Tea Production in Papua and New Guinea.

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INTRODUCTION.

THE possibility of commercial tea production was first envisaged in 1939 when the Highlands Agricultural Experiment Station was established at Aiyura. The Highlands in New Guinea were not at that time open to private settlement. A limited quantity of seed was imported from Sarawak and from this eighty-eight seedlings were obtained. These were planted out and from them thirteen bushes were later selected as seed bearers and allowed to develop. The remainder of the plot was kept cut back to a plucking table. From the seed produced, four acres of plucking tea was planted on the Station between 1947 and 1949 at an altitude of 6,000 feet.

Seed from the South Johnstone Bureau of Tropical Agriculture, Queensland, was planted in the nursery at Aiyura in 1941, and in 1944 a seed garden was established from this material. This was progressively culled to leave a stand of 40 to 50 seed bearers.

At the end of World War II, with the re-establishment of civil administration, further consideration was given to the possibility of commercial tea production in the Territory. To this end the Administration began an investigation of areas suitable for a pilot tea plantation. At the same time the re-establishment of administrative control in the Highlands meant that Europeans began to settle there and to investigate possible crops for the area. Small plots of tea were planted in various parts of the Highlands from seed obtained from Aiyura. No serious private tea growing ventures matured, although one company was formed for the express purpose of planting tea. The initial interest in tea coincided with the spectacular rise in world coffee prices and in the 1950's private investment in the Highlands was, with few exceptions, channelled into coffee planting.

Between 1948 and 1952, a number of overseas companies showed interest in the possibility of tea planting in the Territory and their representatives visited the Territory to determine its potential. The Australian Government also enlisted the services of overseas experts for the same purpose. While the overseas experts expressed confidence in the potential of the Territory in so far as soils and climate were concerned, it was the general opinion that labour was deficient in quantity and perhaps also in quality, and that communications were inadequate, particularly in view of the fact that air transport was obligatory, for competitive tea production.

GARAINA TEA PLANTATION.

The decision to investigate the commercial possibilities of tea was made by the Australian Government in 1947. An experienced estate manager from Northern India was employed by the Administration to make a survey of the areas suitable for tea production and to select a site for the establishment of a pilot commercial tea garden. The area finally selected in the Waria Valley is now known as the Garaina Tea Plantation. It is 2,100 feet above sea level.

The selection of Garaina was governed by considerations of access (Garaina is approximately 30 minutes flying time south of Lae), land availability, and most importantly by the fact that the site is an old Pleistocene lake bed deposit, well drained and virtually level, thus lending itself to investigations into the mechanisation of tea planting and harvesting. At that stage it was considered that, in view of the labour position then prevailing in the Territory, commercial tea planting would be dependent on the development of suitable harvesting machinery.

In 1948, nurseries were established at Garaina with seed imported from South Johnstone Bureau of Tropical Agriculture in Queensland. From

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Plate I.—Part of Garaina Experimental Tea Plantation. Seed bearers in foreground and plucking areas on either side of the airstrip. The factory building is also shown.

[Photo D.I.E.S.]

these nurseries 25 acres of seed bearers and 15 acres of tea for plucking were planted. Serious planting of the main plucking areas commenced in 1954 when large quantities of seed first became available from the seed garden and official approval was given for the establishment of a trial area of 300 acres of commercial tea.

In 1951, a ten acre seed garden was established from seed imported from Boh Estate in the Cameron Highlands of Malaya. There are now 35 acres of seed gardens and 300 acres of plucking tea at Garaina. Plate I is an aerial view of part of Garaina, showing the factory, seed bearers and plucking tea.

The original intention at Garaina was to establish only about 15 acres of plucking tea and to install the minimum amount of machinery consistent with production of commercial grades of tea, the purpose being to establish rates of production and tea quality and to investigate the efficiency of native labour. Subsequently, as mentioned above, the area was extended to 300 acres and a factory built with the capacity to house sufficient machinery to process production from this area. Initially 100 acres was brought into plucking condition and the factory opened in August 1962 with equipment necessary for processing on the basis of an estimated yield of 800 lb. per acre. Yield has greatly exceeded expectations and the factory is currently being re-equipped to handle production from the full 300 acres planted, at higher production rates.

Harvesting under Garaina conditions is continuous throughout the year, with the interval between plucking rounds varying from 7 to 10 days.

Results at Garaina.

Garaina was established to answer the following specific questions about commercial tea production in New Guinea.

1. Would tea grow and yield satisfactorily in New Guinea ?

2. Would the quality of New Guinean tea be acceptable on world markets ?
3. Could New Guinean workers be trained to pluck tea efficiently ?

The answers to these questions have been most satisfactory. Tea at Garaina has grown more quickly than in most traditional producing areas, probably because of the relatively high and well distributed rainfall. Small plots in the Highlands have also grown very quickly and it seems fair to assume that tea in many parts of New Guinea will come into production up to a year earlier than in the main producing areas of the world.

Overseas authorities who helped to select the area for the plantation at Garaina estimated that the yields there would be about 800 to 1,000 lb. an acre. On the basis of one year's experience this estimate will be exceeded ; yields seem certain to reach at least 1,200 and possibly 1,500 lb. an acre. The latter figure should be readily attained at the altitude of Garaina when better spacings are used ; current spacings, designed for mechanical plucking experiments, are too wide for maximum yield. Tea yields decline with rising altitude, but nevertheless, on the basis of Garaina experience, and growth in the few small plots so far established in the Highlands, 1,000 lb. per acre should be attained readily at an altitude of 5,000-6,000 feet in selected areas.

The quality of tea produced at Garaina has been most encouraging. It may be that Garaina has a particularly favourable microclimate which will not be reproduced everywhere in the Territory : nevertheless, the reports on Garaina tea indicate that the planting material available in the Territory is of high inherent quality and there is no reason to doubt that the quality of Highland grown tea will be fully acceptable.

Tea from Garaina has not been consistently sold on one market as it has been the intention of the Administration to assess its acceptance on various international markets. The principal markets have been the United Kingdom and Australia. In the former, prices (in Australian currency) to date have been as follows :— Broken Orange Pekoe (BOP) 4s. 2d. (4s. to 4s. 6½d.); Broken Orange Pekoe Fannings (BOPF) 4s. 7d. (4s. 1½d. to 4s. 9d.); Broken Pekoe(BP) 3s. 3d. (2s. 9d. to 3s. 9d.); Fannings 3s. 8d. (3s. 5d. to 3s. 10d.); and Dust 3s. 4d. (3s. 0½d. to 3s. 8d.). In Australia only BOP and BOPF grades have been marketed and averaged BOP 4s. 10d. (4s. 6d. to 5s. 6d.), BOPF 4s. 8d. (4s. 7d. to 4s. 9d.). Markets in Hong Kong, U.S.A. and South Africa are now being tested with selected grades. These teas have been produced by natural tat withering followed by conventional rolling—i.e., " orthodox " manufacture.

In spite of fears that New Guineans would need years of training and experience before they would match the output and efficiency of overseas tea pluckers, women in the Garaina area showed immediate aptitude for tea plucking. Within six months of the commencement of commercial production the daily harvest averaged 43 lb. fresh leaf with some individuals plucking 80 lb. per day. This is comparable with overseas rates, and all the plucking has been fine. Significantly, not only have the women shown an aptitude for plucking the leaf, but there has been keen competition for employment as well. The women at Garaina, when trained, will pluck on a piece-rate of 1½d. per lb. green leaf. They are seen at work in Plate II.

Although large-scale plucking experience is limited to the women of the Waria valley, small-scale experiments in the Highlands suggest that the local men and women will pluck tea comparably, and piece rates in some parts of the Highlands may well be lower than at Garaina.

As a result of the Garaina experiment the Department has passed from a cautious attitude to one of confidence about the future of tea in the Territory. Other factors which have increased confidence in tea planting since Garaina began in 1949 have been the improved availability of labour, and the introduction of new factory procedures which have led to a lowering of factory costs.

In 1949, overseas advisers stated that a factory with an output of 1,000,000 lb. of made tea a year would cost about £250,000. With new types of machinery now available, capitalisation has fallen to about half this figure. Operating expenses have also been reduced because of lower power and factory labour requirements.

Many parts of the Highlands of New Guinea enjoy an advantage from the processing viewpoint because of the relatively high and well distributed rainfall. The peak day's production at Garaina and in much of the Highlands is likely to be only about one-third of one per cent.

