derris malaccensis.*

* The literature referred to by means of the number in brackets is cited at the end of the article, each reference being numbered to coincide with the numerical order of the literature cited.

Derris elliptica is described[19] as a scrambling shrub with black stems, the undersides of the leaflets and petioles are softly hairy and usually greyish in colour—the flowers are rose pink. Seed pods are rarely produced.

Derris malaccensis is a climbing shrub of erect habit, the undersides of the leaves and petioles are smooth and light green in colour and the young foliage is bright red brown. Varieties of each species have been isolated.

A scheme for the differentiation of the several commercial varieties of *Derris elliptica* grown in Malaya (based on leaf characters only) has been perfected,[13] which proved necessary because of the usual shy flowering and seeding habits of this plant.

There are other groups of plants fairly closely related to Derris which yield rotenone (the main toxic principle in this root) in commercial quantities, thus being a source of competition on the open market.

Two species of cubé root (pronounced coo-bay) *Lonchocarpus* species, are indigenous to British Guiana where they are known to natives as white and black hiari, and are used for catching fish in the same way as Derris is employed by natives in various countries. *Lonchocarpus nicou*, also locally termed cubé root, native to Peru, is of even greater importance.

Cubé root is collected by natives and is being sold in the United States of America in rather large quantities for commercial preparation as insecticides. Manufacturers in New York report that this product analyses 4–7 per cent. rotenone, which compares very favorably with good samples of tuba root.

Commercial sources of Derris are at present in Malaya, Sarawak, British North Borneo and the Dutch East Indies (*see* table II.).

Derris Philippensis and several other species have been collected and analysed from different parts of the Philippine Islands[2], and only a few, including the first named, contain relatively high quantities of rotenone.

Incidence of Derris in New Guinea.

There is one planter in the Bainings district of New Britain, attempting to grow Derris on a fairly large scale. In New Guinea, Derris is much prized by natives and is known as "New Guinea Dynamite". The name has reference to its use in fishing and is derived from an allied practice of dynamiting fish for food supplies, which has wide application on these coasts.

There are probably several species of Derris in New Britain, and the most prized is referred to as "Avun" by natives in Kokopo, and as "Burei" near Rabaul.

The writer has noticed that almost every native village visited in the Talasea and Rabaul districts has a few plants of true *Derris elliptica* receiving care and attention. According to the native villagers the root is placed in tins and bruised until the water is milky white, and then thrown into the sea or pool as the case may be, in order to paralyse any fish present.

There are comparatively few dense stands of Derris in New Guinea because the natives have cut out large quantities of this root in the past for use as fish poison, with little attempt at cultivation or replacement. It has been stated that there are apparently rather extensive areas of Derris south of Madang on the New Guinea mainland behind Melanu and Bogadjin plantations.

Derris Compounds and Their Uses.

Derris products have come into prominence in the group of so-called non-poisonous insecticidal preparations.

Chinese market gardeners in Malaya realized the insecticidal properties of Derris and even cultivated it for local use long before it was exported to other countries.

To control insects it was their usual practice to water their vegetables with an aqueous extract derived from the pounded roots. This is still regarded as their cheapest and most effective insecticide for this purpose.

Tests have proved it to have little toxicity to man, especially in doses applied to plants, and this applies to most higher animals, though some cases of suspected poisoning are recorded. Haag[11] quoted by Adriano[1] swallowed 150 millegrams, equivalent to 23 grains, without ill effect.

In New Guinea the plant is used by natives ostensibly as a poison, but this is believed to be more for moral effect in family questions, &c., as it does not act as a deadly poison. It does occasion severe spasms and paralysis, necessitating the use of the stomach pump by medical officers. One District Officer in the Kavieng district, some years ago issued instructions for all Derris roots to be cut out, believing that it was used as a native poison.

The secret of its use is probably that when eaten the delinquent native becomes very sick for a couple of weeks, usually without fatal effects, so that the relatives and native villagers become sympathetic and forgive them for any rash acts.

Derris has a very wide commercial application as an insecticide for controlling plant pests and insect skin ectoparasites of animals. It behaves both as a contact and stomach poison. In the first case as a contact poison insects crawling on leaves sprayed with Derris, die without eating the dust or spray because of a vaporizing compound present causing respiratory or tracheal paralysis and resulting in suffocation. It has to be ingested through the mouth parts and then absorbed to act as a stomach poison.

