RECOMMENDATIONS FOR THE CULTIVATION OF ROBUSTA COFFEE (COFFEA CANEPHORA) IN THE TERRITORY OF PAPUA AND NEW GUINEA

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ABSTRACT

Recommendations are given for planting and processing of robusta coffee under Papua and New Guinea conditions. Use of the 'Besuki' strain is advised. Details are given of nursery practices, shade establishment and maintenance, spacing of both coffee and shade trees in relation to the pruning system to be adopted, transplanting, field maintenance, different methods of pruning, harvesting, pulping, fermenting, drying, hulling and grading. Brief notes are given on the more common pests and diseases.

INTRODUCTION

THESE notes have been prepared as a guide to the cultivation of robusta coffee under Territory conditions. Recommendations are based on overseas findings as well as experimentation by Department of Agriculture, Stock and Fisheries' officers in both the Lowlands and Highlands.

In the past robusta coffee has received little attention in comparison with arabica coffee grown in the New Guinea highlands. Some of the findings on arabica coffee are applicable, usually in a modified manner, to robusta coffee, while others are completely inapplicable. Nursery techniques and field planting methods are similar for both crops, while light requirements and pruning systems tend to differ.

The articles included in a list of literature consulted at the end of this paper are well worth studying.

GENERAL

Robusta coffee, *Coffea canephora,* has been grown in the Territory since the turn of the century. Prior to the Second World War, there were a number of substantial plantations in New Britain and Bougainville and some in the Popondetta area. These were neglected during the war. At present there are a number of holdings in the vicinity of fifty acres each around Cape Rodney in Papua, as well as several near Lae. Substantial acreages of indigenous plantings occur in the Milne Bay district and the Sepik district and to a lesser extent in parts of the Northern district.

Prices for the last few years have been relatively stable, and there is a reasonable demand for this type of coffee in Australia. Robusta coffee is used in blends of ground coffee as well as soluble coffee extracts for instant coffees, for espresso-type coffee and in chicory mixtures.

Cultivation of robusta coffee can be carried out over a variety of soil types and climatic conditions. It appears to favour light soils but can do reasonably well on heavier soil types. It has been grown successfully up to 1,700 ft. or more in the Mullins Harbour area of Milne Bay. Robusta coffee noted at about 5,000 ft. at Aiyura in the Eastern Highlands has a much slower growth rate. A rainfall of at least 70 to 80 inches, relatively well distributed, is desirable, although dry periods of up to two or three months can be withstood on most soil types. Robusta coffee is tolerant of heavy rain and can tolerate standing water for days.

Unfortunately no accurate figures on robusta coffee yields under Territory conditions are available. From observations at

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Keravat, yields in the vicinity of 1,000 lb. dry beans per acre could be obtained with proper attention.

PLANTING MATERIAL

Over the years numerous introductions of robusta coffee have been made but unfortunately records are scanty. Pre-war plantings, some of which are still in existence, are very variable especially with regard to coffee bean size. Uniformity in bean size, as well as suitable liquoring qualities, are important to manufacturers.

With this in mind a Javanese strain of robusta termed 'Besuki' was introduced by the Department of Agriculture, Stock and Fisheries from Indonesia. This strain is reputedly high yielding as well as producing a large even-sized bean. In quality it is good and has at times commanded premium prices. It is recommended and distributed by the Department of Agriculture, Stock and Fisheries. It should be noted that although 'Besuki' seed produces progeny that are relatively uniform, 'off-types' are still common, as robusta coffee is an outbreeder. Plants displaying abnormalities should be eliminated as soon as they are detected in the field. 'Off-types' commonly have small crinkly leaves associated with poor, if any, fruit production, while others have exceedingly small cherries.

Limited supplies of 'Besuki' seed are available from the Lowlands Agricultural Experiment Station at Keravat. In most lowland districts, seed gardens of twelve selected clones have been established at Agricultural Extension centres and some are now producing seed.

NURSERY PRACTICES

Seed must be sown as soon as possible after receipt. Germination trials at Keravat showed that after two months storage, viability was much reduced. Viability of three to four month old seed was very low and five month old seed did not germinate. Seed planted at half an inch depth germinated quicker than seed planted at one inch depth, but the ultimate germination rate of the latter was greater (Jamieson 1963).