Plate II.—New Guinea women make enthusiastic and efficient tea pluckers.

[Photo D.I.E.S.]

of the annual production. In Assam, the peak day may reach three-quarters of one per cent., and in Darjeeling where there is no production for the four coldest and driest months of the year, the peak day may reach one per cent. In Georgia, the province of Russia where tea is now produced on a large scale, the position is even more extreme with a peak day's production of more than one and a half per cent. of the annual output. Only in a few other favoured places such as the Kenya Highlands does the peak day drop below one-half of one per cent. of the annual output. A high peak necessitates a larger factory which is under-utilized for most of the year, or makeshift procedures leading to lower quality at the peak period.

POTENTIAL FOR TEA PRODUCTION IN THE TERRITORY.

The Territory potential for tea growing in terms of total area of suitable soils has not been fully determined. However, while tea can be grown on a wide range of soils, and, so far as this Territory is concerned, at altitudes from sea-level to 7-8,000 feet, considerations such as tea quality and labour supply will probably lead to the initial development of the tea industry within the more accessible areas of the Eastern and Western Highlands Districts ; there is also the possibility of subsequent expansion into the Southern Highlands District.

Within the accessible areas of the Eastern and Western Highlands Districts, i.e., where there is a well-developed road network servicing a main air strip, are contained those areas previously reported by overseas experts as suitable for tea. These areas can be divided into three geographic units :—

(*a*) Upper Ramu area—centred on Kainantu and Aiyura.

(*b*) Asaro Valley—centred on Goroka.

(*c*) Wahgi Valley—centred on Mount Hagen.

(*a*) and (*b*) are in the Eastern Highlands District ; (*c*) is in the Western Highlands District.

The valley floor in these three areas has an elevation of approximately 5,500 feet above sea level. The average annual rainfall varies from approximately 75 inches at Goroka to 100 inches at Mount Hagen. The following table gives the average monthly rainfall distribution for three representative centres, with corresponding figures for Garaina for comparison.

	Average Monthly Rainfall (in Points)			
	Mt. Hagen	Goroka	Aiyura	Garaina
January	1010	915	930	835
February	1060	1147	1110	1212
March	1210	1049	1010	1022
April	1160	951	1030	1098
May	720	386	420	734
June	430	186	360	534
July	520	197	410	570
August	730	289	510	599
September	810	396	510	822
October	770	544	610	1030
November	840	644	780	1167
December	990	1003	950	1255
TOTAL	10100	7707	8630	10878
No. of years recorded	10	16	21	13

Mean maximum temperatures are in the vicinity of 75 degrees F. with approximately a 5 degree variation over the year. Mean minimum temperatures are approximately 55 degrees F., also with a variation of approximately 5 degrees over the year. As can be seen from the above table, there is a seasonal distribution of rainfall, with May to August being relatively dry months. This dry season is more marked in the Asaro Valley area than in the Wahgi Valley or Upper Ramu areas, where rainfall is generally adequate in all months of the year. In all these areas, climate is conducive to continuous tea production.

The soils of these areas fall into four distinct groups :—

(*a*) *Soils derived from mixed metamorphic material and upper Tertiary sediments.* These occur generally throughout the Highlands and predominate in the Upper Ramu area. A complex pattern of soils has developed under these circumstances, ranging from deeply weathered sandy clays developed on schists, to heavy clays with a strongly developed laterite gravel layer at the top of the " B " Horizon. No tea has been grown on these latter soils, although they have been used for coffee growing.

(*b*) *Soils developed on Pleistocene lake deposits.* These occur in the Asaro Valley and Wahgi Valley areas. They are predominantly grassland areas and, under natural conditions, poorly drained. The soils are generally clay loams, silty clay loams and peaty clays 12-18 inches deep, over-lying clays, sandy clays and silty clays, and may or may not have well developed ironstone concretionary layers. These soils respond to simple open drainage and have been successfully utilized for coffee growing.

(*c*) *Soils developed on volcanic intrusive materials.* These occur extensively in the Wahgi Valley area where they are formed on Pleistocene andesites, which have given rise to deeply-weathered acid orange and yellow clays on a rolling topography. Similar soils also occur in the Eastern Highlands and to an extensive but undetermined degree in less accessible areas of the Eastern and Western Highlands and the Southern Highlands Districts. In the Upper Ramu area also, a number of granodiorite instrusions have given rise to deeply-weathered yellow clays.

(*d*) *Peaty Swamp Soils.* These occur extensively in all areas. In their natural condition they are swamps with an almost pure stand of *Phragmites.* These soils consist essentially of a deep peaty layer overlying pale yellow and grey silty clays. When drained, they have been utilized successfully for coffee growing.

Observation plots of tea have been established successfully on typical soils within the above groups with the exception of group (*a*).

A feature of the lake bed and peaty swamp soils of the Wahgi Valley is the generally high pH levels. The range of pH is 5.5 to 7.0 with the majority falling in the range 6.0-6.5. Under the environmental conditions of the Wahgi Valley experience to date indicates that the pH may be less significant than it is usually considered to be for tea growing. A two-acre observation plot has been growing vigorously on representative soils with a pH range of 6.5-7.0.

The populations of the Eastern Highlands and Western Highlands Districts in 1961-62 were estimated at 352,000 and 280,000 respectively. The two geographic units of the Eastern Highlands District, the Upper Ramu and

the Asaro Valley, are occupied by 8 and 16 per cent. respectively of the total population. The Wahgi Valley has a much heavier concentration as approximately 37 per cent. of the District population is located in this area. The resident populations of the three areas referred to above are :—

Upper Ramu	....	....	28,000.
Asaro Valley	....	....	58,000.
Wahgi Valley	....	....	103,000.

TEA PRODUCTION.

(*a*) *Cultural Practices.*

(i) *Nurseries.*

Tea is generally grown from seed sown in nurseries. Nursery beds are usually four feet wide and are dug to a depth of two feet. Artificial shade is required and as the tea is in the nursery for 18 months, posts and wire are recommended for shade support.

Seed is germinated in well-drained germination beds, which are made of river sand and must be kept continuously moist. The seed is spread densely on the bed in a single layer and covered to a depth of one inch. Germinated seeds are planted in the nursery at a spacing of 5 inches x 5 inches.

(ii) *Drainage and soil preparation.*

Artificial soil drainage is required on flat and gently sloping ground. Open box drains are usually satisfactory though the use of mole drains may reduce the number of box drains required.

Thorough cultivation is required prior to planting tea, particularly on those grassland soils with a high organic matter content. On virgin grassland soils a crop of sweet potato is often taken off the land prior to the planting of coffee and the practice could be adopted with advantage for tea planting.

(iii) *Field planting.*

After approximately 18 months in the nursery, or less under good growing conditions, the plants are stump planted in the field. The stem of the seedling is cut 4 inches above the ground at the time of planting and the stump pulled from the previously-loosened soil. In the field the stumps are planted in holes dug some time previously at a spacing of 5 feet x 2 feet 6 inches, giving a plant density of 3,500 per acre.

Holing may be done by hand using a posthole borer digging to 18 inches. A labourer can, when trained, dig at least 300 holes per day. Alternatively, where heavy equipment is available, a trench can be opened up and the stumps planted into it. Stumps need shading with bracken fern or grass when first planted out and a temporary shade crop such as *Crotalaria* may also be desirable.

(iv) *Permanent shade.*

Light shading is normal practice in growing tea. *Albizia stipulata* is satisfactory. Under conditions at Garaina, shaded tea does not appear to be any better than unshaded tea to date. Permanent shade may prove unnecessary in the Highlands, but is recommended initially.

(v) *Maintenance.*

As with coffee, it is important that grasses be kept out of tea areas and that soft weeds be controlled regularly. Tractor-mounted row crop implements may be useful in the early stages on flat land.

(vi) *Bush formation and pruning.*

Classical systems involve severe annual cutting back in the early years to develop the shape of the bush. However, recent methods of initial bush development depend on the production of two or more shoots from each stump, which in the second year in the field are pegged down in a fashion similar to the Agobiada system in coffee. New shoots which come away from these pegged-down shoots form the basic framework, and the bush is then plucked into shape without further cutting back. No further pruning is required until the sixth year in the field, when the bush is cut back and a new, vigorous framework again built up. The pruning cycle at Garaina is three years, but a 4-year cycle will probably be possible at higher altitudes.

