Original Articles.

The Cultivation of Papaya and the Preparation of Papain.

F. A. STOCKDALE, C.B.E., M.A., F.L.S.,

Director of Agriculture, Ceylon.

THE demand for papain continues to increase and the present prices make the cultivation of papaya remunerative. The Department is continuously being asked for information, and in consequence the following data have been collected together.

The papaya is one of the most common of Ceylon's fruits and thrives from sea-level up to about 3,000 feet on the south-west side of the Island. Papain is a digestive enzyme which is valued in medicine, in the preparation of chewing gum and special foods and in various other commercial businesses. It is obtained by making shallow incisions in the fully grown but green fruit and collecting the milky juice which exudes and drying the same. The exports of papain from Ceylon have increased regularly in recent years and amounted to the following in 1924 and 1925.

		Lbs.	*Value.*
1924	...	51,235	Rs. 317,893
1925	....	60,995	,, 434,458

The greater part of this goes to the United States of America and is used in the manufacture of chewing gum.

Soil Condition and Cultivation.

The papaya grows best in the soil of heavy forest recently felled and burnt. Its cultivation need not be limited to such land as it will also thrive in any soil which is deep and well drained. The best results are secured in loamy soils which are flat or gently undulating, but papaya cultivations on hilly land have been known to do well in Ceylon particularly if planted when the land is first opened. Papaya has been grown most successfully as a catch crop in young rubber plantations and has also been grown on lands which are under re-afforestation. It does not grow

satisfactorily in lands which have been continuously chenaed nor in those which are insufficiently drained. It also does not prosper in wind-swept areas and should therefore preferably be grown in well-sheltered situations.

Cultivations on flat or gently sloping lands should be kept free from weeds but on hilly lands cover plants such as *Vigna*, *Centrosema*, or *Indigofera endecaphylla* should be grown to prevent soil erosion.

Manuring is not necessary for cultivations on new lands but would pay when the cultivations are on old lands. Nitrogenous manures should be used and applications of such manures at rates varying between $\frac{1}{4}$ to $\frac{1}{2}$ lb. per plant according to age and planting distances can be recommended.

Planting out.

Planting may be done by seed at stake, allowing 5-6 to each hole and eventually thinning to one good plant per hole, or seedlings may be raised in beds or pots and planted out when about 3-4 inches high. An experienced cultivator of papaya recommends the raising of plants in baskets. Tea supply-baskets are suitable. In each basket filled with soil 4 to 5 seed should be sown. The baskets of seedlings should be planted out when the young plants are 4 to 6 inches high. This grower writes as follows:—

" I have completely abandoned seed at stake, sowing broadcast, etc., and find far and away the best plan is tea supply-baskets. You are not so dependent on the weather. I germinate my seed first and always put in double the number of baskets required. That is for 1 acre 10 ft. by 10 ft. requires 430 baskets. I prepare 800 baskets and only put those out containing 4 to 5 plants to a basket. This is very important, as it reduces your vacancies to not more than 1 or 2 per cent. on suitable soils. Very often you get 3 or 4 male trees in a basket, I have even had all 5, but this is very rare."

Fresh seed takes from 10-50 days to germinate but old and dried seed may take from 4-6 weeks. About 4,000 fresh seeds go to a pound or 6.000 when the seeds are partly dried, and up to 10,000 if fully dried. One half pound of fresh seed or $\frac{1}{4}$ lb. of the dried seed may be relied upon to give sufficient plants to plant up one acre, and the size of the nursery bed, if such a system is used, should not be less than 60 feet long by 3 feet wide for each acre to be planted. Nursery beds or baskets should be

slightly shaded to break the force of the sun's rays and to protect the seed from being washed away and the young plants from being beaten down and damaged in heavy rains. When the seedlings in the nursery beds are 3 inches high they are fit for transplanting. Planting either from beds or in baskets should only be attempted in wet and dull weather. If bright sunshine is experienced some shading of the young plants for their first week is advisable.