Germination beds consisting of fine, loose soil worked to a depth of at least three inches should be used. Seed should be planted on a two inch square and at a depth of one inch. Any broken or abnormal seed should be culled.

Germination will take from three to seven weeks depending on age of seed as well as on the moistness of the seed bed and the soil temperature. Seed beds must be kept reasonably moist but excessive wetness will inhibit germination as well as causing fungal attack. Collar rot (or damping off) caused by a fungus can be especially damaging under excessively moist conditions. The fungus attacks between time of germination and the appearance of the plant above ground level. A small dead spot forms at the base of the stem at the point of contact with the ground and spreads until the whole stem is encircled. The stem collapses and the plant dies. If it seems likely that this fungus will cause considerable trouble, the following treatment should be adopted: drench seedbed with 4 lb. copper oxychloride dissolved in 100 gallons of water immediately after planting. Repeat treatment at weekly intervals.

Shade over seedbeds should be relatively heavy. *Leucaena leucocephala* formerly known as *L. glauca*) is a very suitable nursery shade. Other shades such as *Gliricidia maculata* or *Erythrina,* as well as a number of temporary shades such as *Crotalaria* or *Tephrosia,* might be used. Artificial covers of bamboo slats, kunai or coconut fronds are also satisfactory.

Once seedlings in germination beds have reached the fully expanded cotyledon (seed-leaves) stage, they can be transplanted either to a nursery bed or to polythene bags as described below.

Traditionally seedlings are transplanted to a nursery bed on an eight inch by eight inch spacing. Seedlings are grown in this nursery, preferably to the five or six pairs of leaves stage or somewhat larger, before they are field planted. Nursery beds should consist of loose, friable soil well worked to a depth of eighteen inches and should have a water supply handy in case of any dry spells. Four or five weeks prior to anticipated field plant-

ing, seedlings should be 'root-pruned' or 'root-snapped' if planting in a sod is to be used. The aim is to prevent the formation of a 'bench-taproot' and also to stimulate seedlings into producing a multitude of new feeder roots. Bench-rooting occurs when tap-roots which are excessively long are bent at transplanting with the result that they grow sideways instead of downwards. Insecure anchorage as well as a restricted feeding area are the result.

Root pruning entails inserting a spade into the ground to its full depth about four inches from the base of the seedling and tilting backwards until a snapping sound is heard. The earth is then firmed down around the plant again.

When planting in sod (this is desirable but can be expensive and inconvenient), all roots extending outside the sod should be pruned away. If seedlings are not sod planted any excessively long tap-roots should be pruned and care taken to avoid bending tap-roots when transplanting.

A second method which is convenient and causes a minimum of shock at transplanting has been used with success at Keravat. Seedlings at the fully expanded cotyledon stage are transplanted to perforated polythene bags (as used for cacao) which are filled with good, rich soil (any 'bush' soil is generally suitable). Seedlings then develop to the five or six pairs of leaves stage when they are ready for field planting. It is important not to delay transplanting much past the five or six pairs of leaves stage as polythene bage will restrict full rooting. Polythene bags must be removed when field planting as they are quite resistant to decomposition and hence will limit the spread of roots. The tap-roots should also be pruned.

Regardless of whether seedlings are planted into nursery beds or polythene bags, it is necessary to water at least for a week after removal from the germinating beds.

Nursery plantings must be timed so as to have seedlings at the appropriate stage for field planting at the onset of the wet season in areas where definite wet and dry seasons are usual. It will take from five to seven months from planting of seed to the five or six pairs of leaves stage.

Careful screening of seedlings before transplanting to polythene bags as well as before field planting is necessary. Any slow germinating seedlings should be discarded. As a rule, provided seed of the same age is used and planted at the same depth, it is best to discard seedlings that germinate more than three weeks after germination is first observed. In addition, seedlings with abnormal leaf characteristics or colouring should be culled.

SHADE AND SPACING

The most common and probably at present the most suitable shade for robusta coffee is *Leucaena leucocephala.* Almost all of the Territory's robusta coffee is grown under this type of shade. *Gliricidia, Erythrina* and *Albizia* have been experimented with but all have disadvantages by comparison with *Leucaena. Gliricidia* has an unruly branching habit and also tends to be susceptible to wind damage. However, it does better than *Leucaena* in wetter situations and is more tolerant of sulphur deficiency. *Erythrina* is a relatively fast growing shade but has the distinct disadvantage of losing its leaves during the dry season. *Albizia* grows to a large tree and necessitates thinning which can result in mechanical damage to coffee trees.