(vii) *Fertilizing.*

The use of fertilizer on tea in production is standard procedure. Current practice at Garaina is to apply two cwt. of Sulphate of Ammonia per annum, divided into two applications. Sulphate of Ammonia is preferred to more concentrated nitrogenous fertilizers such as urea, as there is a demonstrated sulphur deficiency at Garaina and sulphur deficiencies are suspected in other grassland areas.

(*b*) *Processing.*

Tea factory procedures have undergone a major revolution in the postwar period, leading to substantial savings in capitalization and running costs. The Department recommends that Territory tea growers give careful consideration to some of the newer processes. In order to understand the advantages of the newer processing techniques, it will be helpful to consider orthodox manufacture first, and then the departures which have been made from it.

(i) *Withering.*

Traditional withering is a natural process whereby the fresh leaf, spread in thin layers, loses a percentage of its moisture and becomes flaccid, usually over a period of 18-24 hours. Over half the total area of an orthodox factory may be withering space. Tat withering at Garaina is illustrated in Plate III.

(ii) *Rolling.*

In orthodox manufacture, tea is rolled from 2 to 6 times, each roll taking about 30 minutes. This process has a high power requirement.

Plate III.—The traditional method of natural withering on hession tats has been used at Garaina.

[Photo D.I.E.S.]

(iii) *Fermentation.*

Orthodox tea requires 3 to 4 hours for fermentation, which is a chemical process.

(iv) *Drying.*

Tea is dried by hot air, the process taking 20 to 40 minutes in a modern dryer.

(v) *Sorting, Grading and Packing.*

These are the final processes and involve purely mechanical techniques.

When tea was first grown on a plantation scale in Indonesia, India and Ceylon in the 19th century, processing machinery was introduced to replace the old Chinese hand methods. Up to the early part of the 20th century, no new principles were introduced, although the design of machinery was steadily improved. A study of the nature and effect of each manufacturing process has led more recently to the adoption of entirely different processes at certain stages of manufacture. The essential part of processing is fermentation, when tea flavour is developed. However, some method of rupturing the leaf cells and releasing the juices is necessary before fermentation will begin. The firing process stops fermentation at the desired stage.

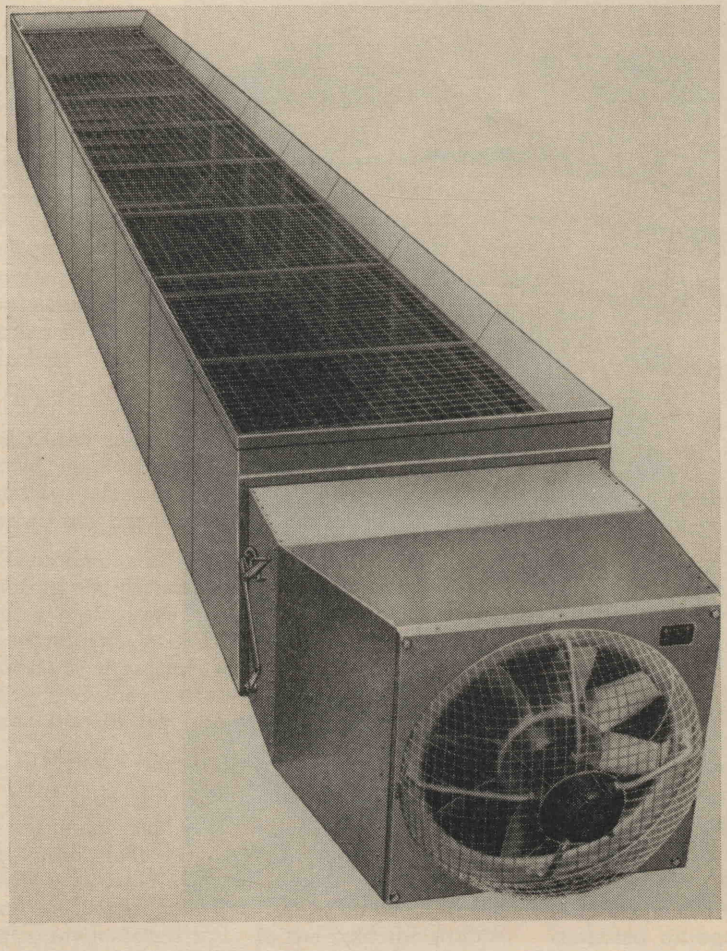

Plate IV.—Controlled withering in troughs of this type is superseding tat withering.

[Photo Davidson & Co. Ltd., Belfast, N. Ireland.]

The main revolution in processing has been the discovery of cheaper ways to rupture the leaf cells and initiate fermentation. There have also been major advances in withering techniques, and refinements in the drying process. The present position with regard to the five basic steps in processing is outlined below.

(i) *Withering.*

The functions of withering are to reduce moisture, thus minimising the work of final drying, and to render the leaf flaccid so that it will be capable of undergoing distortion and releasing the juices without breaking up. Although it is generally held that withering has a favourable effect on quality and some chemical changes do occur during the withering process, it is possible to eliminate withering entirely,

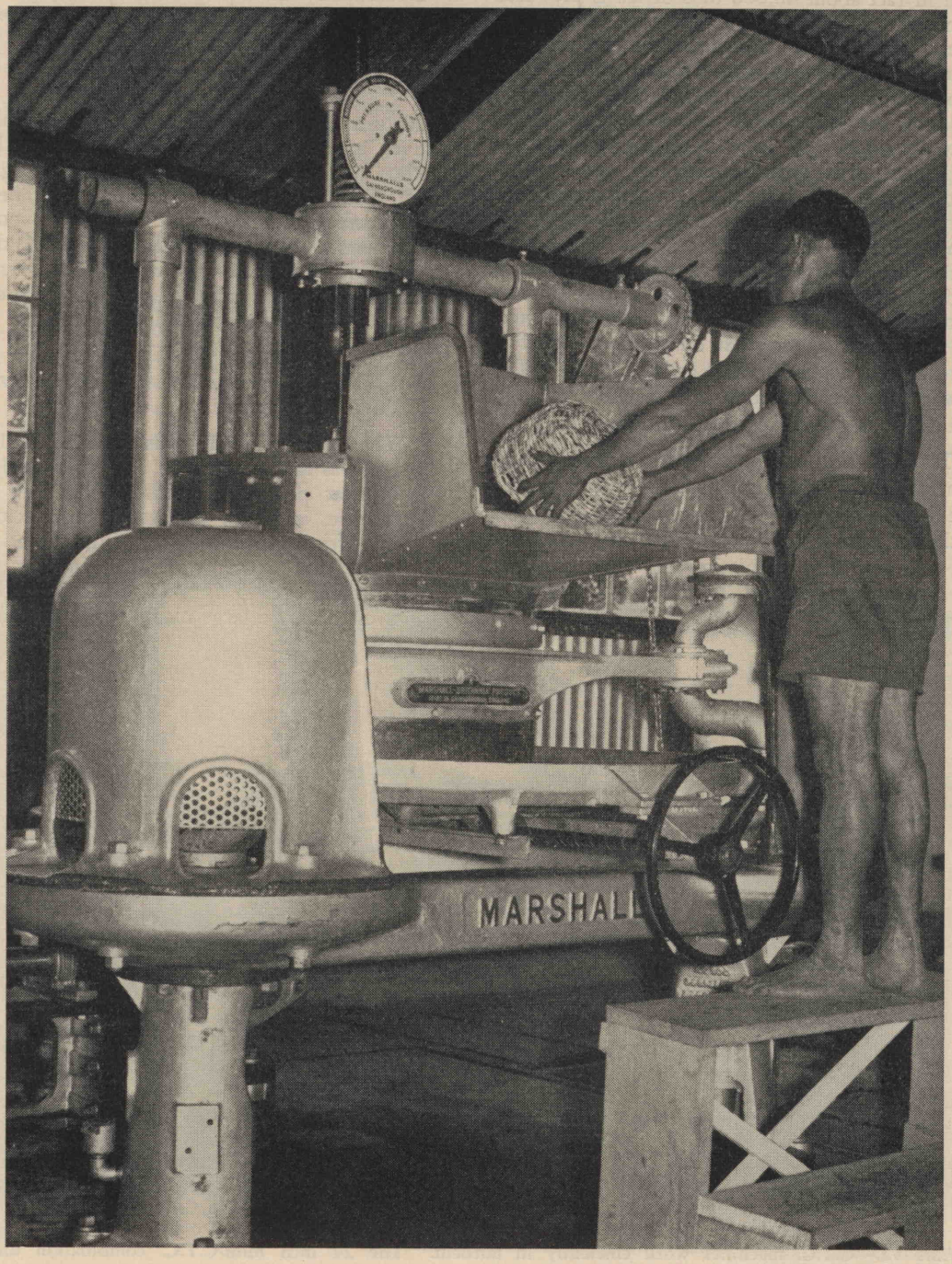

Plate V.—The orthodox type of roller is a heavy machine with a high power requirement.

