INVESTIGATION OF THE RUBBER INDUSTRY IN PAPUA AND NEW GUINEA—I

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(Mr. Mann's detailed report on the rubber industry in the Territory is being published in two sections in this and the January, 1954, issues of the *Gazette*.)

Introduction.

In 1952 the author of this report was invited to visit the Territory of Papua and New Guinea to make observations and to report upon the rubber producing industry in these Territories. The terms of reference are quoted below.

Terms of Reference.

(A) To report on the quality of Papuan rubber and the efficiency of present methods used in the Papuan rubber industry judged by standards in other countries, and to suggest means of improvement in methods and product. This report should include comment on the following specific matter :—

(i) Location of existing plantations with respect to terrain, accessibility, climate, etc.;

(ii) Soils, soil deficiency and manuring;

(iii) provision of high yielding plant material including local selection of high yielding clones and cross-breeding;

(iv) Disease and pest control;

(v) Methods of cultivation, planting and harvesting (including mechanization);

(vi) Factory techniques;

(vii) Methods of preparation for market—

(*a*) baling;

(*b*) grading, particularly reclassification of grades and chemical grading;

(viii) Advisability of establishing a central (co-operative or other) factory; and

(ix) Desirability of concentrating on latex production and the problems involved.

(B) To advise upon setting up a rubber research scheme.

(C) On the assumption that some expansion of the industry is desirable, to advise upon best methods of achieving expansion.

(D) To report to the Department of Territories, Canberra, on the above matters.

Field observations were undertaken in August and September, 1952, these are reported in the following sections together with comments on the specific matters indicated in the terms of reference.

PART 1.

THE writer's experience in the rubber producing industry has been gained mainly in Malaya and is supplemented by some acquaintance with the industry in other territories, namely Ceylon, Indonesia, Thailand, Vietnam (Indo-China) and British Territories in North Borneo. In accordance with the first term of reference, which asks for comparison of the Papuan rubber industry with the industry in other countries, a brief outline of the development of the rubber

plantation industry in other countries is first presented. This outline is based largely on development in Malaya; where notable divergences in the course of development in other territories have occurred, reference is made to them.

From the introduction of the Para rubber tree (*Hevea brasiliensis*) to the Far East in 1876, first to Ceylon, and from Ceylon to Malaya and Indonesia and other countries, the gradual development of a rubber plantation industry has followed a very similar course in the principal producing territories. The common stimulus was of course the rise of the motor car industry and the need for rubber for pneumatic tyres, which still remains the largest single field of consumption of rubber. The first planting of Hevea rubber as an estate crop was made in Ceylon and Malaya in the last decade of the last century but large-scale development may be regarded as starting in the first decade of the present century; the industry is about fifty years old. The earliest plantings of Hevea in Papua and New Guinea are believed to have been made between 1901 and 1905.

The industry developed rapidly in Ceylon, Malaya and Indonesia : financed mainly by British and Dutch capital, it remained during the first decade of its development almost entirely a large plantation enterprize. The rapidly increasing demand for rubber resulting in the " boom " years of 1910 to 1914 stimulated further planting not only by large company organizations, but also by Native land owners in the principal producing countries. In Papua the industry has remained almost entirely a European enterprize.

Much has been written on the advantages and disadvantages of rubber as a permanent crop for Native cultivation; the objections to it, that have become increasingly evident in the past decade, might well have been avoided by wiser planning and control in the early stages of the development. It has been stated, for example, that unrestricted planting of rubber by Native land owners has prevented the development of a rational system of Native agriculture in which a proper balance is maintained between food production and the cultivation of cash crops. This is undobutedly true in many districts in Malaya and probably in other territories, on the other hand much Native planting of rubber has been done on land that is quite unsuitable for the continued cultivation of short term food crops although it can be productively used in the cultivation of a permanent crop that will thrive reasonably well on soils of only average fertility. In another connection the planting of a permanent crop, whether it be rubber or any other tree crop, provides a valuable means of checking the wasteful system of shifting cultivation practised by relatively primitive peoples. The establishment of a perennial cash crop may prove an essential first step in the development of a rational system of Native agriculture based on permanent settlements with a proper balance of short term food crop production, with livestock and permanent cash crops. No excuse is offered for this digression, for the development of a Native rubber growing industry in the wake of the advancing plantations has been a common feature of the development of the industry in Malaya, Ceylon, Indonesia and North Borneo. Exceptionally, rubber production in Sarawak and Thailand has been developed almost entirely by Native land owners, and company-owned estates represent only a very small proportion of the total rubber producing areas in these countries (see Table 1). On the other hand, practically the whole rubber producing area in Indo-China has been developed in Cambodia and Cochin China in large highly organized modern estates by a small number of companies with French capital; of the planted area of close on 330,000 acres only 6 per cent. represents Native planting whilst the labour employed to develop and operate the plantations has been recruited largely from Tonkin and from other provinces of the country.

Rubber is not a difficult crop to grow, it does not demand a fertile soil, neither is a high standard of skill required in its cultivation beyond reasonable care and attention during the first year or two from planting; these considerations favour its adoption by Native land owners. On the other hand, systematic

harvesting and preparation of the crop are laborious and skilled occupations, involving regular daily work; this makes the crop less attractive to more primitive people whose essential food production is not an arduous business and whose cash needs are small.

It will be noted that the establishment of the rubber plantation industry made rapid progress in Ceylon and Indonesia, where during the early years of its growth there was adequate local labour already skilled in tropical agriculture, in the production of copra, coffee, tea, sugar and other major crops. Similarly in Malaya, at least in the initial stages, there was an adequate supply of labour of the indigenous races, including immigrants from Indonesian territories, and immigrant Chinese agricultural labourers. As the pace of development increased there was no difficulty in attracting additional labour from other territories and immigration was encouraged.