Shade can be established from either seed or seedling stakes. The latter method is preferable as it provides a quick shade and is usually cheaper.

Shade From Seed.

Seed should be inoculated with the appropriate strain of Rhizobium, a bacterium which induces nitrogen-fixing nodules on the roots of *Leucaena,* unless it is known that this is unnecessary in a particular area. Inoculum is not necessary in many areas of the Gazelle Peninsula and lower Markham Valley where satisfactory nodulation is ensured by sufficient inoculum in the soil. Inoculum can be procured by writing to the Director, Department of Agriculture, Stock and Fisheries, Konedobu.

Spectacular responses have been shown in different sections of the Gazelle Peninsula, New Britain, to sulphur fertilizer, especially on old kunai land subject to frequent burning. Stunted *Leucaena,* about three years old and still only waist high, has greened up within two weeks of sulphur application and has provided adequate shade within about six months. Applications of about 1 lb. of flowers of sulphur to each 100 ft. row of *Leucaena* are recommended where necessary. As sulphur deficiency has been observed in the Popondetta area, these results might well be applicable to that locality if difficulty in establishing *Leucaena* is encountered.

Leucaena seed should be sprinkled at a rate of eight to ten seeds per foot about a quarter of an inch below the surface along proposed shade rows. From five to fifteen pounds of seed per acre will be needed depending on the efficiency of the labour and the shade spacing adopted.

Shade from Stakes.

To provide seedling stakes, a nursery should initially be prepared. One acre of nursery should provide stakes for at least fifty acres of shade. Seed, inoculated if necessary, at a rate of eight to ten per foot and at a depth of a quarter of an inch should be sown in rows about a foot apart. Germination takes four to five days under good conditions.

Stakes are ready for field planting when they are approximately half an inch thick at the base, usually after three or four months. Stakes are cut off about three inches below ground level and planted at a depth no more than one inch (this is important) below the original level.

Shade Requirements.

For coffee seedlings shade at transplanting should be relatively heavy as grass competition will be reduced with adequate shade. Field planting should be possible within about six months of planting stakes.

If it appears likely that permanent shade will be inadequate at time of transplanting, temporary shade such as *Crotolaria anagyroides* or *Flemingia congesta* can be sown in the vicinity of the planting holes. As soon as permanent shade is adequate, temporary shade can be removed.

The degree of shade necessary will depend largely on the environment and will change with the age of the coffee. Areas subject to frequent heavy cloud will need less shade than sunnier areas. Soil fertility will also play a part in determining what shade intensity is needed.

Broadly speaking, shade will control a plant's growth rate if other factors are not limiting. The less the shade, the greater the plant's potential growth rate and hence the greater the demand for nutrients. If these nutrients cannot be adequately supplied, (either through the soil being inherently poor or grass competition being severe), the plant's physiology is upset, leading to leaf chlorosis and dying back.

Under Territory conditions and with traditional systems of maintenance newly planted seedlings require a relatively high level of shade, certainly more than older trees which are substantially self shading.

At Keravat, seedlings planted in full sunlight survive but are very chlorotic and stunted. Experience in the Milne Bay area has shown shade to be essential even in areas such as the Sagarai valley which are characterised by a heavy cloud cover. Recent experimentation has shown that seedlings can be successfully established under conditions of very light shade provided nutrition requirements are satisfied—in this case elimination of weed competition through clean weeding sufficed. As a general rule, however, it would be safest to establish coffee under relatively heavy shade and thin shade later after seedlings are well grown.

Shade and coffee spacings will depend on pruning systems adopted (these are discussed later). Recommendations are made for the arch or Agobiada system of pruning and a single stem system involving rotational stumping.

Arch or Agobiada Pruning.

A ten foot triangular spacing allowing 502 trees to the acre seems adequate for this system of pruning.

Shade should be planted initially in rows 10 ft. apart and 3 ft. apart within rows. This will enable two rows of coffee to be established between rows of shade (taking rows at right angles to the base line so that the coffee is seen as planted in rows 5 ft. apart with a 17 ft. 4 inch spacing within rows). At this stage there will be roughly one coffee tree to three shade trees.