The planting distance should not be less than 10 feet by 10 feet. The plants require adequate room in which to develop and close planting may result in disease. In wet districts and in very good soil planting 12 feet by 12 feet is strongly to be recommended. And when papaya is used as a catch crop in young rubber, distances of less than 12 feet by 12 feet should not be employed. Planting may be done in either monsoon.

Seed.

The ordinary oblong papaya, locally known as the Ceylon kind, in distinction to other forms which are labelled Madagascar, Egyptian or West Indian, is the best type for latex production. Yields of latex from the oval type are generally in excess of yields from the long types. The oblong type is generally thought to be preferable to the round type.

Seed should only be secured from well-grown fruit and from plants which have borne good crops. It is important that careful selection of seed should be adopted if good yields are to be anticipated. The number of seeds per fruit varies so considerably that it is not possible to estimate accurately the number of fruit required to provide sufficient seed to plant up one acre.

Fruiting.

The papaya begins to come into bearing in good soil and under favourable conditions in 8 months but generally it takes 10-12 months on the average before fruiting commences and fruits are tappable when they are 3 months old.

Fully grown fruit alone should be tapped as the latex from immature fruit gives a lower proportion of papain of an inferior quality.

The flowers are usually unisexual and there are therefore "female" and "male" plants. Some plants do however produce bi-sexual flowers. And male plants as they flower should be cut or pulled out from a plantation. Male plants amount

to 50 per cent. on the average and it is on account of the necessary removal of these " male " plants that the leaving of two or three plants per hole is recommended.

How to Extract the Latex

The latex is procured by making a scratch or shallow incision in the skin of the fruit while still green. Steel knives are sometimes used but they are not recommended; bone, glass or a sharp-edged piece of bamboo is more usually employed. The milky latex exudes and should be caught in containers which may be made out of the leaf sheaths of areca palms. Fruits may be tapped every 4-5 days or at longer intervals until they cease to yield, and a plantation is reported to be profitable until the end of its third year if the soil is good and the general conditions favourable. Tapping must be done in the early morning and in every case should be completed before 10 a.m.

The latex soon becomes coagulated and forms a white curd possessing a somewhat pungent smell. Drying must be effected as speedily as possible; otherwise decomposition sets in. When considerable quantities of latex are being collected this work should be undertaken early in the morning so that drying may begin before midday. This ensures that by evening the material is in a sufficiently dry condition to keep without deterioration until the following morning when the drying can be completed.

Drying can be hastened if the coagulated curd is pressed through a cullender so as to come out in the form of small worms. When small quantities are being prepared a potato squeezer has been used with great advantage.

Drying of Latex.

Drying of latex must be effected without delay but should not be too rapid. In dry weather, drying in the open may be adopted. Drying in the sun is not to be recommended as the product becomes darkened. Some form of drying apparatus is necessary when large quantities of latex have to be dealt with and is generally to be advised in Ceylon on the south-west side of the Island where weather conditions are rather uncertain.

Photo by H. F. Macmillan.

Collecting the Milky Juice by Scarification.

Yields.

The following is a summary of experiments which were carried out at the Experiment Station, Peradeniya:—

Method of tapping	No. of trees	No. of tappings	No. of fruits tapped per month	Total weight of dry papain	Average yield per tree
				grams.	oz.
Long papaya trees tapped every 8th day	12	34	1,460	722 95	2·08 in 34 tappings
Round papaya trees tapped every 8th day	12	34	1,126	726 0	2·08 in 34 tappings
Long papaya trees tapped every 5th day	12	52	1,682	789·9	2·25 in 52 tappings
Long papaya trees tapped once a week	12	35	1,003	495 5	1·41 in 35 tappings
Papaya trees tapped every 10th day	204	17	7,781	5,689·15	3·88 in 17 tappings