Gradually the pattern of the industry in Malaya emerged. The estates opening from virgin forest land employed Chinese labour for the heavy work of felling, clearing and preparation for planting. Planting, cultivating and harvesting has been largely undertaken by immigrant South Indian labourers who have gradually become the permanently settled, specialist workers of the large plantation section of the industry. Meantime the Malay land owners, many of whom had worked on the plantations in the early days, cleared and planted their own land, often with the help of immigrant labour and with planting material readily obtained from the estates. Between the two extremes of the large Company enterprize of several thousand acres and the family smallholding of from two to five acres, plantations of all sizes have been established. The industry is now regarded as consisting of two main sections, the estates, of 100 acres or more, and the smallholdings, comprising properties of less than 100 acres. The average distribution between these two categories in the principal producing countries is shown in Table 1.

TABLE I.

World areas under Rubber, Estates and Smallholdings, in acres (a)

Territory	Estate	Smallholders	Total
Malaya	2,107,000	1,374,000	3,481,000
Indonesia	1,567,000	3,200,000	4,767;000
Ceylon	359,000	280,000	639,000
India	83,000	54,000	137,000
Burma	68,000	43,000	111,000
North Borneo	74,000	59,000	133,000
Sarawak	18,000	222,000	240,000
Thailand	19,000	400,000	419,000
Indo-China	311,000	20,000	331,000
Totals	4,606,000	5,652,000	10,258,000
(b) Papua and New Guinea	(c) 25,623	762	26,385

NOTES.—

(a) Data in this table are obtained principally from the official figures published by the International Rubber Regulation Committee in 1944 (*The History of Rubber Regulation* 1934-43. Edited by Sir Andrew McFadyean; Allen & Unwin, London), Minor corrections indicated by later information have been made.

(b) The data for Papua and New Guinea are from latest official records.

(c) Of the smallholdings not more than 300 acres represents Native owned plantings.

The pattern of development in Java and Sumatra has been similar to that in Malaya except that in Java with its dense population there was never any problem of shortage of labour for the new crop, in fact the development of the rubber plantation industry provided a welcome outlet for surplus labour from Java in the establishment of the large plantation industry in the East Coast district of Sumatra. Furthermore, the planting of rubber by smallholders in previously undeveloped areas of South and West Sumatra and in South Borneo was encouraged and fostered by the former Dutch administration with the result that the total acreage of rubber smallholdings in the Republic of Indonesia is estimated to be not less than 3,000,000 acres. Much of this planting has been carried out on land that might have reverted to secondary jungle, or possibly have become derelict, under the wasteful system of shifting cultivation which still obtains in the less advanced parts of Malayasian territories. In Ceylon, as in Malaya, South Indian immigrant labour was brought in to work on the large estates, whilst Ceylonese landowners established their own smallholdings. In North Borneo the pattern is much the same with 55 per cent. of the total acreage in large Company owned estates and 45 per cent. consisting of smallholdings. However, the smallholdings in North Borneo have been developed almost entirely by immigrant Chinese settlers the Native Malay races having shown little interest in rubber cultivation in the territory.

It will be clear from the foregoing, and a glance at the data in Table 1, that a close comparison of the development of the rubber industry in Papua and New Guinea with that in most other rubber producing territories is by no means straightforward. Possibly the nearest parallel would be with North Borneo where the estates have been developed by capitalist enterprise and now employ indigeous labour, but the comparison is only valid to a limited extent. In North Borneo the original opening and planting was mainly undertaken with immigrant Chinese and Javanese labourers, many of whom have long since settled, taken up land and gone into business on their own account, but for harvesting and general maintenance estates rely largely on indigenous Native labour, a large proportion of which is seasonal, working on the estates between the periods of rice planting and harvesting.

In the absence of a close parallel the most useful approach may be a comparison between a typical Malayan estate and one of comparable acreage in Papua. Taking for example an estate of 1,500 acres, the Malayan estate organization would be approximately as follows—

One European manager, exceptionally one junior European assistant manager, with a small office staff of one senior Asian clerk/book-keeper and possibly one junior assistant clerk. In the field, one Asian assistant or conductor to supervise tapping and general field work, with a junior conductor if there should be a large programme of replanting. In the factory, one Asian factory and store clerk, who is usually a qualified " dresser " or medical attendant, and may share part of the office work. A labour force of approximately 400 includes both male and female adult workers. This basic labour force, one adult labourer to four acres, lives on the estate, the estate providing approved housing accommodation, medical attention, a school, a Native temple, a day nursery for younger children and many other facilities as required by the Labour Ordinance. The estate also provides the same facilities for dependants of labourers, these may account to about 40 per cent. of the total adult labour forces; dependants and children are given casual work on the estate. Labourers are organized in small groups for their specific duties, tapping, weeding, disease control, etc., each group under the supervision of a foreman, an experienced worker and instructor, appointed by the manager. The estate also employs a small staff of locally trained artisans, carpenters, engine drivers and fitters adequate for the operation and routine maintenance of machinery and equipment; for major jobs skilled professional services are readily available. All

estate labourers are paid in cash, in accordance with standard rates agreed by negotiations between the estate workers' trade unions and the employers' associations. Estates may assist their labourers by purchasing food supplies, particularly rice, in bulk for distribution at cost but such arrangements have largely given place to the establishment of estate co-operative stores, managed by the labourers, or by estate shops operated by a Native shopkeeper under the nominal control of the management of the estate. The estate also provides land for labourers' gardens and a grazing area for cattle, with sheds and byres, this provision being especially important for Indian labourers who customarily invest a large part of their savings in livestock.

The organization briefly outlined above is typical of the older medium sized estates in Malaya. The resident labour force is usually of the Tamil race, originally recruited from South India and now more or less permanently settled on the estates. In many of the older planting districts on the coast a large proportion of the labourers may have been born and brought up on the estate and have in their various occupations attained a high level of skill in all branches of rubber cultivation and manufacture. In comparison with this organization the picture in Papua on an estate of comparable size exhibits many contrasting features.