As the coffee develops shade should gradually be thinned. The following programme is suggested:-

1. Six months after transplanting remove alternate shade trees within rows, to leave 6ft. spacing within rows.
2. Twelve months after transplanting remove alternate shade trees within rows, to leave 12 ft. spacing within rows.
3. Eighteen months after transplanting remove alternate rows of shade trees, to leave 20 ft. apart with a 12 ft. spacing within rows.
4. If after twenty-four months coffee trees are of good appearance and showing little sign of chlorosis, alternate shade trees within rows could be removed to leave rows 20 ft. apart with a 24 ft. spacing within rows.

In approximate terms the original three shade trees to one coffee seedling at transplanting should be thinned to only one shade tree to five coffee trees.

For high yields a relatively low level of shade is required. However, unless the soil is extremely fertile additions of fertilizer, usually a nitrogenous type, will be necessary.

Single Stem Pruning with Rotational Stumping.

An eight foot triangular spacing giving 785 trees to the acre would be suitable. The closer spacing is used as the lateral spread of single stem trees and is considerably less than that of trees pruned to an arch system.

Shade should be planted initially in rows 8 ft. apart and 4 ft. apart within rows. Two rows of coffee can be grown between rows of shade (taking rows at right angles to the base line so that coffee is seen as planted in rows 4 ft. apart with a 13 ft. 10 inch spacing within rows).

The following thinning programme is suggested:-

1. Six months after transplanting remove alternate shade trees within rows, to leave 8 ft. spacing within rows.
2. Twelve months after transplanting remove alternate shade trees within rows, to leave 16 ft. spacing within rows.
3. Eighteen months after transplanting remove alternate rows of shade trees, to leave 16 ft. row spacing with trees 16 ft. apart within rows.
4. If after twenty-four months trees are of good appearance and colour remove alternate trees within rows to leave rows 16 ft. apart with trees in rows 24 ft. apart.

Considerations of shade and fertility are as given above for arch pruned trees.

Thinning of Leucaena.

Unless *Leucaena* is thinned in the correct fashion, it can become rather troublesome. Cutting out without previous or subsequent poisoning will result in profuse suckering. Spraying the tree bases with a mixture of 2,4,5-T (such as Shell Weedkiller 'B') and diesel distillate is an extremely efficient method of thinning *Leucaena.* A concentration of $\frac{1}{4}$ per cent. 2,4,5-T active ingredient is adequate (about 3 pints of 2, 4, 5-T 30 per cent. concentrate per 44 gallons diesel distillate). There is no need to 'frill' the bark.

For old *Leucaena* (stem diameter of more than about 3 inches), a $\frac{1}{2}$ per cent. solution is recommended.

PLANTING

Preparation of planting holes three or four months prior to the anticipated time of transplanting is generally recommended. These holes should be at least 18 x 18 x 18 inches. Three or four weeks before planting, they should be refilled with *top soil only* and a small mound formed to allow for settling. Holing is of special importance in heavy soils.

Timing of nursery preparation should be such that seedlings are ready for field planting at the beginning of the wet season.

The following points are worth noting:

1. Transplant at a young stage, i.e. the five or six pairs of leaves stage, to minimise transplanting shock.
2. If seedlings are grown in polythene bags, prune the tap-roots and *remove bags*. When transplanting in sod, prune away any roots extending beyond the sod.
3. Plant on cool, cloudy days into a moist soil.
4. Be certain that the level of planting is slightly above the surrounding level so as to avoid waterlogging.
5. Ensure that roots exposed when plants are lifted from the nursery are kept moist until field planting is completed.

MAINTENANCE

As robusta coffee has a swallow root system, any competition from associated plants, particularly grass, greatly restricts development.

At the transplanted seedling stage, shade will restrict grass development. Ring weeding as well as periodical general slashing must, however, be carried out. Mulching in the proximity of the seedlings is also very desirable and will suppress weeds for an extended period.

