

Cultivation and Marketing of Papaya in the West Godavari District.

By A. SANKARAM, B.Sc. (Ag.)

Introduction. The papaya is one of the quick growing and early yielding fruit crops. Its cultivation at the present day is of importance, as a rapid increase in the production of quick growing fruits is incumbent on the nation. In the presidency of Madras, it has not been very popular to the extent it deserves, in spite of the existing possibilities for the same. This is partly due to want of adequate knowledge of its cultural details among the cultivators, and the scant demand for the fruit as a major part of the public are unaware of its nutritional value and dietetic importance. As a health-food the papaya has few equals and should therefore receive wider recognition in a country with immense possibilities for its successful culture. Besides its fruit value, the papain which it yields is much valued in medicine, in the preparation of special foods and in various other commercial businesses.

The original home of papaya is said to be West Indies, the shores of the Gulf of Mexico and perhaps Brazil. It is said to be indigenous to Tropical America but its exact origin is yet unknown. In Tanuku Taluk (West Godavari District) of this Presidency, the fruit is grown in recent years, to the extent of 20 acres. The area under this fruit crop is steadily increasing owing to the growing interest in its culture among the farmers of the area. In the present paper the details of cultivation as practised in and around Tanuku are presented and the stages at which it needs improvement are indicated. The method of extraction of papain, which is not practised at present for want of practical knowledge of the same, is embodied in this paper with the hope that it may receive wide recognition among the enterprising growers of this fruit. In this country the fruit is successfully grown in Bombay, Bengal, Bihar and the United Provinces. Its cultivation is also known in Assam, Orissa and many other parts of India.

Climate and soil. Its supposed origin in the tropics is indicative of its heat-loving nature. Intensive cold weather and heavy frost are definite set-backs for fruit development. It thrives well from sea level up to 3,000 ft. Strong windy areas are adverse to the growing of this fruit, as such winds carrying sand and grit may scratch the tender skin of the fruits causing exudation of the milky juice. This not only renders the marketing of the fruit difficult but also impairs its keeping qualities. Best results are always obtained on soils of high fertility and good drainage. With the supplementing of good manure the fruit can be raised even on poor soils. In Tanuku taluk bumper crops are seen in the garden lands where the soil is a rich sandy loam admitting free drainage. Deep soils with high clay content are definitely unsuitable.

Seed and Selection. In nature papaya is cross pollinated except in hermaphrodite plants, where self pollination seems to take place. Owing

to cross pollination the progeny usually exhibits wide variability even between plants raised from the seed of the same tree. It is therefore of very great importance for the grower to obtain his seed from a reliable source, where selection of seeds from inbred strains has been in operation to ensure uniformity with respect to quality, shape and size of fruit, etc.

Propagation. The most common method of propagation is by seeds obtained from matured fruits. The plant can also be propagated vegetatively by cuttings but its adoption is uncommon on account of practical disabilities and uneconomic character.

Nursery. Seeds are sown in specially prepared nursery beds. The seed bed is brought to fine tilth after ploughing six to eight times. About half a cart load of well rotten cattle manure is applied to the plot to raise vigorous and healthy seedlings. The seed beds are finally levelled and seeds are sown during the first week of June. The sown bed is lightly covered with soil and next day early in the morning a light irrigation is given. The seed beds are not watered every day during the first week and on alternate days during the subsequent weeks. Later the beds receive watering as and when found necessary. About $\frac{1}{2}$ lb. of seed sown in a plot of 30' x 6' can be relied upon to give sufficient plants to plant an acre. About 8,000 seeds go to make a pound. In cases of heavy rain or severe sun the beds are protected with thatches. After a week the seeds begin to germinate and the planting material will be ready in four to five weeks from the date of sowing the seeds, when they attain a good growth of 9" to 12" from the ground. The seedlings are planted in the main field 8' apart on the square and the number of seedlings required is 680 per acre. Two or three seedlings are generally planted at each spot and thus the seedling requirements will be 1,400 to 2,000. A pound of good seed costs from Rs. 1-8-0 to 2.