The ill effects of arsenical spray residue on the leaves of fruit trees and its effect on human health, where present to excess on the fruits, has recently received much attention. The conclusions resulted in some countries bringing in legislation to control the amount of arsenical spraying allowable on edible food stuffs, which greatly increased the uses of Derris and Pyrethrum.

Derris is particularly useful in the control of insects and aphids on vegetable plant food products at stages of maturity where the application of arsenical compounds may be dangerous to human health and it does not affect the leaves to the same degree as arsenical sprays. The ground up roots when ingested dry by some insects are not toxic, but may become immediately toxic on mixing with water or when sprayed on wet plants. The juice or sap when expressed from the roots is only slightly toxic to insects, as little of the toxic principle comes away with it.

The conclusions reached from actual spraying and dusting experiments with Derris and its compounds have often proved most inconclusive probably due to wide variations in toxic content of the original material and the numerous and varying methods of preparations used.

Derris compounds have been tried on a very wide range of insect and animal pests under the most varying conditions. It appears very useful as an aphicide for controlling plant aphis and is effective against thrips, biting caterpillars and spiders, &c., and is being tried in the control of insects on coco-nuts and other palms.

It is used with great advantage against animal lice, house flies, and as a larvicide in mosquito control. In animal husbandry it has proved effective against "Ox Warble Fly", poultry pests such as "Red Poultry Mite", and more recently against the "Bush Tick" which is the carrier of paralysis of dogs in Australia. An important use is as the basis of some proprietary sheep dips.

Its compounds may be applied as sprays, dusts, or dressings, and have proved particularly valuable in combination with other insecticides and fungicides. Talc, gypsum, inert clay, and finely ground tobacco dust have been used as fillers for Derris dusts, and several firms are selling mixtures of Pyrethrum and Derris. The Pyrethrum acts more quickly but loses its toxicity sooner than Derris, hence their combined value in a mixture. Mixtures of Derris with acetone, bordeaux mixture, lime sulphur, lead arsenate, soap (very wide application), castor oil, white oil, fish oil, sulphur paraffin, pyridine kaolin and kerosene have been tested in various combinations for insect control. Acetone has wide use for extracting rotenone but keeps it in fine suspension, hence resin soap, also acting as an insecticide—is used with a little gum or starch added to compound a proper spray mixture.

Chemistry of Derris.

The main toxic principle present in Derris root is rotenone ($C_{23}H_{22}O_6$) with a most complex chemical formula and which has been found very effective as an insecticide. Derris also contains varying amounts of other toxic compounds such as dequelin tephrosin and toxicarol, which are chemically closely related to rotenone. These compounds are not so highly toxic to insects as rotenone and constitute smaller percentages of the natural root, though the proportion present varies with the species and variety. *Derris malaccensis* for instance is shown by analysis to contain relatively high percentages of toxicarol, which is only one-third as toxic as rotenone against fish. Tests are being conducted in Malaya and elsewhere to determine whether rotenone alone is as toxic as where the other toxic compounds are present in greater or lesser proportions.

There has been a stupendous amount of research conducted on the chemical composition and insecticidal properties of Derris root and its components by phyto chemists, entomologists, and others, the scope of which can only be indicated in this article.

Georgi & Lay, Teik[9] in discussing the valuation of "Tuba Root", state "that there are two methods by which the roots are valued by buyers (*a*) those who buy on 'an ether extract basis', which includes the total amount of material extracted by the solvent, (*b*) buyers on the 'rotenone content basis', which method of valuation is based on the results of an investigation carried out by the United States Department of Agriculture." The first method of evaluating Derris is used mainly in respect of roots offered for sale in the United Kingdom, whilst the rotenone basis is for most part restricted to material exported to the United States of America.

It was believed formerly that *Derris malaccensis* and *Derris elliptica* had much the same toxic properties because the percentages of ether extract obtained proved very similar in both cases. The American investigators were first to point out that the ether extract of the former contained so much less rotenone than that from the latter species owing to varying percentages of other compounds present.