[Photo D.I.E.S.]

and in fact about 40,000 tons of tea is produced annually in India from unwithered leaf. However, the higher moisture content of the fermented leaf necessitates a much greater dryer capacity than when withered leaf is used. On balance the elimination of withering is not recommended but, instead of the old natural wither of leaf spread thinly on tats, trough withering is now favoured. Troughs may be of various sizes, a common size being about 48 feet long, 6 feet wide, and 5 feet high. The leaf is placed in the upper part of the trough, which includes a layer of weld-mesh, wire-netting or similar material, covered with a removable sheet of hessian or nylon cloth on which the leaf is spread to a depth of eight or nine inches. The lower part of the trough is a chamber through which air is forced to effect withering.

Troughs take less space than tats, give greater control of the withering process, greatly reduce the labour required for handling the leaf, and make it possible to use carefully controlled hot or cold air, thus regulating the time schedule in the factory. Plate IV illustrates a withering trough.

Drum and tunnel withering have been tried but have certain disadvantages when compared with trough withering.

(ii) *Leaf Distortion.*

As mentioned above, there are several alternatives to rolling, which basically is merely a method of distorting the leaf and disrupting the cells. Orthodox rollers, illustrated in Plate V, are expensive, slow, and have high power requirements. Few new factories install them to-day, although one or two rollers may be installed to give a single light roll before or after alternative methods of leaf distortion. The alternatives are as follows :—

(*a*) *The Cutting, Tearing and Curling (C.T.C.) Machine.*

The C.T.C. machine was invented in 1930 but was not adopted on any scale until the postwar period. Currently about half the factories in North India and many factories in Africa use this type of machine, and more and more orthodox factories are changing over to them. The C.T.C. machine is essentially a large mangle with two fluted

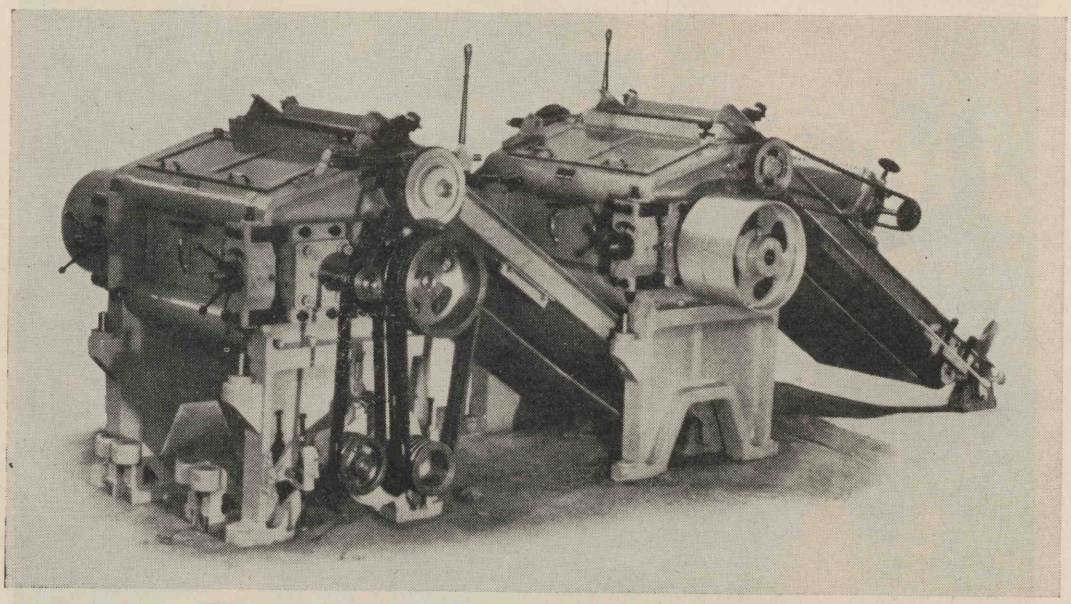

Plate VI.—C.T.C. machines work efficiently in tandem. The 24 inch mini-C.T.C. combination unit is illustrated.

[Photo Davidson & Co. Ltd., Belfast, N. Ireland.]

rollers operating at a speed differential of about 10 : 1. The leaf is subjected to a cutting, tearing and curling action while passing between the rollers. Greatest efficiency can be achieved by operating two machines in tandem. The leaf must be withered, and some consider it advantageous to give one light roll first, taking off about 15 per cent. of the fine leaf, and putting the remaining "big bulk" through the C.T.C. machines.

These machines have a large output and relatively low capital cost and power requirements. The main markets of the world accept C.T.C. teas as at least equivalent in quality to those of orthodox manufacture. Territory producers should give serious consideration to the installation of these machines, one of which is illustrated in Plate VI.

(*b*) *The Rotorvane.*

This machine was first produced as recently as 1958 but is already being used in a number of factories. It can handle unwithered leaf, but is better suited to receiving withered leaf. It is essentially a mincing machine, consisting of a rotor with vanes rotating inside a cylinder through which the leaf passes. Varying pressures may be applied and the speed of the rotor may also be varied. The Rotorvane has very high output together with relatively low capital cost and power requirements. Early hopes that it might supersede the C.T.C. machines do not appear to be eventuating, but present indications are that a Rotorvane feeding a C.T.C. machine, rather than tandem C.T.C. machines, might be a very good arrangement. Plate VII shows a Rotorvane.

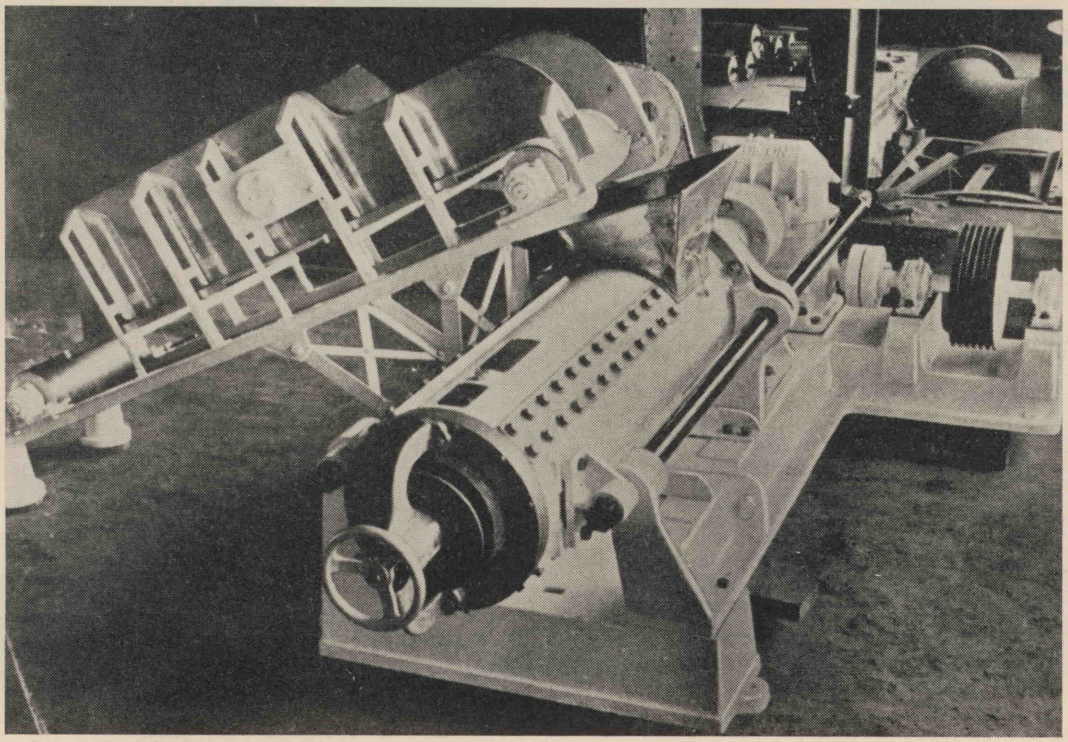

Plate VII.—The Rotorvane is an efficient machine for producing leaf distortion.