In Papua mangerial supervision is provided on a basis of one European for about 500 acres. An estate of 1,500 acres in full production would probably employ one manager and three assistant managers. Experienced subordinate staff, equivalent to the Asian office, field and factory staff are usually of the same race as the labour force, as employed in Malaya, are not found in Papua. Thus a most important link between the administration and the labour force, as judged by accepted practice in Malaya and in most other major producing countries, is hardly represented in the Papuan plantation industry. It is not a simple matter to assess the true significance of this essential difference. In practice it means that in Papua all field and factory supervision and instructions of labour, together with essential clerical work, crop recording and costing of field work has to be done by the European staff. The employment of a limited number of " boss boys " some of whom are experienced helps to some extent in the training of raw recruits. A full labour force for an estate of 1,500 acres, on the basis of one man for 3 to 4 acres, would be 400 to 500 labourers. The present system of employment provides for the recruitment of men only, rarely are entire Native families employed on an estate, and there has been no attempt to encourage the establishment of a normal village community life on Papuan plantations. This is in striking contrast with the situation in other rubber producing countries. Labourers in Papua are now largely recruited from the Highlands districts where rubber is not grown nor is ever likely to be grown ; they arrive on estates quite unsophisticated and untrained and serve for 18 months. It is hardly to be expected that their standards of work will compare with those of established labour on otherwise comparable plantations in other producing countries. Taken in conjunction with the difference in the system for supervision and training of labour, the absence of the middle stratum of locally trained Native assistants, the inexperience of available labour results in standards of work and production on Papua estates that cannot be fairly compared with those in Malaya and elsewhere.

To complete this survey it is necessary to refer to the provision of technical services for the rubber plantation industry in other countries. The pattern of the application of agricultural science to the problems of growing and production of natural rubber has been very similar in each of the major countries where Hevea is grown. Whilst originally scientific advice was provided by the Government Department of Agriculture in most territories the industry demanded more. In Java and Sumatra the large plantations recruited their own specialist scientific advisers, establishing their own experiment stations for rubber as early as 1915-1916. This lead was followed by Ceylon in 1921 with the establishment of the Ceylon Rubber

Research Scheme, and in 1925 Malaya established the Rubber Research Institute of Malaya for rubber producers in Malayan territories. These Research and Advisory organizations were financed either by private contributions made on an acreage basis (Indonesia) or by a cess on rubber exports (Ceylon and Malaya). The job of the industries research stations is to investigate all problems of the production and processing of natural rubber and to provide information and advice upon such problems. The *modus operandi* is illustrated in some detail in Appendix to this report which describes the current organization of research and advisory services for the Malayan rubber industry. Besides drawing freely on the services of the research and information stations, estate companies usually employ planting advisors (who have largely taken the place of the old " visiting Agent "). These are men of wide experience and knowledge of practical developments in the industry who pay regular visits of inspection to estates and advise the management on administrative, operational and technical matters. Usually they keep in very close touch with the specialist workers at the industry's research stations and translate their work clearly to the man on the job.

In Papua as in other territories involved in the upheavals of World War II technical services to the rubber planters, the industry is not large enough to carry additional specialist services of the kind that have grown up in the larger producing countries.

Part II.

Statistics.—

In Papua as in other territories involved in the upheavals of World War II many valuable records have been lost, but the Department of Agriculture, Stock and Fisheries, has done an excellent job of re-assembly of essential data and, subject to the errors inseparable from records obtained largely in response to questionnaires, a fairly complete statement of the acreages under rubber, and production for the post-war years, was available. Principal data for the period 1st April, 1950, to 31st March, 1952, are summarized in Table II. It should be noted that these years include the phase of panic buying of natural rubber for stockpiles and the resulting " boom " period.

No details of rubber acreages in New Guinea are included in the statistics because it was found that records of plantings of Hevea and Ficus rubber in New Guinea were confused, so that it was best to omit them. No further reference to Ficus rubber is made in this report; observations on Hevea rubber in New Guinea are contained in Part V.

Rubber in Papua is grown in three, or more accurately four, fairly clearly defined regions, namely—

(i) the coast alluvial plains and broad river valleys of Western, Gulf, Central and Milne Bay Divisions, with some 9,000 acres in the Kanosia area;

(ii) the Sogeri plateau of Central Division, at 1,400 to 1,600 feet, with about 7,000 acres;

(iii) the Northern Division of Papua in—

(*a*) the Kokoda-Yodda Valley about 2,000 acres; and

(*b*) the Popondetta-Awala-Sangara area about 3,500 acres.

Each of these four regions has its own characteristic features which are described in more detail in the notes on the surveys undertaken, Part IV. It is to be regretted that separate yield data are not available for the Kanosia and Sogeri areas, both within the Central Division; the figures in Table II. column 4, and details in Table III. show that these two areas are responsible for the major part of Papuan production, but they do not indicate the relative levels of production in the two regions.

Generally, the overall yields per acre recorded in Table II are lower than the writer had been led to expect. In an economic survey carried out at the end of 1949 * an overall yield of 400 lb./acre/year was accepted, and was compared with a reported overall yield of 564 lb./acre/annum for Malaya. The official records tabulated in this report indicate an overall yield for Papua of 239 lb./acre tapped in the year ending 31st March, 1951, and 308 lb./acre tapped for the year ending 31st March, 1952. The apparent discrepancy can probably be accounted for by the shortage of tappers and selective tapping. Areas tapped selectively do not yield maximum crops per acre; in the effort to secure maximum output with incomplete and inexperienced tapping forces the actual production attained was no doubt a good performance. Principal yield data are summarized and compared below.

(i) Rubber Acreages and Production, Papua—1951 and 1952.
(Year ends 31st March.)

Year	Number of Plantations	Total Planted Acres	Tapped Acres	Total Yield Pounds	Yield in lb./acre/year
1951	49	24,597	17,467	4,180,262	239
1952	49	26,197	18,166	5,602,117	308

(ii) Rubber (Estate) Acreages and Production, Malaya—1951 and 1952.
(Year ends 31st December.)

Year	Number of Estates	Total Planted Acres	Tapped Acres	Total Yield Tons	Yield in lb./acre/year
1951	2,252	1,963,735	1,597,012	327,956	460
1952 †	2,252	1,963,735	1,575,606	338,323	481

For the year 1952 separate data are available for these two categories :—

(*a*) Ordinary seedlings—acres tapped 1,174,688; yield/lb/acre 363;

(*b*) High-yielding material—acres tapped 400,918; yield/lb/acre 827;

(*c*) Total, both categories—acres tapped 1,575,606; yield/lb/acre 481.