A number of grasses can be used successfully for mulch. Giant kangaroo grass (*Themeda gigantea*), Kunai (*Imperata cylindrica* or wild sorghum *(Sorghum spp.)* can be utilised. Elephant grass (*Pennisetum purpureum*) has been specially grown for mulching because of its high yield per acre. It should be thoroughly dried out before use or it will root from the stems. Once established it is very hard to eradicate.

Experiments at Keravat have clearly demonstrated the importance of weed control. Coffee grown in experimental plots which were kept clean weeded reached the same stage of development about fourteen months after field planting as coffee grown under field conditions, with periodical ring weeding and grass slashing, for about twenty-four months.

Chemical weedicides such as 2,4-D with dieselene and Dalapon with water have been used successfully overseas for weed control. Territory experience, however, does not allow any definite recommendations to be made for chemical weed control in robusta coffee plantings.

PRUNING

At present there is no single pruning system that can be described as best for robusta coffee.

Pruning systems at present utilised are briefly described as follows:-

Single Stem System.

This system, although commonly used, is by no means ideal for robusta coffee. In classical single-stem pruning the main stem is topped at four and a half to five feet. Laterals touching the ground, as well as varying numbers of other laterals on the main stem, are removed to allow more light penetration and a better general air circulation. Secondary branches on the laterals are also thinned and eventually secondaries are trained to take the place of primary laterals. Fruiting gradually progresses down the laterals and then onto the secondaries and the tertiaries. Single-stem pruning requires a considerable amount of skill as well as time.

Single-stem pruning of the classical type is not really applicable to robusta coffee for the following reasons:-

(i) The growth rate of robusta coffee is very rapid and it is difficult to form an adequately shaped bush. Secondary branching generally does not occur.

(ii) Robusta coffee flowers on the current year's growth and flowers only once at the same site. Flowering on one lateral is usually restricted to one year. The result is that laterals usually only produce for one year. Topping will therefore limit fruiting sites quickly and will produce an umbrella shaped tree which has a productive life of only a few years unless regenerated.

Multiple Stem Systems.

Capping System—Several uprights, usually three or four, are encouraged with the idea of training each as a separate stem. Although secondary shoots often appear on transplants as a matter of course, capping soon after transplanting in order to induce sucker production is recommended. Capping involves cutting off the stem above the last pair of leaves.

Once the stems have reached the flowering stage, interlacing laterals at the centre of the tree should be removed to permit better light penetration and air circulation. This, combined with the weight of developing fruit, will bend the stems outwards and leave them more or less separated from each other. A stage will come when these stems will have to be topped to facilitate picking. Topping at between eight and ten feet is recommended. In the 'topped' condition a stem will bear a worthwhile crop for only three years at the most. This means that regeneration is necessary by systematically removing one stem a year and replacing it. After the first year of bearing, one stem is stumped and a basal shoot encouraged (usually before stumping), the next year another stem is stumped and so on. Theoretically this appears sound but successful replacement of stumped stems can be difficult. New shoots are usually excessively shaded by other stems as well as by neighbouring trees, frequently resulting in a weak spindly stem.

The Agobiada System—This type of pruning is one of the most commonly used with robusta coffee in the Territory. A main stem is allowed to grow to a height of two and a half to three and a half feet and then bent over in an arch and fixed to the ground by means of a forked stick or heavy gauge wire. As a consequence a large number of orthotropic (upright) shoots are formed. Four or five of these are selected as far apart on the bent stem as possible and are allowed to develop as separate stems. Restricted pruning is conducted to facilitate light penetration and air circulation between laterals of the different stems. Volunteer suckers are also periodically removed. A rotational system of stumping and rejuvenation is applied. Topping at a height of between eight and ten feet is recommended. Again difficulties are met in getting replacement stems away successfully. Stems are often weak and spindly, with long internodes and hence fewer fruiting sites. They often suffer wind damage as well as breakage under the weight of developing fruit.

A newer system used mainly with arabica coffee in some Central American countries and Hawaii utilises closely spaced single-stem trees which are stumped rotationally The plantation is planted in blocks each consisting of four closely spaced rows. On the first year after harvest, row one is completely stumped and a new shoot is encouraged, next year row three is stumped, then row two and finally row four.

Close spacings are used to encourage high early yields as well as to minimise grass growth. As trees are stumped every fourth year, reduction in yield owing to crowding will not be great. In any case, low yields per tree are more than compensated for by high tree numbers per acre. Heavy fertilizing and no shade is generally utilised.