[Photo Davidson & Co. Ltd., Belfast, N. Ireland.]

(*c*) *The Legg Cutter.*

The Legg cutter is essentially a tobacco cutter. It shreds unwithered leaf very finely, and has attracted attention in areas where natural withering has always been difficult. After shredding, the leaf is lightly rolled. The main advantage is the saving in capital costs through the elimination of withering, but the quality of Legg cut tea is somewhat suspect and the fine shredding of the leaf necessitates a reduction in the air draught through the dryers. This, together, with the high moisture content, leads to a multiplication of dryers. The main advance in the use of Legg cutters took place before trough withering was devised in the areas where a natural wither could not be obtained regularly. This cutter is not considered necessary in Papua and New Guinea.

In brief, for leaf distortion it is suggested that the Territory producer use tandem C.T.C. machines or Rotorvane and C.T.C. machines. In a large factory, one or more rollers might be installed for a single light roll before the leaf goes to the other machines, or to produce some 'orthodox' tea for selected markets.

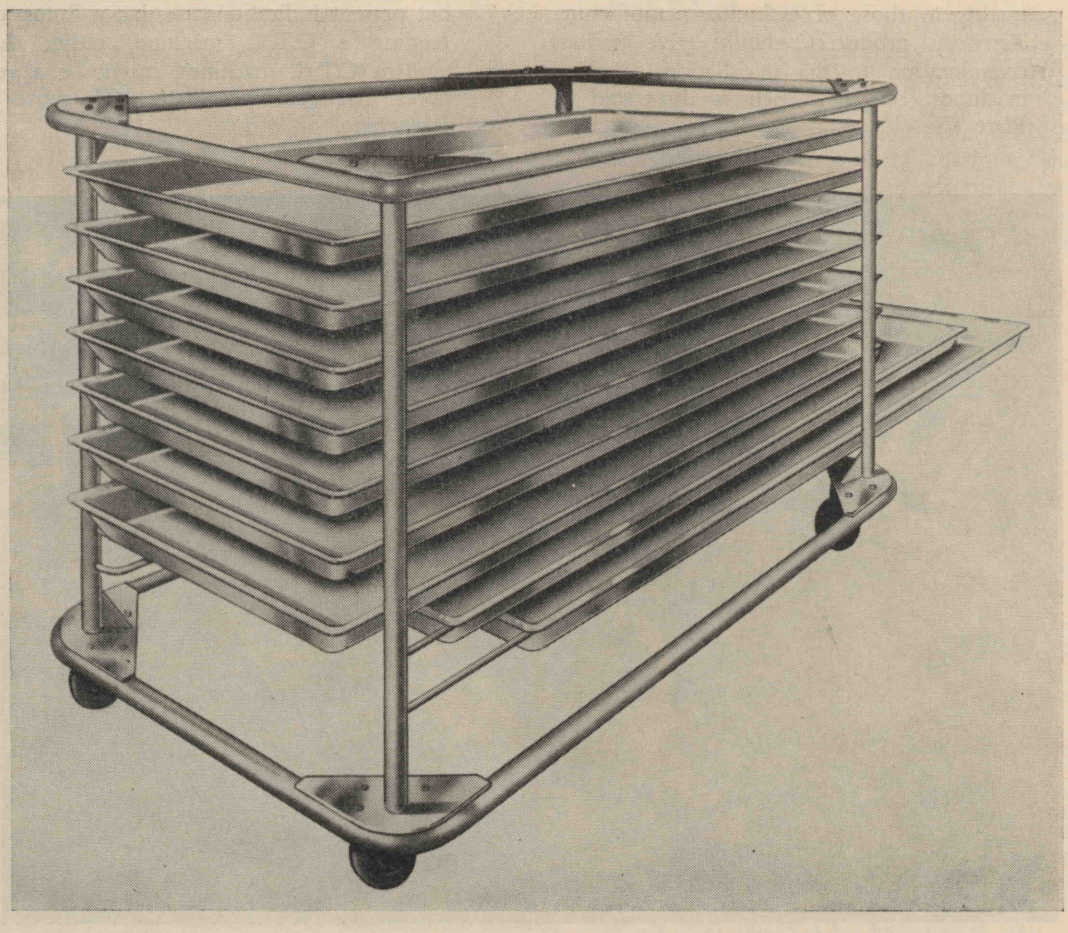

Plate VIII.—**Fermentation in shallow trays is standard procedure.**

[Photo Davidson & Co. Ltd., Belfast, N. Ireland.]

(iii) *Fermentation.*

The process of fermentation has not changed, although the speed of fermentation varies according to the method of leaf distortion used. The more vigorous methods of distortion such as Legg cutting, C.T.C. and Rotorvane manufacture lead to quicker fermentation.

After distortion, the green leaf is usually sifted to aerate and cool it and break up balls. It is then fermented in trays, usually of aluminium or fibreglass in modern factories, a rack of which is illustrated in Plate VIII. There it undergoes chemical changes. The first stage is an enzymic process whereby polyphenols of the catechin group are converted under the influence of the enzyme polyphenol oxidase to orthoquinones. These substances then undergo chemical condensation to the yellow-coloured bisflavanols and theaflavins which are further changed to the red and brown-coloured thearubigins, which give tea its distinctive colour. Unless the process is stopped at this stage, the thearubigins are degraded to insoluble substances.

The so-called fermentation process is chemical, not biological, and good factory hygiene is essential to prevent bacterial contamination during fermentation. Any contamination inevitably leads to a lowering of quality.

(iv) *Drying.*

There have been no fundamental changes in the drying process although a steady improvement in the design and efficiency of dryers has occurred. Oil-fired forced-draught tray dryers will probably be most useful in Papua and New Guinea. Dryers with extended chambers handle the high moisture content teas produced by modern processing more efficiently than standard models. A large, modern dryer is shown in Plate IX.

(v) *Sorting, Grading and Packing.*

A variety of machinery is available to handle the purely physical processes of grading and packing. Packing in standard foil-lined plywood tea chests is desirable in order to gain acceptability on world markets ; cardboard cartons may eventually replace the plywood chests.

Dried tea is usually passed through a stalk-extracting machine. The most useful machine of this type for use where C.T.C. tea is manufactured is the Myddleton stalk extractor. In this machine the leaf passes over a tray with raised metal bosses each with a hole at the top. The agitated leaf passes through the holes in the bosses whilst the stalk slides down between them. The leaf is then sorted into grades.

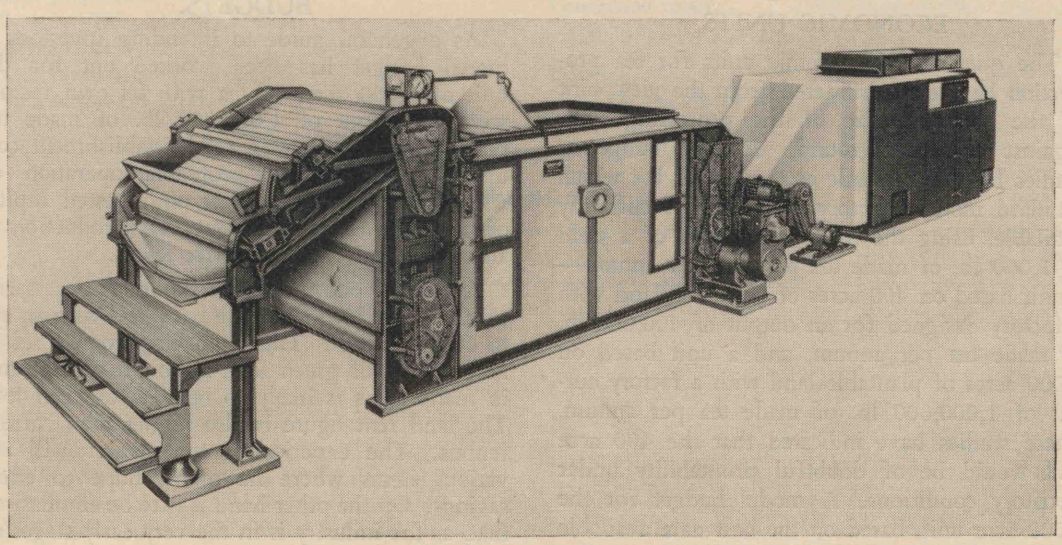

***Plate* IX.—A modern forced-draught tray drier.**

[Photo Davidson & Co. Ltd., Belfast, N. Ireland.]