The principal figures summarized above and in Table II provide some interesting comparisons.

First, it is emphasised that the Malayan data are for the estate group only—holdings of over 100 acres—no smallholding production is included in these returns. The majority of estate yield returns also include all scrap rubber which may be estimated at 12 per cent. of total production.

Secondly, considering the 1952 Malayan figures it will be noted that average yield from old, unselected seedling rubber was 363 lb/acre/year. If it can be fairly assumed that a good deal of the scrap rubber that might have been obtained on Papua estates was not processed for sale, the comparative production figure for Papuan estates in 1952 would have been 308 plus say 10 per cent. = 338 lb/

* *The Papuan Rubber Industry.* Commonwealth of Australia, Department of Commerce and Agriculture, Bulletin No. 7, January, 1952.

Sources—

(i) Data supplied by the Department of Agriculture, Stock and Fisheries, Port Moresby, Papua.

(ii) Data extracted from Malayan Rubber Statistics issued by the Registrar of Statistics, Federation of Malaya.

† In Malaya, mature rubber in tapping is now separately classified as (*a*) planted with ordinary unselected seedlings; (*b*) planted with improved material, budgrafts and clonal seedlings.

acre/year. Thus, figures of comparative production for old seedling rubber in Malaya and Papua are close enough to justify the inference that *potential* yields of rubber plantations in Papua are not very different from those in Malaya. But, turning to data of yields of those plantations in Malaya established with high-yielding material, it will be noted that over 400,000 acres or 25 per cent. of the tapped area is planted with such material and yielded 827 lb/acre/year, nearly two and a half times as much as the old seedling areas.

A further important point, the difference between areas planted and areas tapped in Papua is accounted for by backward 1945 plantings and by obsolete old rubber hardly worth tapping on the other hand, in Malaya the difference is accounted for principally by young replanted areas most of which have a potential yield of 1,000 lb. per acre or more.

TABLE II.

Rubber Acreages and Production, Papua, 1951-1952.

(From Official Returns for years ending 31st March.

Division	No. of Holdings	Year	ACREAGE STATEMENT (1) Total planted	(2) Not in Tapping	(3) Total Tapped	YIELD DATA (4) Production lbs. Dry Rubber.	(5) Pounds per acre tapped
Western	1	1951	300	100	200	26,000	130
	1	1952	300	85	215	24,600	115
Gulf	3	1951	2,072	860	1,212	205,542	170
	4	1952	2,221	812	1,409	327,183	232
Central	29	1951	17,577	4,557	13,020	3,303,687	254
	28	1952	17,668	4,363	13,305	4,292,243	323
Milne Bay	5	1951	1,278	713	565	132,257	234
	5	1952	1,478	440	1,038	261,883	252
Northern	11	1951	3,370	900	2,470	512,776	207
	12	1952	4,530	2,331	2,199	696,168	312
Totals	49	1951	24,597	7,130	17,467	4,180,262	239
	49	1952	26,197	8,031	18,166	5,602,117	308

Notes on Table II.

Column 1.—Official returns, from which the above summary is compiled, indicate that records are based on holdings which have been worked through the year. This may account for the apparent discrepancies in Column 1.

Column 2.—Areas *Not in Tapping* may be either immature or mature, the latter being out of tapping because of shortage of labour or for other reasons. In 1952 the records show 5,998 *acres as immature*, much of this is 1945 planting that suffered from neglect as a result of the change in official Regulations for the employment of plantation labour.

Column 3.—*Areas Tapped* include areas tapped selectively, i.e., only a proportion of the trees may have been tapped owing to shortage of tappers. This is reflected in the yield-per-acre figures in Column 5, which should therefore

be accepted with reserve; they do not indicate the maximum yield per acre that might be attained with a full tapping force.

Column 5.—*Yield in Pounds per Acre* falls notably short of the figure of 400 lb./acre accepted in the economic survey of 1949.

TABLE III.

Principal Rubber Plantations, Papua, their locations and planted acreages.*

Division	Name of Estate or Holding.	Location	Ownership	Planted Acerage.
Western	Madieri	Fly River	Proprietary	405
Delta and Gulf	Ogambu	Kikori	Proprietary	542
	Kerema	Kerema	Kerema Rubber Ltd.	1,500
Central	Koitaki	Sogeri	Koitaki Pltns. Ltd.	2,358
	Itikinumu	Sogeri	B.N.G. Devt. Co. Ltd.	1,575
	Eilogo	Sogeri	Eilogo Estate Ltd.	800
	Sogeri	Sogeri	Sogeri Rubber Ltd.	720
	Subitana	Sogeri	Subitana Rubber Ltd.	600
	Mororo	Sogeri	Mororo Rubber Estate Ltd	450
	Ilolo	Sogeri	Proprietary	170
	Tahria	Sogeri	Proprietary	50
	Warisaeroa	Sogeri	Proprietary	200
	Kanosia	Kanosia	Kanosia Estate Ltd.	1,600
	Lolorua	Kanosia	Lolorua Rubber Estate Ltd.	1,280
	Mariboi	Kanosia	Mariboi Rubber Ltd.	3,000
	Rubberlands	Kanosia	Rubberlands Ltd.	1,200
	Doa	Kanosia	B.N.G. Devt. Co. Ltd.	870
	Sagarai	Kanosia	Proprietary	450
	Veimauri	Kanosia	Proprietary	500
	Aroana	Kanosia	Proprietary	183
	Moyale	Kanosia	Proprietary	114
	Robinson River	Abau	Robinson River Pltns. Ltd.	200
	Merani	Abau	Proprietary	250
	Sivigolo	Rigo	Proprietary	70
Milne Bay	Mamai	Samarai	Steamships Tdg. Co. Ltd.	550
Northern	Amada	Yodda	Proprietary	220
	Komo	Yodda	Proprietary	120
	Mamba	Yodda	Proprietary	300
	Kokoda	Kokoda	Government	293
	Awala	Awala	Proprietary	70
	Sangara	Popondetta	Sangara Rubber Estate Ltd.	2,500

Note on Cost of Production.