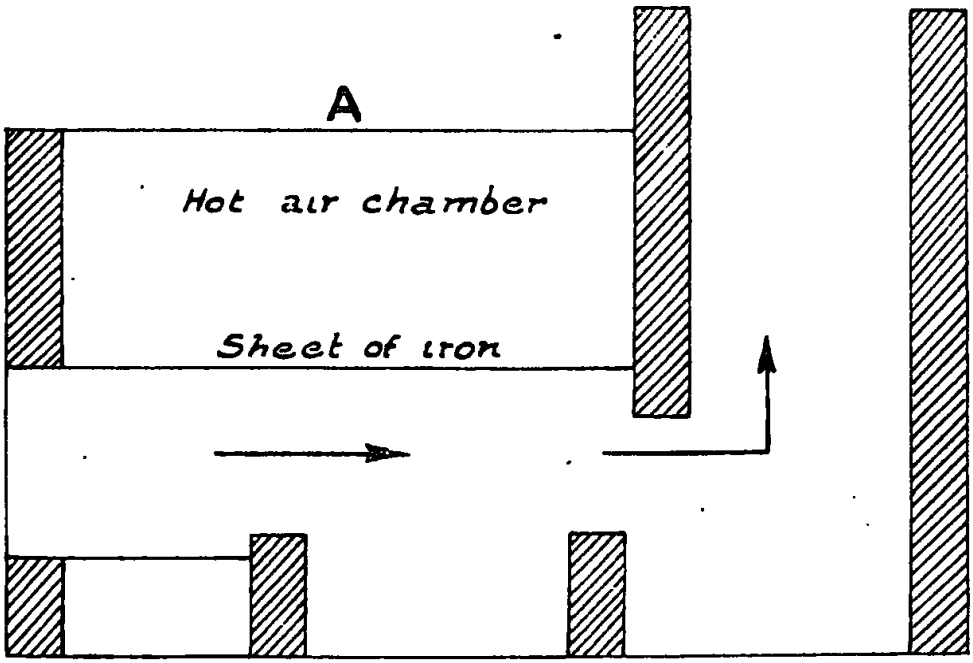
It is generally estimated that a good yield is 175 lb. per acre but growers have informed the Department of Agriculture that average yields of 100 lb. per acre per annum for first year after coming into bearing would be satisfactory for flat lands and 80 lb. per acre per annum for hilly or rocky lands. In the second year the yield is roughly one half of that of the first year.

Prices and Costs.

Costs of production are reported now to average about Rs. 3·00 per lb.—half of the cost being for cultivation expenses and half for tapping and drying.

The market is now demanding a much lighter coloured product, and discoloured and dark coloured papain only fetches at the present time poor prices. A good light coloured—almost white—papain can be obtained by drying in a hot air chamber, but such a procedure could only be adopted on large estates.

For the small producer a drying stove can be erected. This may be constructed by building in brick a chamber about 3 feet high, 3 feet wide and 6 feet long, in accordance with the following plan which was recommended in the West Indies by Sir Francis Watts:—



The coagulated latex should be placed in thin layers on frames made by stretching clean cloth on light wooden frames across the space marked A. Glass is not recommended.

Smoking will spoil the latex and therefore coconut shells or charcoal are recommended as the fuel for drying. A simple apparatus on the lines of a small copra drying shed, with the coagulated latex spread on clean cloth, has been seen and appeared to be answering well.

Drying should not be carried out at a temperature above 100°F. as overheating destroys the active principle and a carelessly prepared product becomes useless and valueless.

As the substance becomes dry it shrinks in bulk and the contents of several trays may now be emptied into one and the drying continued. Drying must continue until the substance is crisp, and may take, if heat is not used, 24 hours under favourable conditions or between 2-3 days if weather conditions are unfavourable. If heat is used drying can be effected in about six hours.

The dried powder should be white or pale cream, with a characteristic odour. It should be packed in tins which are properly soldered so as to make them completely air-tight.