(c) *Future Developments.*

What of future developments in tea processing ?

With the major advances over the last twenty years, the question may be asked whether a further revolution is likely, rendering the machinery at present recommended out-dated in a few years. It is impossible to be dogmatic on such matters, but at least the Territory tea producer who equips himself with the most modern machinery will be as well placed to meet future changes as his competitors. There may be development from a batch to a continuous type of processing, which would lead to greater factory efficiency. Further experiments are taking place in many countries, including work on a technique developed in Holland whereby all processes take place in a single drum. The leaf cells are disrupted by means of a vacuum and the leaf is broken by metal balls which crush it as the drum revolves. Drying also takes place in the drum.

Instant tea is attracting a great deal of attention at the present time. The share of the world market which instant tea will eventually capture is an open question, but it seems likely that for some large plantations it will be found worthwhile to consider the production of instant tea on the plantation.

ECONOMIC UNITS.

The question of economic units for tea production has been considered from the viewpoint of the optimum size of the processing unit. Against this background, detailed budgetary studies have been made at two levels for which standard modern factory equipment is currently available, using the basic assumption of a yield of 1,000 lb. of made tea per acre per annum—a unit based on 400 acres of plantable land with a factory designed for an output of 400,000 lb. of made tea per annum, and a unit based on 1,000 acres of plantable land with a factory output of 1,000,000 lb. of made tea per annum. These studies have indicated that the 400 acre unit would be of doubtful profitability under Territory conditions. A model budget for the 1,000 acre unit, based on the best data available at the present time, is given as the concluding section of this article and shows good prospects of profitability.

The producing component in an economic unit of this type might theoretically take a number of forms.

(1) A completely self-contained area of 1,000 acres of tea supplying its own factory.

(2) A syndicate or group whose members controlled sufficient areas of reasonable size and proximity to one another to supply their own central factory.

(3) A tea area of 400-500 acres partially supplying a factory which bought in its remaining leaf from surrounding smallholders.

Smallholdings, ranging from units combining several acres of tea with food crops and livestock up to larger specialised tea plantations under individual owner-management, would be dependent on external factories for the sale of their leaf.

No efforts at budgetary analysis have been made for the type of unit envisaged under (3) above or for the larger specialised smallholdings and sound practice would await local experience of collection costs and price structuring. Both would appear to be possibilities only in a post-establishment phase of the industry, the former being dependent on a well established smallholder component in plantings and the latter on adequate factory capacity for price competition.

BUDGETS.

As a general guide to intending investors, a model budget has been worked out for the unit of 1,000 acres of tea with its own factory with an output of 1,000,000 lb. of made tea per annum. It shows a total establishment cost up to the point of profitable operation of £355,000 including interest on invested capital of £56,000. Profitability at full production is also calculated for three price levels.

A general budget of this nature is necessarily calculated on a conservative basis and with an eye to future trends. Thus, plucking cost is set at 2d. per lb. of green leaf, although current cost in many areas is likely to be 1½d. or even less. The land rent figure is also higher than current rentals. The experienced tea planter will see various items where he might hope to effect savings. On the other hand it is to be emphasised that, as the industry is in the very early stages of establishment, this is a purely theoretical budget and contingencies will inevitably arise which cannot be foreseen.

MODEL TEA BUDGET

Basic Assumptions

Physical Data.

Area of Plantation—1,000 acres. Planted on grassland.

Nursery—Grown from seed. Seedlings remain in nursery for 18 months before transplanting into field.

Planting Density—Spacing 5 feet x 2½ feet. 3,500 plants per acre.

Bush formation—Bush formation aims at producing two or more shoots from each stump plant.

Fertilizing—Sulphate of ammonia, at 56 lb. per acre in the first year in the field increasing by 56 lb. per acre annually to 224 lb. at full rate. Applications to be made twice a year.

Planting Programme.

Year 1.
Nursery—2 acres.

Year 2
Nursery—3 acres.
Land preparation—150 acres.

Year 3
Nursery—5 acres.
Land preparation—250 acres.
Planting—150 acres.
Maintenance—150 acres.
Bush formation—150 acres.

Year 4
Nursery—5 acres.
Land preparation—300 acres.
Planting—250 acres.
Maintenance—400 acres.
Bush formation—250 acres.
Harvesting—150 acres.

Year 5
Land preparation—300 acres.
Planting—300 acres.
Maintenance—700 acres.
Bush formation—300 acres.
Harvesting—400 acres.

Year 6
Planting—300 acres.
Maintenance—1.000 acres.
Bush formation—300 acres.
Harvesting—700 acres.

Year 7
Maintenance—1,000 acres.
Harvesting—1,000 acres.

Year 8
Maintenance—1,000 acres.
Harvesting—1,000 acres.
Pruning—150 acres.

Year 9
Maintenance—1,000 acres.
Harvesting—1,000 acres.
Pruning—250 acres.

Yields.

Year.	Yield per acre (lb. made tea)	Total production (lb. made tea)
Year 4	150	22,500
Year 5	450	105,000
Year 6	800	277,500
Year 7	1,000	530,000
Year 8	1,000	775,000
Year 9	1,000	940,000
Year 10	1,000	1,000,000

Conversion factor.

100 lb. green leaf equals 22 lb. made tea.

Currency.

All figures are in Australian currency.

Table 1.

Structural Improvements (£).

Year.	1	2	3	4	5	6	7	8	9	Total
Staff accommodation	6,000	20,000	5,000	5,000	....	....	....	....	....	36,000
Ration stores and tool shed	....	1,500	....	....	....	....	....	....	....	1,500
Machinery shed/ workshop	....	....	....	3,000	....	....	....	....	....	3,000
Tea factory	....	....	35,000	....	....	....	....	....	....	35,000
Tea store shed	....	....	....	....	1,000	....	....	....	....	1,000
Fences	600	600	600	600	....	....	....	....	....	2,400
Roads	1,000	1,000	1,000	....	....	....	....	....	....	3,000
TOTAL	7,600	23,100	41,600	8,600	1,000	....	....	....	....	81,900

Table 2.

Plant and Equipment (£).

Year.	1	2	3	4	5	6	7	8	9	Total
Factory Machinery	....	....	....	66,000	....	....	....	....	....	66,000
Field Machinery	2,000	....	....	....	....	....	1,400	2,000*	....	5,400
Motor Vehicles	1,200	....	....	....	3,000	1,200	....	....	....	5,400
Other	400†	150	50	50	50	50	50	50	....	850
TOTAL	3,600	150	50	66,050	3,050	1,250	1,450	2,050	....	77,650

† Includes hand tools, office equipment, wireless. Hand tools replaced at £50 per annum to keep value up to £300.

* replacement.

Table 3.

Labour Costs (£).

Year.	1	2	3	4	5	6	7	8	9	10
Plantation										
Nursery	1,330	1,995	3,325	3,325	....	....	....	....	....	....
Land Preparation	....	4,165	6,940	8,325	8,325	....	....	....	....	....
Planting	....	....	3,000	5,000	6,000	6,000	....	....	....	....
Maintenance	....	....	2,070	5,520	9,660	12,765	11,040	8,970	6,900	6,900
Fertilizing	....	....	225	825	1,250	2,250	3,100	3,700	4,000	4,000
Bush formation	....	....	3,000	5,000	6,000	6,000	....	....	....	....
Pruning	....	....	....	....	....	....	....	2,000	2,000	2,000
Plucking (*a*)	....	....	....	980	4,230	11,150	21,090	30,620	37,385	39,785
Tractor driver (1)	130	130	130	130	130	130	130	130	130	130
Factory										
Permanent staff (*b*)	....	....	....	1,860	1,860	1,860	1,860	1,860	1,860	1,860
Mechanic	....	....	....	300	300	300	300	300	300	300
Clerk	....	....	....	400	400	400	400	400	400	400
Carpenters (2)	....	500	500	500	500	500	500	500	500	500
Tea Maker	....	....	....	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Driver	....	....	....	130	130	130	130	130	130	130
Management/supervision										
Manager	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Asst. Manager	....	....	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Directors' Fees (*c*)	500	500	500	1,000	1,000	1,000	1,000	1,500	1,500	1,500
TOTAL	5,460	10,790	25,690	41,795	48,285	50,985	48,050	58,610	63,605	66,005

(a) Includes foreman pluckers, reaching 15 at full production.