Most planters had studied the excellent economic survey made in 1949, published in *Bulletin No. 7* of the Department of Commerce and Agriculture early in the year, and although the object of the present survey was concerned in the main with technical agricultural aspects of Papuan rubber production, it was inevitable that questions of cost of production and comparison between those recorded for Papua with those recorded in other countries would be raised.

From figures provided by one group of estates in Papua the writer has constructed a graph which illustrates in striking fashion the progress of increase

* Table compiled from data supplied by the Planters' Association of Papua supplemented by additional information collected on the tour.

in total cost of production over the past decade. Indicated on the same graph are the figures for cost of production obtained from the Grogan report. The additional histogram giving a broad analysis of production costs shows clearly the predominance of labour charges as the principal cost item. (Figures 1 and 11.)

The writer had neither the time nor the facilities to make a detailed assessment of production costs, but an official estimate of average costs of production was provided, against this corresponding costs from a comparable Malayan estate in the old rubber 400 lb/acre/annum category, are cited for comparison (TableIV).

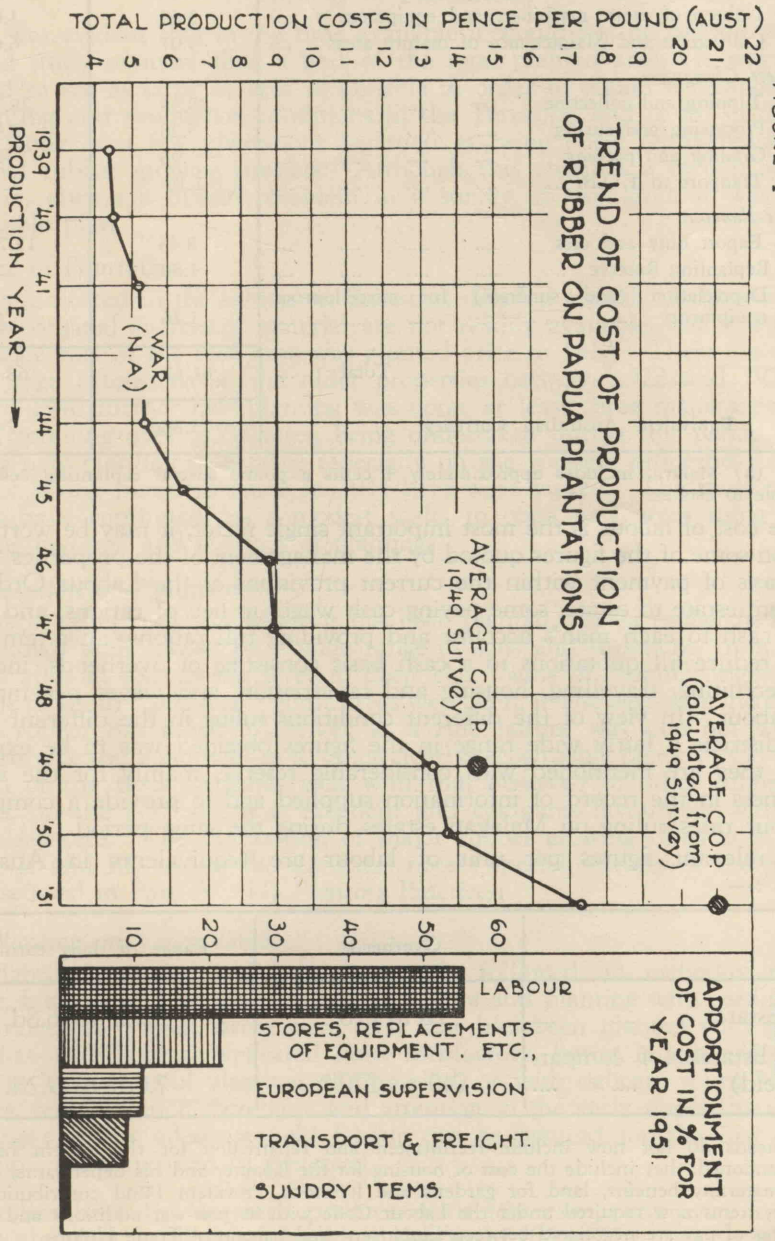

FIGURE I

FIGURE II

TABLE IV.

Comparison of Costs of Production on Average Estates of comparable Yielding Capacity in Papua and Malaya.

ITEM	Amount in Malayan Cents per pound.	
	Papua cents	Malaya cents
(1) *Indirect Charges*—		
(*a*) Proportion of general charges	2.13	15.38
(*b*) Upkeep of estate machinery and equipment	3.09	1.04
(*c*) Cultivation and Maintenance of mature areas	9.07	6.00
(2) *Direct Charges*—		
(*d*) Tapping and collection	28.38	28.18
(*e*) Processing and curing	5.20	2.98
(*f*) Grading and packing	.96	.49
(*g*) Tranport to F.O.B.	1.10	1.10
(3) *Miscellaneous*—		
(*h*) Export duty and cess	8.43	12.79*
(*i*) Replanting Reserve	1.80	....
(*j*) Depreciation (and sundries) for miscelloneous equipment	1.26	.92
Total	61.42	68.88
Equivalent Australian Currency.	21.86d.	24.5d.

* Item (*h*) Malaya, includes approximately 4 cents a pound special replanting cess which is refundable to estates.

Since cost of labour is the most important single factor, it may be worthwhile to mention some of the figures quoted by the management of the properties visited. As the basis of payment within the current provisions of the Labour Ordinance varied from estate to estate, some paying cash wages in lieu of rations, and others crediting cash to each man's account and providing full rations, an attempt was made to reduce all quotations to a cash basis consisting of overheads, including cost of recruiting, travelling, housing and repatriation, and wages per man day unit of labour. In view of the different conditions ruling in the different rubber growing districts a fairly wide range in the figures obtained was to be expected, therefore they are mentioned with considerable reserve, mainly for the sake of completeness in the record of information supplied and to provide a comparison with labour rates ruling on Malayan estates during the same period.