There is still much controversy as to whether the rotenone basis or the ether extract basis is best for commercial purposes. The prices of Derris or Tuba at Singapore are compared on an ether extract basis as against a rotenone content basis (*see* table V.), and it is seen that the sales on a rotenone basis consistently yielded highest prices.

This does not necessarily present a true picture of the position, however. The two largest British firms operating in Malaya are mainly interested in ether extract Derris, most of which is not sold on the open market hence the difference in prices noted might not be a true reflex of the valuation methods used. It is emphasized that neither the methods of analysis, commercial sampling, or the methods of selling have been accurately standardized, though research workers and buying organizations are rapidly attaining that end.

Strictly speaking, the relative toxicities of the different species and varieties of Derris can only be determined by controlled insecticidal tests combined with chemical analysis. The results of the relatively few tests of this nature already available display very conflicting results. Some species of insects, for example, are much more resistant to the action of Derris than others. Miller[16], entomologist in Malaya, has described several insects capable of attacking Derris roots in the dry state. Froggatt[7] has recorded a borer belonging to the Bostrychid species, *Xylotrips religiosus* (Boisd), as causing severe damage to dried root in New Guinea. The author has noticed an ascomycetous fungus, not yet identified, causing severe leaf spotting on New Guinea Derris.

Cockroaches have been fed on pure dry rotenone apparently without effect, rats also can eat it with impunity, but are poisoned when it is injected into the blood. It has been found that insect pests usually live on the larger tubers only, and these have been proved by numerous chemical analyses to contain much less rotenone than small sized pencil roots. This explains why buyers express definite preference and usually require fine roots of definite size. Analyses have shown that the centre part of the root contains more rotenone than the outside portions of the same root.

McCormack & Co., United States of America, in correspondence state "that they can obtain rough standardization by a system of blending". The root is milled and after every 1,000 lb. milled analyses are made, after which various lots are mixed in proper proportion. Other firms have mentioned blending with high quality root as a method of using lower quality root.

One of the great defects of Derris products containing rotenone is the loss of toxicity in storage, largely due to the decomposition of the toxic products on exposure to light.

Recent research carried out by the Council for Scientific and Industrial Research, Australia[20] indicates this loss of toxicity on exposure to light is one of photo chemical oxidation, i.e., due to the action of light and air, which occurs at a much slower rate with pyrethrums derived from *Chrysantheum cinerariaefolium*, &c.

Recent chemical research has given very great promise of obviating this loss of toxicity on storage and certain chemical derivations of rotenone are now known which are even more toxic and decidedly more stable than the original compound. The commercial and economical application of this research is still in the experimental stages.

Analysis of New Guinea Derris.

Lenz, in 1911[15] recorded the results of successive extractions of *Derris elliptica* root from New Guinea with various solvents, and obtained an ether extract of 8.9 per cent. at room temperature.

TABLE I.—DERRIS ROOTS FROM NEW GUINEA—ANALYSIS BY THE IMPERIAL INSTITUTE, LONDON (4).

	Present samples from New Guinea.		Commercial samples of Malayan roots.
	Fine roots.	Coarse roots.	
	Per cent.	Per cent.	Per cent.
Moisture	7.8	7.4	10.2
Total Carbon Tetrachloride Extract* ..	7.8	4.8	10.4
Rotenone*	3.2	2.1	2.2

* Expressed on the moisture free material.

The results show that the rotenone content of each of the present samples from New Guinea compared satisfactorily with that of the commercial sample of Malayan *Derris elliptica* roots used for comparison. It is commented by the present author that bulk samples and the rotenone content in both cases is lower than the standard required by most buyers.

Derris Uses as a Mixed Culture.

Derris belongs to the family of leguminous plants which has nitrogen fixing bacteria present in root nodules, capable of fixing nitrogen from the air, and thus acting as a definite soil improver. It has been used in mixed cultivation with coco-nuts, kapok, cocoa, rubber, &c., in countries such as Malaya and Java, although this aspect of Derris cultivation is still in the experimental stage.