This system is relatively cheap as grass maintenance is at a minimum and virtually no pruning is required except for periodic removal of suckers.

Experimental plots at Aiyura utilising such systems are promising.

Unfortunately little work has been done in robusta coffee with similar systems. It is probable that modifications would be needed. While proven recommendations cannot be given, the following method of cultivation should be successful:-

1) Divide plantation into blocks of four rows at about eight foot spacing.

2) Establish shade as previously recommended, plant coffee and prune on a single-stem system, i.e. top at about eight feet (this will take about two years under field planting under good conditions), as well as removing any secondary growth (mostly basal suckers).

3. After the first worthwhile harvest stump row no. 1. Allow one regenerated shoot to come away on each tree. There should be enough light to permit the formation of a sturdy stem. Next year stump row no. 3, in the third year stump row no. 2, and in the fourth year, row no. 4.

4) Thin shade gradually as previously indicated.

Experimental work is needed to see whether fertilizing and lower levels of final shade are warranted.

HARVESTING

Ripe cherries ready for harvest are usually a dark red colour, but colour varies from area to area. At Keravat ripe cherries are a bright red, while in Milne Bay they are usually pink. In the Sagarai Valley ripe cherries turn yellow and have only streaks of pink colouring.

A ripe cherry will split and eject its beans if pressed gently between thumb and finger. It takes only a little experience to select ripe cherries.

Unfortunately all cherries at a node may not ripen at precisely the same time and a mixed sample will result if the entire cluster is picked. This should be avoided if possible as it results in an uneven product.

Frequency of harvesting will vary greatly from place to place. Coffee stumped and rejuvenated at Keravat in March, 1964, was harvested in May, August, November of 1965, and January, February, April, June, July, August and October of 1966. There is no definite harvesting season at Keravat. In the Milne Bay area the main pick is between May and August, with a peak in June-July. There is, however, a little picking all year round. Harvesting in Indonesia is continuous.

Cost of picking will depend on the crop as well as cultural variables such as spacing and pruning systems and the quality of labour. At Keravat the average picker harvests seventy-five pounds of cherries per day while the best labourers pick up to one hundred and thirty pounds per day.

PROCESSING

An efficient system of collecting and transporting cherries to the factory is essential.

The morning pick should be pulped as early as possible in the afternoon and placed in fermenting vats, while the afternoon pick should be pulped separately and placed in separate vats. The morning pick should not be held for processing with the afternoon pick, as ripe cherries left unpulped for any period of time will start fermenting and detrimental flavours and bean discolouration may develop.

Coffee cherry for pulping is placed in a receiving vat full of water above the level of the pulper. On agitation, unripe cherries as well as over-ripe cherries float to the top—they should be removed and treated separately if the amount warrants it, or alternatively discarded. Cherries then pass through the pulper which removes the fleshy covering and releases the beans (normally two to a cherry). Adjustment of the pulper can be critical. If the adjustment is even slightly out, mechanical damage to beans may result. Broken beans are liable to develop off flavours and unsightly stains during fermentation.

As cherry size will vary considerably, it is always likely that a certain amount of crop will be lost despite careful pulper adjustment. If losses are considerable, grade cherries before pulping.

After pulping, the beans, still enclosed in the parchment skin, pass into fermenting vats where they remain until all the mucilage covering the skin has disappeared. There are different methods of fermenting.

Fermentation in water is the commonest method. The process is complete when a handful of beans no longer feels slimy and slippery but gritty when rubbed. Time for fermentation depends on the amount of coffee as well as the dimensions of the fermenting vat. For robusta coffee the time will vary usually from twenty-four to thirty-six hours.

Other fermenting systems involve 'dry' system fermentation for a specified period followed by completion of fermentation in water.

If desired, fermentation can be by-passed by removing coffee mucilage with caustic soda, which takes about fifteen minutes and has no adverse effect on the product. One pound of caustic soda is sufficient for two hundred pounds of freshly pulped coffee (i.e. approximately four hundred pounds of cherries). The calculated amount of caustic soda is mixed with water and added to the pulped beans, which are agitated for about fifteen minutes, by which time all the mucilage is removed. Excess alkali is of no benefit.