The relevant figures per unit of labour are (equivalents in Australian currency) :—

	Overheads	Range of daily earnings
Papuan Estates	£8 to £18	5.3d. to 6.8d.
Malayan Estates (of comparable yield)	£40 to £70 *	7.0d. to 9.2d.

* Overheads do not now include recruitment and repatriation for the system has been virtually abandoned, they include the cost of housing for the labourer and his dependants, holidays with pay, maternity benefits, land for gardens and livestock, Provident Fund contributions and other sundry items now required under the Labour Code with its post-war additions and amendments. Rates of pay are negotiated between Employers and Labourers' Trade Unions.

The tenative conclusion to be drawn from these admittedly somewhat superficial observations is that Papuan estates are in a position to produce rubber at a slightly lower cost than their Malayan counterparts. It would of course be possible to cite C.O.P. data from a Malayan estate planted partly or entirely with modern high yielding material that would be very much lower than those quoted in Table IV; the obvious inference is that a Papuan estate with equally good rubber in tapping could do just a little better.

Part III.

Survey of Plantations.

It was evident that in the time available it would not be possible to make a detailed study of more than a part of the total planted area. It was therefore decided to see as large an area as possible in order to obtain a complete picture of planting and production conditions in the Territory, and to fill in detail by a closer study of a few plantations regarded as being fairly representative in the principal rubber growing districts. Although this entailed a certain amount of selection, always a difficult problem in a survey of this kind, it was the only practicable plan.

(i) *Age of Plantings.*—

As indicated in the section on Statistics, detailed records of dates of planting and the original sources of material are not readily available, but it is clear that the major part of the total area was planted prior to 1917. There are records of fairly large extensions on the older properties between 1922 and 1928. From 1937 to 1940 further new planting was done, at least three major new developments, totalling over 6,000 acres, being undertaken during this period. In 1945 further new planting took place especially on the younger properties; over 1,500 acres of young plantings made in 1944-1945 were visited. The most progressive estates have continued, on a modest scale, to open new areas using improved planting material and methods of planting.

(ii) *Location of Plantations.*—

As in other countries where it has been planted, Hevea rubber in Papua has been grown with success on a wide range of soils and situations, from river and coastal alluvial soils at sea level to deep clay loams of basaltic origin up to an altitude of about 2,000 feet. Some areas were seen, in the aggregate inconsiderable, where rubber has failed to thrive; as a rule failure was due not so often to unfavourable soil conditions as to other clearly recognizable factors. On the whole growth of the trees compares well with that observed in other rubber growing regions, on the best soils it is excellent and compares favourably with anything seen elsewhere. The distribution of major rubber growing districts is shown in Tables II and III, and in the statistical notes; special features of the main areas are discussed in Part IV, (iii) *Planting Practices.*

(*a*) *Planting on Virgin Land.*

Planting on virgin land has generally followed an orthodox routine of felling, burning and clearing, lining and holing and planting with seedling stumps from nurseries. Small areas were seen that had been planted with germinated "Seed-at-stake" which appeared quite satisfactory, but it is appreciated that in order to be successful plantings of this kind, or with delicate young seedlings in baskets, require much more care and attention in the early stages than "stump" plantings; unless adequate field labour can be assured for the first year then "stump" planting is to be preferred.

It has been the accepted practice, with few exceptions even in the most recent plantings, to plant at a standard density of 100 to 120 trees per acre, square

planting at 20 feet x 20 feet being most usual. This has for long been regarded as giving too low an initial stand in most other countries; for example, in Malaya the generally accepted practice is to plant either bud-grafts of proved clones at 150 to 180 trees per acre, or approved clonal seedlings at 200 to 250 trees per acre reducing stands to 130 to 150 trees by selective thinning during the first 8 to 10 years from planting. Thinning in the first stage is based on growth and general observation, in the second stage on the results of test-tapping. Lack of selection is indicated in all Papuan plantings in the uneven development of the trees, particularly in older fields. It seems likely that this condition reflects the early difficulties experienced in obtaining supplies of good planting material. In the early days much seed had to be imported from distant sources, from Java, Malaya and Ceylon, losses were undoubtedly heavy and planters would be reluctant to discard any plant that reached transplantable size in the nursery. The result is evident in many uneven old stands and is probably one of the chief reasons for the failure to obtain optimum yields per acre with the material available. Unfortunately in the most recent plantings, due no doubt to the scarcity of supplies of improved planting material, the custom of planting at a low density without much elimination at the nursery stage has persisted.

As mentioned above, most planting has been on the square or rectangle irrespective of slope and lie of the land; contour planting has only very recently been attempted in new clearing work. It has been customary to plant leguminous covers in new areas, *Centrosema pubescens, Pueraria javanica, Calapogonium mucunoides* and *Dolichos hosei* (vigna) having all been used with fair success, but as in Malaya, though not on the high phosphate soils of Java and Sumatra, leguminous covers have not persisted under shade, they have been replaced by a mixed cover of soft herbs, grasses and seedlings. Maintenance is by periodic slashing of this mixed cover, including " kunai " (*Imperata cylindrica*). The latter, known as " lalang ", and regarded as the most troublesome and damaging weed in Malaya, appears to be far less vigorous and damaging to the growth of rubber in Papua.

Despite lack of special soil-conservation work, e.g., contour terracing, pitting and bunding, except on some of the oldest areas, erosion was not generally severe. Few areas have suffered seriously from the ruinous system of clean weeding, formerly practised in Ceylon and Malaya, but abandoned in favour of the system of maintenance under a mixed cover of soft grasses, herbs and volunteer seedlings controlled by periodic slashing as in Papua.