Of special interest to local planters is that Derris grows well under coco-nuts, although there are some disadvantages which accrue from their mixed cultivation. Derris roots become large and tuberous and grow down 3 feet or more after two years growth, besides growing 6 or 7 feet away from the base, i.e., where no other crops are competing. Harvesting Derris roots of correct size for marketing means digging deeply into the soil which may injure roots of other trees or crops present.

The surface roots of coco-nuts at 5 yards distant from the base may be only 1 foot below the surface, and the roots of two coco-nut palms in adjoining rows may overlap 6 feet or more. This leads to the possibility of root competition with the Derris and root injury to the palms where the two crops are grown together in mixed culture.

The mixed cultivation of Derris and young coco-nuts could be advocated for several years after planting the latter, as there is much less chance of root competition in early growth. There is a decided risk of root injury and root interference where Derris is interplanted with old coco-nuts, but the practical effect of such competition on the two crops remains to be tested on an experimental basis in this country.

Interplanting with kapok in Malaya was described by Georgi and Curtler[8] where the kapok trees were spaced 20 feet by 20 feet square. Tuba cuttings were planted in rows 3 feet apart and spaced 3 feet apart in the rows, which was equivalent to 3,555 plants per acre.

Cultivation of Derris.

Derris grows in most kinds of soils and is said to prefer a clayey loam containing a fair quantity of sand, but may even grow profitably on worn-out lands where other crops do not thrive.

The species of Derris are readily propagated from stem cuttings 18 inches long, which are usually struck in nursery beds, preferably of light or sandy soil.

Collapsible bamboo baskets, or baskets made from strips of palm fronds, have been employed in some instances for rooting the cuttings. This also allows the plants to be set out in properly made holes without disturbing their growth or giving them a setback on transplanting.

Experiments are being conducted with different kinds of composts, leaf moulds, soil, &c., both in seed beds and in the field, to increase the yield where possible.

In growing plants to develop cuttings it is preferable to train them over light poles or bamboo trelisses with *Crotalaria* or *Tephrosia* as a leguminous shade, grown in rows on either side of the trellis rows. The plants must be grown for nearly two years before the stems are ready to provide cuttings for increasing selections on a field scale. The stems must develop good firm mature bark, as immature shoots with soft bark will strike badly. Cuttings root earliest and do better in a moist lightly shaded nursery bed, and are often ready six weeks from the date of planting. If they are exposed to full sun it is advisable to remove the leaves to prevent drying from excessive transpiration.

A recent publication[5] describes the methods of cultivation adopted by Chinese market gardeners in Malaya. They plant long cuttings which have been twisted into a circle at distances of about 6 feet apart and then allow the plants to run over the land. During growth pig manure is applied to the soil and the crop is not harvested at one time, but lifted as required.

In ordinary sole cultivation[19] the rooted cuttings are transferred to the field at a planting distance of 3 feet apart each way, giving 4,840 plants to the acre. Good results have been obtained by ridging the land in rows at 3 feet apart, the soil being worked into a fine tilth during the operation.

Methods of growing and shading Derris still requires much experimental testing and experiments in this direction have been commenced at Keravat Experiment Station, Territory of New Guinea.

A promising new method of cultivation is under test at the Government Plantation at Tjipitir, West Java, where attempts are being made to develop Derris as a permanent crop. There the Derris is planted under permanent shade, spaced at correct distances for protection. Bamboo poles for support are fastened between each contiguous pair of shade trees in the same row. The Derris plants are planted in holes in the centre of the space between the trees and allowed to climb on to the supports. It is intended to dig out the roots when ready to harvest from opposite sides of the supports at alternate periods. Thus the Derris, which is naturally a fairly long lived plant, will only be lifted partially, and it is

expected that the remaining roots will keep the plant going and provide a continuous harvest for some years. The effect of root injury, and effect on yields, cost of harvesting and danger of Termite or white ant injury are the serious considerations in this method.

Harvesting of Derris ordinarily means digging up the roots, and the preparation prior to marketing is discussed elsewhere. The optimum age for harvesting Derris roots has been the subject of experimentation, and one investigation shows 23-24 months as the best age to harvest the roots, but this is subject to soil and hereditary variation. A time of harvesting experiment, where Derris was interplanted with kapok, was indicated previously under mixed cultures. Here the root was harvested at the end of 21, 23, 25 and 27 months, respectively, and yields of 1,277, 2,190, 2,697 and 3,445 lb. of root per acre were recorded at the end of each period. It was found, however, that the ether extract noticeably reduced after the 25 months period.[3] The roots may severely reduce in rotenone content after an optimum period, although the yield of root usually increases.