On completion of fermentation, beans are thoroughly washed with clean water. Insufficient washing can lead to a poor product.

Coffee may be sun dried but in the Territory mechanical drying will usually be necessary. Partial sun drying followed by mechanical completion of drying may be used. With sun drying, the beans must be protected from sudden showers. Sliding roof driers are convenient. Sun drying takes a minimum of nine days to reduce moisture content to the required eleven to thirteen per cent. If a bean 'gives' when bitten it is insufficiently dried.

Mechanical drying is necessary in many areas where high rainfall and a resultant lack of sunshine render sun drying impossible. Most cocoa driers can be adapted to coffee drying quite easily. At Keravat both coffee and cocoa are dried simultaneously on a Universal drier. Rotary driers are quite successful.

Some authorities recommend high initial drying temperatures (about 85 degrees C. or 185 degrees F.) and then, about six hours later, a reduction to 75 degrees C. (167 degrees F.). Others recommend lower temperatures throughout.

Once the coffee is dried it is ready for hulling and polishing. If a time lag of several days occurs between completion of drying and hulling, a quick re-drying may be necessary. The hulling process consists of removing the parchment skin (loose outer covering of the bean) and the silver skin or testa which in the case of robusta coffee adheres firmly to the bean.

There are a number of makes of machine available for pulping and hulling. Most are satisfactory.

Grading of hulled coffee for broken beans and traces of silver skin is recommended as uneven samples are frowned upon by buyers.

PESTS AND DISEASES

Robusta coffee is relatively free from serious pests or diseases.

The following pests sometimes occur:-

Mealybugs (*Planococcus* spp. and others) can be a minor problem. Heavy infestations reduce effective leaf area in mature trees and limit growth in seedlings. They are associated with ants which can be a nuisance at harvest.

Scale Insects can also be a minor pest. Green scale *(Coccus viridis)* is quite common, occurring more in overshaded areas and often in association with mealybugs.

Ants, both 'Kurakums' (*Oecophylla smaragdina)* and 'fire-ants' *(Solenopsis geminata*], are common on robusta coffee. 'Fire-ants' culture mealy bugs and scale insects as well as making picking exceedingly difficult where infestations are heavy. A high volume spray of 0.2 per cent. dieldrin and about a 1 in 80 emulsion of white oil will control ants, mealybugs and scale insects. Alternatively dieldrin could be applied separately as a spray to the trunks of the coffee bushes. A concentration of white oil any higher than 1 in 80 should not be used as it may cause leaf burn.

Coffee Stem Borer (*Zeuzera coffeae*) larvae can cause damage by burrowing through main stem and also lateral branches. Limbs may be killed. Serious outbreaks are rare.

Caterpillar Damage — damage to new foliage and flowering buds occurs on occasions. Loopers are generally responsible.

Cacao Army Worm (*Tiracola* sp) has been responsible for damage on coffee in the Wau area.

The following are some diseases of robusta coffee in the Territory.

Pink Disease, caused by a fungus (*Corticium salmonicolor).* This condition is seen as whitish threads over young limbs and a pinkish crust on older wood. It is usually associated with high humidity, often as a result of excessive shade. It can be controlled by pruning away infected branches and, if the outbreak warrants it, spraying with fungicides such as copper oxychloride or Bordeaux mixture before the branches are pruned in order to kill any spores on the surface. All pruned material should be burnt.

Thread Blight, caused by a fungus *(Pellicularia koleroga).* The fungis appears on the underside of leaves and on fruit as white silvery threads eventually causing a brown rot of leaf or stem. It is often prevalent during the wet season and especially under heavy shade. For control, reduction of shade may be necessary. Pruning of diseased parts should be carried out and all prunings burnt.

White Thread Blight *is another* fungal condition caused by a species of *Marasmius* or *Corticium.* It can be controlled by reducing shade and pruning of infected parts.

Root Rots are all fungal diseases. The most common are caused by species of *Fomes.* Symptoms consist of a fairly sudden wilting of the leaves, sometimes within a few days. The leaves turn brown and the tree dies. Affected trees should be dug out. All root material *must* be removed and burnt as the root rot fungi can exist for long periods on dead root material.

If *Leucaena* or other shade is thinned it should be poisoned or pulled out entirely so that it will not serve as a host for the root rotting fungi.

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