(*b*) *Replanting of Obsolete Rubber.*

Replanting of obsolete rubber has not been undertaken in Papua except on a small experimental scale by one or two plantations. This is in marked contrast to the situation on Indonesian and Malayan plantations. In Malaya on estates some 25 per cent. of old seedling areas have been replanted with buddings or clonal seedlings. Some of the most progressive estates now have up to 75 per cent. of their total acreage planted with approved high-yielding material. Yet it is certain that a large part of the old seedling rubber on Papuan estates, which is at present capable of maximum yields of not more than 300 lb. an acre, is on land capable of producing three times the crop if planted with the right material.

(*c*) *Manuring of Rubber.*

Manuring of rubber has received little attention; apart from manuring of nurseries and one example of experimental manuring on a small replanting no information on local experience with fertilizers on young rubber was available. The prohibitive cost of imported fertilizers and heavy transport costs to most of the rubber growing districts will continue to discourage the use of fertilizers, yet in connection with replanting it is essential that trials on the use of fertilizers should be undertaken. Experience elsewhere has shown that fertilizers at relatively

small rates per acre may reduce by as much as two years the time taken to bring a replanting into bearing : the cost of fertilizers has been more than fully recovered, without fertilizers it is doubtful whether some of the land in Malaya that has been successfully replanted with rubber would have been worth replanting. In the writer's opinion much of the old rubber seen in Papua is on land that would replant successfully without heavy expenditure on manuring, but experiments are necessary to confirm this.

(*d*) *Mechanization of Planting and Maintenance Operations.*

Mechanization of planting and maintenance operations on rubber plantations has not yet been developed on any appreciable scale. Clearing of land with heavy mechanical equipment was seen in one district, but the cost of such work would be quite prohibitive for the preparation of land for rubber planting. Limited experience in Malaya has generally indicated that except for very large scale operations, the use of heavy mechanical equipment is seldom justified on costs. Under Papuan conditions, assuming that replanting and new planting may be done, the scale of operations and wide distribution of plantations seem unlikely to favour the use of the types of heavy equipment needed to uproot and clear mature rubber or forest. The older and simpler methods of felling and clearing, with or without a burn, are likely to prove much less costly and in practice, quite satisfactory. On a few plantations light, rubber-tyred tractors of the Ferguson type, and semi-track units up to 35 h.p. with suitable attachments have been used with success in light clearing and cultivation work. Such units may be extremely useful in replanting operations, following felling and burning, provided that layouts and planting distances are planned to ensure smooth operation in subsequent work.

(*e*) *Other Methods of Planting.*

Other methods of planting seen included one development of special interest. A small proprietary holding of about 100 acres was being developed on land under light forest, probably secondary growth or an area from which all sizeable timber had been felled and removed. In successive years, areas of 20 to 40 acres were felled, given a light burn and cleared sufficiently to give access for lining, holing and planting. Planting was with good seedling stumps and upkeep during the first two years was mainly confined to keep the plants clear and ensuring a good getaway. Maintenance otherwise was restricted to sufficient slashing of undergrowth between the rows to keep the young rubber trees ahead of competition. As the shade from the developing rubber trees increased the undergrowth had become progressively weaker and maintenance costs were small. In one section smothering of undergrowth has been greatly assisted by the successful establishment of *Pueraria javanica.* Although the growth of the rubber had been retarded by competition of the undergrowth in the first two or three years and the period between planting and coming into production may be a year or more longer than by more orthodox and expensive methods, a very satisfactory stand of seedling rubber was being established by the method outlined and soil losses from erosion are reduced to a minimum.

Part IV.

Planting Material.

All planting prior to 1928 was with common unselected seedlings, such material is capable of yielding under average conditions a maximum of about 500 lb. per acre per annum. With a low initial stand and casual losses due to storm damage and disease, effective tappable stands have been reduced from 100 to about 60 trees per acre or less in many old fields, and average yields of not more than 300 lb. per acre can be expected from old rubber in this class.

In 1928 Koitaki Plantations, Sogeri, planted an area of 55 acres with Tjikadoe seedlings, selected material imported from Java. Since 1933 fair quantities of

" Koitaki Selected Seed " collected from the original Tjikadoe seedling planting on the Koitaki estate, have been used in new plantings. In 1934 Itikinumu Estate, Sogeri, established a small area of about 5 acres with clonal seedlings raised from Prang Besar isolated garden seeds imported from Malaya through Singapore. This block after removal of low yielders after test tapping and yield recording has provided limited quantities of " Singapore " selected seed for use on Itikinumu Estate and for sale to others.

Despite several attempts by the Department of Agriculture, first in 1934 before prohibition of export of improved planting material from countries within the International Rubber Regulation Agreement came into force, and again in 1944, when restriction on export was removed, the total area of rubber planted with buddings of proved clones, including a recent replanting of 10 acres, did not exceed 20 acres in the entire Territory.

Plantation owners in Papua, with few exceptions, have not accepted the value of budgrafts for commercial plantings and are almost unanimous in their preference for clonal seedlings. Unfortunately, no clonal seedlings of the type that can be confidently recommended for commercial planting are available in Papua ; to import them is difficult and very costly.

There can be no doubt whatever that the lack of local supplies of improved planting material has been the principal weakness of the rubber producing industry in Papua and New Guinea. In contrast with the reluctance of rubber planters to accept new material, the outstanding advances that have been made in Keravat in the production of high yielding selections of cacao, and their ready reception by planters are remarkable.

Part V.

Tapping and Harvesting.

(*a*) *Standard of Tapping.*—

Most planters will agree with the general statement that " the capital of a rubber plantation is in the bark of the trees ". The standard of the tapping operation therefore is of paramount importance and merits special attention. There is plenty of evidence of a good standard of tapping in the past, but most of this evidence is to be found in the evenly renewed bark of panels tapped seven or more years ago, prior to 1946. On those estates which have been fortunate in retaining experienced tappers, principally those recruited from the coastal districts of Papua, Rigo and Abau, and some from the Nothern Division, a reasonably good standard of tapping is still to be seen. But this cannot be said for the majority of estates, who now depend largely on inexperienced labour. It takes more than a few months, even with expert tuition, to teach a tapper and a poor tapper can do irreparable damage in a few days. It is perhaps a small consolation that most plantations have extensive old areas overdue for replanting on which under a few skilled " boss boys " new tappers can learn the rudiments of their trade. Indifferent standards of tapping were however too frequently to be seen on younger rubber that will have to provide the bulk of the crop for some years to come.