Manufacture of Derris.

This is mostly in the hands of proprietary firms as there are few simple methods of preparing the product for commercial use, and usually efficient grinding machinery is necessary. Where costly solvents such as ether, acetone, or carbon tetrachloride are used, there must be provision for recovery and repeatedly using the same solvent.

It is prepared as dusts, sprays, Derris extracts, mixtures with other compounds, &c., but most of the processes are covered by wide patents. Local manufacture should not interest New Guinea planters for some time to come, and hence is not discussed in this article. It will be of interest, should both tobacco culture and Derris culture expand, and essential particulars are available.

Preparation of the Roots for Market.

It is the buyers' requirements which need consideration at this juncture, and, firstly, they demand a dependable supply, and, secondly, satisfactory toxic content. Continuity of supply and regular delivery of quality root is very important, but somewhat difficult to fulfill with a culture such as Derris.

Derris is not usually subjected to any preparation after harvesting, other than drying and removal of the dirt. The usual practice after harvesting the roots is to wash away the dirt, place them in open sheds and allow to dry for about ten days. They must be thoroughly dried and stored in a cool place to prevent deterioration and entree of insect pests. The smaller roots of pencil thickness have the greatest toxic value, hence it is the recognized practice to sort the smaller from the larger roots. The preparation for shipment necessarily must be thorough and demands cheap labour.

Shipments from Malaya are usually cut into suitable lengths of about 3 feet and the Derris roots are then dried, bundled into bales measuring approximately 42 inches by 30 inches by 28 inches and weighing from 220 lb. to 250 lb. net, which are wrapped in jute bags.

Another method now used is where the roots are ground up in a suitable disintegrator and put into rubber and tea cases weighing about 100 lb. net.

In Malaya chips were made from the roots and then bagged, this proved unsatisfactory as a preparation for shipment.

Koolhaas[14] invented a method in Java where the roots are ground and pressed into cakes of very hard consistency to save space and prevent loss of toxic content.

Control of insect bores in the dried Derris is practicable by fumigation prior to shipment.

Selection and Plant Improvement of Derris.

In Malaya and Java many named varieties of *Derris elliptica* have been originated and increased from single plant selections of proved high toxic content.

In the same manner much selection remains to be done in original unselected material present in all tropical countries such as New Guinea, where this species grows naturally.

According to Roark,[17] single plant selections of *Derris elliptica* have been isolated and analysed and found to be totally free of rotenone. Some selections and samples yield 2 per cent. and others as high as 7–8 per cent. rotenone, with a total ether extract varying up to 13–18 per cent., and even 22 per cent. has been recorded.

Species or varieties of Derris may have a high ether extract and a low rotenone content and to a lesser extent vice versa, whilst selections with both high ether extract and high rotenone content are more desirable, and this constitutes an important aim in selection.

Selections of Derris of known high toxic content have been introduced from Malaya by this department and are now undergoing tests.

Work has been commenced in collecting selections of Derris from all parts of New Guinea, to determine by plant breeding and chemical analysis whether high toxic content selections can be isolated from the indigenous material.

Variation in toxic content has been attributed to soil and climate as well as hereditary differences.

Insufficient work has been done to indicate to what degree soil and climate affect the hereditary characters tending to high rotenone content which is present in some selections. A high rotenone content selection grown in one place and transferred to another place in Malaya was found by their chemist to vary considerably in percentage of rotenone present.

Yields Recorded in Other Countries.

The Malayan Department of Agriculture has indicated that under suitable conditions the yield of fine dry roots is about 1,000 to 1,200 lb. per acre.

They have recorded 1,600 lb. per acre after using chillies as a catch crop and 2,700 lb. per acre when interplanted with kapok and harvested after 25 months.

The average weight of roots per plant at their Serdang Experimental Plantation, Kuala Lumpur, has been recorded as 1 lb., whilst a loss of weight of 40 per cent. was stated to take place during drying.