(b) Includes foremen.

(c) Includes travelling expenses.

Financial Data.

Field Costs. (See Table 3—labour costed at 6s. a day).

Field Costs—labour costed at 6s. per day.

Nursery Preparation—£665 per acre.

Land Preparation—includes burning, ploughing, lining, holing, shade (temporary and permanent), drainage—£28 per acre.

Planting—includes replacements—£20 per acre.

Maintenance—weeding—

£13.8 to third year in field
£6.9 subsequently.

Fertilizing—labour in spreading—

First year in field—£1 per acre.
Second year in field—£2 per acre.
Third year in field—£3 per acre.
Fourth year in field—£4 per acre.

Bush Formation—£20 per acre.

Pruning—plantation pruned at estimated annual cost of £2,000 after year 7.

Tractor driver—£130 per annum.

Plucking—2d. per lb. green leaf.

Buildings—(see Table 1).

	Estimated Cost.	Year of Construction.
Manager's house *	6,000	1
Asst. Manager's house *	5,000	2
Tea Maker's house *	5,000	3
Labour quarters	15,000	2
Married native quarters (6)	5,000	4
Ration stores and tool shed	1,500	2
Machinery shed and workshop	3,000	4
Tea factory (including office) 11,700 square feet (2-storey)	35,000	3
Tea store shed	1,000	5
	£76,500	

* Includes furniture and fittings.

Factory Machinery—(see Table 2).

	Estimated Cost.
Withering troughs (10)—40 h.p.	£3,600
C.T.C. unit—48-inch, 3 units * plus spare roller—50 h.p.	8,500
Ball breaker and aerator—4 h.p.	1,000
Drier—1 x 6 feet—7 h.p.	10,700
Stalk Extractors (2)—4 h.p.	1,300
Heat exchange units (2)—14 h.p.	1,500
Packer—4 h.p.	500
Generating equipment—3 x 50 k.v.a. includes wiring, lighting, etc.	18,000
Fermenting trays (100) 3 feet x 2 feet	1,000
Racks	200
Trolleys (6)	300
Storage Bins	500
Scales (2)	400
Hand tools	300
Foundations—machinery	5,200
Freight	13,000
	£66,000

* Or equivalent Rotorvane & C. T. C. machines,

Field Machinery (see Table 2).

	Estimated Cost (£).	Year of Purchase.
Tractor, trailer, implements	2,000	1
Tractor and trailer	1,400	7
	£3,400	
Motor Vehicles.		
Small 4-wheel drive	1,200	1
Truck—5-ton	3,000	5
	£4,200	
Office Equipment.	100	1
	200	2
	£300	
Roads (2 miles).	£3,000	1, 2, 3
Fences (6 miles).	£2,400	1, 2, 3, 4

Plant Operating Expenses.

Fuel—Fuel costs have been estimated at 6s. per gallon until Year 5. This figure includes freight costs. After Year 5, fuel will be flown into the area on the inward charter flights at a cost of 2s. 9d. per gallon (duty paid), Madang.

Oils and Greases—have been assessed at ten per cent. of the fuel cost.

Spare parts—to cover tyres, etc., on agricultural equipment, vehicles, etc., spare parts for this equipment together with factory equipment.

Years 1-4 .... £150 per annum.
Year 5 .... £300 per annum.
Year 6 .... £400 per annum.

Fertilizer.

Estimated cost on wharf Madang £40 per ton. Freight cost (Madang-Mount Hagen) to Year 4, £20 per ton. After Year 3, freight included in charters :—

Year 3	£225
Year 4	550
Year 5	1,250
Year 6	2,250
Year 7	3,100
Year 8	3,700
Year 9 and thereafter	4,000

Salaries.

Manager *	£3,500	
Assistant Manager *	2,500	
Tea Maker *	2,500	
Carpenters (2)	250	each
Driver	130	
Clerical Assistant	400	
Foreman pluckers (15)	130	each
Mechanic	300	
Factory foreman (2)	130	each
Factory staff (16)	100	each

* Includes leave, superannuation, etc., where applicable.

Directors' Fees.

Year 1	£500
Year 3	750
Year 5	1,500

Packaging.

Tea chests—assumed equal numbers of full chests and half chests.

Average costs. c.i.f. Madang (ex Japan)—full chests —13s. 7d.

c.i.f. Madang (ex Japan)—half chests —11s. 3d.

Stencils, etc. 5 per cent. of cost :

Full chests .... 14s. 3d.
Half chests .... 11s. 10d.

Cost per year.	£
Year 4	130
Year 5	620
Year 6	1,650
Year 7	3,140
Year 8	4,600
Year 9	5,570
Year 10	5,930

Repairs and Maintenance.

Buildings—2½ per cent. of original cost.
Agricultural equipment—15 per cent.
Plant and machinery—5 per cent.
Motor vehicles—15 per cent.
Fences—2½ per cent.
Roads—£150 per mile per annum.
Office equipment—covered in office expenses.

Interest.

Interest has been treated as the cost of capital and has been assessed at 6 per cent. It has been assumed that the outflow of money during each year will be fairly constant and interest on the debit balance in any year has been charged at half of the annual rate. Interest on the cumulative balance brought down has been assessed at 6 per cent.

Depreciation Rates.

These have been calculated according to *Income Tax Ordinances* 1959-1961 for the Territory of Papua and New Guinea. For the machinery in the factory, average rates have been determined as some of the machinery is not listed in the Ordinance. The rates are as follows :—

	Per cent.
Expatriate housing—timber frame and walls	3
Indigenous housing—concrete	3
Factory—concrete floors, steel frame	4
Machinery foundations	3
Machinery (averaged)	10
Sheds, etc.—concrete floor, steel frame	3
Fences—netting	10
Agricultural equipment and vehicle	20
Office equipment	10

Depreciation has been calculated on the diminishing value of the asset method.

Freight.

Included in cost of items. From Year 4 no freight component included, as all items carried on inward flights of charters which carry tea out.

Charter flights—Madang/Mount Hagen/Madang estimated at £150—D.C.3 type of aircraft.

At the present time, the maximum permissible D.C.3 load from Madang is 7,500 lb. and from Mount Hagen 6,000 lb.

Land Rent.

Land rent has been estimated at 12s. per acre but this figure is subject to revision.

Formation Expense.

This item has been estimated at £300—Year 1.

General Charges.

Office expenses (including stationery, etc.)
Year 1—£100.
Year 2—£200.

Insurance.

Year 4 onwards at £1 per £100—£1,500 per annum.

Income.

Average price of tea has been estimated at 4s. 3d. (Australian) per lb. The main budget has been calculated at this price but a range of prices has been used, namely 3s. 9d., 4s. 3d. and 4s. 9d. per lb. in estimating profitability.

Marketing Costs.

Handling charges, freight (to Australia) and insurance have been calculated at 4½d. per lb. and agents' commission at 3 per cent. on selling price.

Price at factory — 4s. 3d. less 4½d. less 2d.
= 3s. 8½d. per lb.

Corresponding adjustments to agents' commission have been made for the other estimated prices ; namely

At 3s. 9d., at factory — 3s. 9d. less 4½d. less 1½d.
= 3s. 3d. per lb.

At 4s. 9d., at factory — 4s. 9d. less 4½d. less 2d.
= 4s. 2½d. per lb.

Replanting Provision.

The net cost of field establishment alone has been estimated at—

(*a*) £130,000—tea at 4s. 3d. lb. (3s. 8½d. lb. airstrip Madang).
(*b*) £137,000—tea at 3s. 9d. lb. (3s. 3d. lb. airstrip Madang).
(*c*) £116,000—tea at 4s. 9d. (4s. 2½d. lb. airstrip Madang).

On the basis of these establishment costs, replanting provision has been assessed on an estimated economic life of the plantation of 40 years.