Whilst these observations are severly critical, it is very necessary to record that plantation managers are doing their utmost to improve this situation, but it may be a very long time under the present system of short-term employment of unskilled labour before adequately skilled tapping forces will be available.

(*b*) *Tapping Systems.* —

Tapping systems with a single left to right spiral cut on half circumference, tapping daily for one month and resting for one month, or daily in alternate fortnightly periods, appear to be generally accepted. These are standard systems

still in general use in Indonesia though in Malaya, alternate day tapping is more usual. As regards total yields there is little to choose between these different standard systems : in Malaya the alternate day system is preferred because it gives latex of a reasonably constant dry rubber content reducing factory difficulties in coagulation and processing. In daily periodic tapping the d.r.c. falls gradually from a high level at the beginning of a tapping period to a low level at the end. Unless latex is bulked from areas in which changes from tapping to rest for different areas have been suitably staggered, variation in d.r.c. can introduce difficulties in coagulation and machining, causing variation in thickness of sheet and in the drying time in the smokehouse.

(c) *Task Size and yields.*—

Tapping tasks vary from 300 to 400 trees per tapper, depending on terrain and stand per acre. Bark consumption appeared to be about 10 inches per year with the best tapping standards, in other cases bark consumption was double this amount and wounding was severe. There was evidence of a good deal of selective tapping, the poorest yielders being left untapped especially in the older areas. With shortage of skilled tappers this is sound practice, but it means that neither recorded yields per acre nor records of yield per tapper may give a true index of the full productive capacity of a plantation (Reference the data summarized in Table II).

The average daily crop per tapper was estimated at 10 lb. dry rubber, the range being from 20 pounds per tapper on the best areas to less than 8 lb. on the poorer old areas. It was as a rule difficult to obtain data of yield per acre from any but a very few plantations, almost invariably managers spoke of production in terms of yield " per unit " of tapping labour, reflecting again the general concern to build up an adequate skilled tapping force. On several estates large areas of old rubber, mostly 1904 to 1912 plantings of low productivity, were not tapped even during the height of the " boom ", owing to shortage of tappers. There is no doubt that the shortage of skilled tappers, and the difficulties of training (and retaining them) is one of the most serious handicaps of the Papuan rubber industry.

Part VI.

Incidence and Control of Pests and Diseases.

In general, Mevea in the Eastern hemisphere has not been seriously affected by destructive diseases and pests. Apart from the severe damage to rubber trees in Ceylon by mildew (*Oidium heveae*), which causes serious secondary leaf fall, and occasional heavy losses in Malaya and Indonesia due to root diseases caused by root parasitic fungi (*Fomes lignosus*, white root rot ; *Ganoderma pseudoferreum*, red root rot ; and *Fomes noxious*, causing a brown rot of roots and branches), other diseases are generally of little economic importance. Hevea in Papua and New Guinea showed a remarkable degree of freedom from most of the recorded major and minor diseases and pests.

This survey was made just before the " wintering " season so that it was possible to visit a few plantations before wintering, during leaf fall, and again during the refoliation period. No trace of secondary leaf fall due to the presence of Oidium was found. This was particularly interesting and important, especially in the Sogeri area, for in other rubber growing countries, notably in eastern Java and Ceylon, where Hevea is grown at a fairly high altitude, over 1,000 feet, heavy attack of the young foliage by mildew has caused widespread damage. In Ceylon it is estimated that some 200,000 acres of up country rubber plantations have been virtually written off by Oidium. It will be of the greatest importance to try to keep Oidium and other rubber diseases out of the Territories of Papua and New Guinea by imposing strict phytosanitary regulations on the importation

of any new material of rubber or living material of any other tropical crops, from countries where rubber is grown. Other leaf diseases of minor importance, Gleosporium and Helminthosporium (Bird's eye spot), were noted occasionally on nursery material, though in general all nurseries seen were cleaner and healthier in appearance than many seen in Malaya.

Stem and branch diseases, *Ustulina zonata* and *Corticium salmonicolour* (" pink " disease) both of which, the latter especially on young trees up to the 7th or 8th year of age, have occasionally proved serious on Malayan plantations, were not greatly in evidence in Papua. No bad cases of " pink " disease were seen though a few suspect cases were pointed out.

Die-back of old trees, especially on eroded areas and in the drier Kanosia district, was common; although often associated with Diplodia the presence of the fungus was almost certainly incidental, the main cause of die-back being unfavourable conditions of soil and climate and general debility of played-out trees.

Regarding diseases of the tapping panel, " mouldy-rot " caused by the fungus *Ceratostomella fimbriata* may be severe, more evident in the Sogeri district than elsewhere, but is everywhere in evidence. The standard control treatment is by painting the tapping panels, over young renewing bark, with a preparation of tar and a tar-oil, such as solignum, emulsified by boiling with water and soft soap. Painting is done fortnightly or monthly when tasks are changed over from tapping to resting and a good measure of control is obtained. Although experience in Mayala has shown that spraying of the tapping panels with tar-oil emulsions or some of the newer synthetic fungicides may give more effective control the continued use in Papua of a smothering tar-based dressing provides a good illustration of the need to do what is practicable and reasonably effective rather than to attempt new methods with unskilled labour. Unfortunately, wounding from unskilled tapping and damage from mouldy rot generally occur together. The tar dressing in common use, whilst it smothers and checks the spread of mouldy rot also delays wound healing and retards the rate of bark renewal. There is an urgent need for a new type of dressing, possibly one based on a wound healing grease, such as V.P. 2295.C., in which a fungicide may be incorporated, to take care of the fungus and to stimulate the rate of bark renewal and wound healing at the same time. Occasional indications of black stripe (*Phytohpthora palmivora*) were noted, though it does not appear to have caused serious damage on any plantation visited. The standard treatment for mouldy rot has probably taken care of this trouble also.

[To be continued in Volume 8, No. 3, January, 1954.]