In Cebu, Philippines, according to Adriano et Al[2] production has been estimated at 2,500 to 3,500 kilos of fresh root per hectare (kilogram equals 2.25 lb., hectare equals 2.472 acres, hence equivalent to about 2,000–3,000 lb. per acre). They claim that 600 kilos of dried root per hectare (nearly 500 lb. per acre) is a low average yield.

Dividing the acreage planted in Malaya into the tonnage exported in 1933, it appears that the average yield for the whole country is about 4 cwt. per acre, i.e., if the comparatively small amount used externally is excluded and if little Netherlands Indies root for transhipment has been included.

Overseas Prices.

Fuerst Bros. & Co., London, quote the price of Derris root at 31st August, 1934, as 7¾d. per lb. less 1 per cent. c.i.f.

Brown & Dureau Ltd., Melbourne, in a letter received 7th March, 1935, state that continental firms in England quoted as follows for a parcel of Tuba Derris root with a rotenone content of about 4 per cent. (without guarantee). They suggest £15 per ton c.i.f. Rotterdam, excluding duty (equivalent to about 1s. per lb. landed).

Prices appear to have varied in the United States of America from 12–20 cents per lb. According to the Imperial Institute 1933,[3] the price of Derris has fallen considerably during recent years. The spot price of Derris root in London, according to the *Chemist and Druggist*, is 8½d. per lb. (November, 1933), compared with 10d. per lb. earlier in the year.

If a yield of 1,000 lb. per acre is assumed for purpose of calculation, and the quoted prices of 7¾d. per lb. and 8½d. per lb., the gross returns per acre would be £32 5s. and £35 8s., respectively. This would be reduced to £16 2s. and £17 14s. gross returns per acre if the stated low average yield of 500 lb. per acre was harvested.

The cultivation and harvesting expenses should not be high since the plant does not need much attention.

Little accurate costing for cost of production is available from outside countries.

Adriano et Al[2] state that 600 kilos of dried Derris root will yield about 14.52 kilos only of crude rotenone crystals, but this is assuming only 2.42 per cent. rotenone. They advocate extraction of the rotenone on spot in the Philippines to avoid cost of shipment. Bower, 1930,[6] stated that "so far no suitable means have been found for extracting the toxin before shipment."

General Discussion.

Planters in New Guinea should not regard Derris as a crop which is likely to provide quick returns, largely because its culture is only in the experimental stages. Only a few original plants are available in this country, which are known to be derived from plants of satisfactory toxic content. It will be necessary to grow these for two years before cuttings will be available for increase on a field scale.

Large scale introduction of selected plant material from outside countries (e.g., Malaya) is possible, but it may prove difficult to obtain their best selections. Then there is the risk of landing the cuttings in good condition for planting and also the effect of this climate on their rotenone content is unknown.

Indigenous New Guinea plant material is being collected from widely scattered areas. Single plant selection combined with chemical analysis will be necessary before selections are isolated, which should favorably compare with the best material available in Malaya and Java.

Chemical analysis of some New Guinea root[3] showed 7.8 per cent. tetrachloride (approximately equivalent to ether) extract and 3.2 per cent. rotenone in the fine roots, and 2.1 per cent. in the coarse, respectively. This was stated to compare favorably with 10.4 per cent. extract and 2.2 per cent. rotenone present in a commercial sample of Malayan root.

The consensus of opinion amongst Derris manufacturers in England and America is that both of these samples contain rather too little rotenone for satisfactory commercial manufacture, although they could be used by blending with higher quality root.

The shipment of fine and coarse New Guinea Derris root sent to the Imperial Institute for analysis and comparison with Malayan root, represented a bulk sample. This did not indicate the value of individual samples from selected New Guinea stock, which is known to vary considerably in vegetative characters. Chemical determination of the rotenone content combined with individual plant selection preferably should be carried out by the New Guinea Department of Agriculture, and such work is under way at Keravat Demonstration Plantation.

Economic Prospects.

There is no information available as to expected yields and monetary returns from prospective New Guinea Derris culture. Inquiries instituted elsewhere by the Department of Agriculture, such as in the United States, England, Australia and Holland, have yielded much conflicting information.