	Yield-lb./acre.	
Year 4	150	
Year 5	450	
Year 6	800	
Year 7	1,000	2,400
Full Bearing—		
Years 8-30 at 1,000 lb.	—	23,000

Table 4

Establishment Costs (£) 1,000 acres of Tea.

Year	1	2	3	4	5	6	7	8	9	10	Total End of Year 6
Formation Expenses	300	....	....	....	....	....	....	....	....	....	300
Structural Improvements	7,600	23,100	41,600	8,600	1,000	....	....	....	....	....	81,900
Plant and Equipment	3,600	150	50	66,050	3,050	1,250	1,450	2,050	....	....	74,150
Staff	5,460	10,790	25,690	41,795	48,285	50,985	48,050	58,610	63,605	66,005	183,005
Plant Operating Expenses	370	820	820	820	1,490	2,070	3,580	5,060	6,040	6,400	6,390
Fertilizer	....	....	225	550	1,250	2,250	3,100	3,700	4,000	4,000	4,275
Packaging	....	....	....	130	620	1,650	1,140	4,600	5,570	5,930	2,400
Air Charters	....	....	....	700	2,800	7,420	14,000	19,880	24,920	28,460	10,920
Overhead—											
Rent	600	600	600	600	600	600	600	600	600	600	3,600
Office Expenses	100	100	200	1,700	1,700	1,700	1,700	1,700	1,700	1,700	5,500
Miscellaneous	100	150	150	250	250	250	250	250	250	250	1,150
Annual Outflow	18,130	35,710	69,335	121,195	61,045	68,175	75,870	96,450	106,685	111,345	373,590
Income—at 3s. 8½d. at Madang	....	....	....	4,170	19,470	51,450	98,260	143,700	174,290	185,420	75,090
Debit Balance	18,130	35,710	69,335	117,025	41,575	16,725	+22,390	+47,250	....	....	298,500
Interest : 6 per cent. ‡	545	1,070	2,080	3,510	1,250	500	....	....	....	....	8,955
Total Annual Debit	18,675	36,780	71,415	120,535	42,825	17,225	+22,390 *	....	....	....	307,455
Cumulative Debit b/d	....	18,675	56,575	131,385	259,805	318,220	354,540	....	....	....	....
Interest on Cumulative debit b/d	....	1,120	3,395	7,885	15,590	19,095	21,270	....	....	....	47,085
Total Cumulative debit c/d	18,675	56,575	131,385	259,805	318,220	354,540	353,420	....	....	....	Say £355,000

‡ See note on interest - all charged to nearest £5.

* Credit balance.

Decreasing Yields—

10 years at average of 700 lb.— 7,000

32,400

Total yield for 1,000 acres = 32.4 million lb.

Establishment Costs—At 4s. 3d. lb.—£130,000.

Replanting provision is—

$\frac{32,400,000}{130,000}$ = 0.96d. per lb.

At other establishment costs for plantings—

3s. 9d. lb. .... 1.0d. per lb.

4s. 9d. lb .... 0.86d. per lb.

Budget of Establishment Costs.

This budget was formed to estimate the liability a company would incur before a tea estate of 1,000 acres, developed according to the plan shown, became productive. The problem is to find the break-even point, which is where the annual net inflow of money first exceeds the outflow. The establishment cost is equal to the cumulative total of net annual cash outflow plus the compound interest on the capital required, up to the break-even point.

Establishment costs will be influenced by the selling price of tea and in this budget the price has been assessed at 4s. 3d. lb., i.e., 3s. 8½d. lb., delivered airstrip Madang. Table 4 shows the establishment cost for the estate when the selling price of tea is 3s. 8½d. lb. It is estimated that approximately £355,000 is the liability a company would incur before the estate became productive. The break-even point is in Year 7, when income first exceeds cash costs. The establishment cost of the estate is reflected in the cumulative debit balance (including interest) brought down at the beginning of Year 7, which is the same as the cumulative balance carried down at the end of Year 6.

Similar budgets of establishment costs were calculated for selling prices of 3s. 9d. lb. and 4s. 9d. lb., i.e., delivered price Madang airstrip of 3s. 3d. lb. and 4s. 2½d. lb. respectively. At 3s. 9d. lb. establishment costs were assessed at about £370,000 with the break-even point in Year 8. At 4s. 9d. lb. the corresponding figure was £345,000 in Year 7.

Table 4 summarises the major items of the establishment costs at 4s. 3d. lb. Labour costs account for approximately 43 per cent. of the establishment costs, followed by structural improvements 19 per cent., plant and equipment 17 per cent., interest (annual and compound) 13 per cent.

Principal Items of Establishment Cost.

Staff			
Plantation	129,435		
Factory	18,070		
Management/Supervision	35,500	£183,005	43%
Plant and Equipment		74,150	17%
Structural Improvements		81,900	19%
Interest.			
Annual	8,955		
Compound	47,085	56,040	13%
Other		34,535	8%
		429,630	100%
Tea Income		75,090	17%
		354,540	83%
		(say) £355,000	

This is equivalent to £355 per acre of tea.

Budgets of Income and Returns.

The establishment cost budget shows only the estimated total liability of the estate. When income exceeds annual expenditure, it is necessary to construct a production budget.

Three prices are used in the following budgets (Tables 5, 6 and 7) which show costs for years 8, 9 and 10, together with the estimated rate of return on capital.

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Table 5. PRODUCTION BUDGET YEAR 8.

	Price 3s. 3d. lb.		Price 3s. 8½d. lb.		Price 4s. 2½d. lb.	
Gross Income—775,000 lb.				143,700		163,070
Costs—						
Labour			58,610		58,610	
Plant Operation			5,060		5,060	
Fertilizer			3,700		3,700	
Repairs			6,700		6,700	
Packaging			4,600		4,600	
Aircraft charters			19,880		19,880	
Rent			600		600	
Office expenses			1,700		1,700	
Depreciation			8,020		8,020	
Replanting provision			3,100		2,780	
Miscellaneous			100		100	
Gross Costs				112,070		111,750
Surplus				31,630		51,320
Interest 6 per cent.			355,000	21,300	345,000	20,700
Return to operator				10,330		30,620
Return to capital				26,630		46,320
Per cent. return to capital				7.5		13.4

Table 6. PRODUCTION BUDGET YEAR 9.

	Price 3s. 3d. lb.		Price 3s. 8½d. lb.		Price 4s. 2½d. lb.	
Gross Income—940,000 lb.		152,700		174,290		197,790
Costs—						
Staff	64,605		64,605		64,605	
Plant operation	6,040		6,040		6,040	
Fertilizer	4,000		4,000		4,000	
Repairs	6,700		6,700		6,700	
Packaging	5,570		5,570		5,570	
Aircraft charters	24,920		24,920		24,920	
Rent	600		600		600	
Office expenses	1,700		1,700		1,700	
Depreciation	7,680		7,680		7,680	
Replanting provision	3,920		3,760		3,370	
Miscellaneous	100		100		100	
Gross Costs		125,835		125,675		125,285
Surplus		26,865		48,615		72,505
Interest 6 per cent.	370,000	22,200	355,000	21,300	345,000	20,700
Return to operator		4,665		27,315		51,805
Return to capital		21,865		43,615		67,505
Per cent. return to capital		5.9		12.3		19.6

Table 7. PRODUCTION BUDGET YEAR 10.

	Price 3s. 3d. lb.		Price 3s. 8½d. lb.		Price 4s. 2½d. lb.	
Gross Income—1,000,000 lb.		162,000		185,420		210,420
Costs—						
Staff	66,005		66,005		66,005	
Plant operation	6,400		6,400		6,400	
Fertilizer	4,000		4,000		4,000	
Repairs	5,570		5,570		5,570	
Packaging	5,930		5,930		5,930	
Aircraft charters	26,460		24,460		24,460	
Rent	600		600		600	
Office expenses	1,700		1,700		1,700	
Depreciation	6,710		6,710		6,710	
Replanting provision	4,170		4,000		3,580	
Miscellaneous	100		100		100	
Gross Costs		127,645		127,475		127,055
Surplus		34,855		57,945		83,365
Interest 6 per cent.	370,000	22,200	355,000	21,300	345,000	20,700
Return to operator		12,655		36,645		62,665
Return to capital		27,855		52,945		78,365
Per cent. return to capital		7.5		14.9		22.7