It appears questionable whether most of the Derris buying is not in the hands of relatively few buyers. It is difficult to gauge buyers' requirements and obtain information as to what quantities they would absorb, or what prices they would be prepared to offer. An important consideration is the competition with Cubé root from South America, which is becoming increasingly common in the American markets.

It must be decided whether growing for rotenone or ether extract buyers, or both, is going to prove the most profitable. The indications according to prices are that high rotenone content Derris will pay best, especially for the American market. It seems that the rapidly expanding uses to which Derris is being put should ensure a profitable market in the future. It has been stated[1] that the United States imports 10,000,000 lb. of pyrethrum flowers annually, and that rotenone promises to supplement this in part and also supplement the limited supply of nicotine which it rivals as an aphicide.

The Director of Agriculture has sent, and intends sending further shipments to London and American buyers as soon as there are sufficient stocks on hand for this purpose. It will soon be possible to make more definite recommendations to planters as to the future prospects for this crop.

Derris should have decided value for native agriculture in this Territory, and requires testing in that direction.

Planters in New Guinea should not regard Derris as a culture which is likely to provide quick returns at this stage. Its cultivation is still in the experimental stages here, and there is insufficient planting material of high toxic content available for distribution.

TABLE II.—DERRIS STATISTICS (4' 12).

EXPORTS OF DERRIS ROOT IN TONS.

—	1930.	1931.	1932.	1933.
Malaya	55½	74½	167	642
British North Borneo	34½	25	(a)	(a)
Sarawak	735	108	37½	(a)
Sumatra	3	8½	2	20
Dutch Borneo	3	4	1½	

(a) Not available.

TABLE III.—MALAYAN STATISTICS.(10)

TOTAL CROPS SPECIFIED CULTIVATED IN MALAYA, 1933.

	Acres.
Federated Mayal States, F.M.S.	1,369
Straits Settlements, S.S.	2,514
Unfederated Malay States, U.M.S.	1,566
Total Malaya	3,500

ACREAGES UNDER SOLE CROPS, 1933.

	Acres.
Perak Derris	725
Singapore Derris	350
Total	1,075

TABLE IV.—TUBA ROOT DERRIS.

Year.	Imports.		Exports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.	Straits dollars.	Tons.	Straits dollars.
1930	39	11,655	90	88,176
1933	72	18,328	642	282,795

N.B.—One Straits dollar = 2s. 4d. sterling.

TABLE V.—PRICES OF DERRIS TUBA AT SINGAPORE, 1934.

(FIGURES SUPPLIED BY CURATOR VAN DER KOPPEL, HANDELS (ECONOMIC) MUSEUM, BATAVIA).

—	Ether Extract Basis per Pikul = 133⅓ lb.	Rotenone Basis per Pikul = 133⅓ lb.
January	24C	30½C
February	25	30½
March	25	30½
April	26	37½
May	28½	37
June	30½	40
July	34½	40

N.B.—Prices in Dutch cents, 100 = one guilder; equivalent to about 2s., now worth about 3s. 4d. owing to exchange.

SUMMARY.

1. Derris has been the subject of many inquiries to the Department of Agriculture, Mandated Territory of New Guinea, from planters and others interested. Its economics, culture and prospects are discussed in this article, as this is a valuable source of insecticidal material which is receiving much attention in most tropical countries.

2. Derris as a source of rotenone is discussed, including species indigenous to New Guinea as is its probable competition with Cubé root (*Lonchocarpus* species).

3. Insecticidal properties of rotenone and methods of extraction from Derris as well as its use in various insecticidal mixtures are outlined.

4. Importance of selection and propagation of suitable varieties is stressed, there being wide variation in rotenone content of different varieties.

5. Methods of cultivation, uses for interplanting, and preparation of roots for market are described.

6. Chemical analysis of bulk samples of New Guinea Derris root, conducted by the Imperial Institute,[4] showed that rotenone and toxic content to compare favorably with samples of Malayan root. (Root from both sources apparently gave a somewhat lower analysis than the accepted standard.)

7. The economics and future possibilities of Derris culture are dealt with. While it is too early to give very definite data, it appears that the rapidly expanding uses to which Derris is being put should ensure a profitable market in the future, which would allow of its development as a culture crop in this Territory of New Guinea.

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