In Ceylon, where the cultivation of this fruit is very common, plants are raised in baskets. In each basket filled with soil 4 to 5 seeds are sown, the number of baskets depends upon the number of planting holes per acre in the main field. Each basket is planted out when the plants are about 3 to 4" high. This method is reported to give very good results and it deserves a trial here also.

Preparatory Tillage. The preparatory tillage of the main field commences in the month of May, soon after some showers are received. About eight ploughings are given to bring the land to fine tilth. The fields are ready in July and planting commences by the end of this month.

Manures and Manuring. Along with ploughing cattle penning is commonly resorted to in the main field. This is supplemented by a basket of well rotten farm yard manure at each planting spot, applied a month after transplanting the seedlings. This is all the manure that the crop receives during the first year. In the second year the same dose is repeated only in case it is available. But as the crop responds to heavy manuring it will be profitable to apply $\frac{1}{2}$ lb. of bone-meal, 1 lb. of castor cake and a basket of cattle manure and ashes to each plant every year.

Transplanting and Thinning. Transplanting is done in the well prepared main field towards the end of July. The seedlings are transplanted in planting holes 2' x 2' x 2' previously dug out for the purpose, as is common in other areas where the fruit is grown on a large scale. The planting spot is stirred with a hand hoe before planting. The nursery beds are previously pot watered to facilitate their lifting. Transplanting is generally done on a wet or dull weather towards the evening. Before and after transplanting pot watering is done. 3 to 4 seedlings are planted at each planting spot and the young plants are shaded until they are well established. After a month, when the plants attain a good size, the vigorous growing one is retained and the rest are thinned out. The growers have no knowledge of the importance of sex in thinning and the vigour of the plant is the only chief consideration for retention or otherwise. It is advisable that growers should be in a position to distinguish the sex as soon as the plants begin to flower, so as to retain only one male plant for every 30 to 35 female plants, pulling out the rest of the males. This ratio of males to females is adequate to provide enough pollen. In the absence of correct knowledge of sex the excess of male plants will only be a burden to the garden as their place can better be occupied by fruit-yielding female plants. Strict observance of this would go a long way in increasing the net profits of the growers.

* **Experiments—Sex in Papaya.** The fact that the sex forms are identical in general appearance, excepting for the flower and fruit characteristics makes their distinction impossible in the early stages. At the Fruit Research Station, Koduru (Cuddapah District) experiments were conducted to test the efficacy of certain existing notions in the determination of sex in papaya in the nursery stages. The trials with the metal indicator could not furnish an efficient means for the purpose. Studies to associate sex with the morphological characteristics of the roots during the seedling stage was found to be neither sound nor a feasible practice. The common belief that some relationship exists between the sex and the position of the seed in the fruit was experimented upon, but the results were not conclusive. Lastly heading back of the male trees soon after flowering was attempted, to see that if this treatment induces the trees to change their sex. This treatment was also found to be ineffective.

Similar to Dr. Hofmeyer's experiments, on the continued inter-crossing of plants raised from the seed from the same tree, to see if some uniform types of the fruit in respect of quality, size, shape, etc., can be obtained, are under trial at the Fruit Research Station, Koduru.

Irrigation. Pot watering is only resorted to during the growing of the plants in the nursery and later till about a week when the plants get well established. During the next week the plants are pot watered on alternate days and afterwards regular irrigation commences. Well irrigation drawn by a mhote is the usual practice. Under conditions obtaining in West

* Madras Agricultural Stations Reports 1936-37, 1937-38 and 1938-39.

Godavari in all 15 waterings, besides the normal rainfall, are necessary in a year (August—July) to get at good results. Watering is generally done once in ten days according to soil and weather conditions. In years of low rainfall even twenty waterings are necessary to keep the crop in good yielding condition. Though the crop responds fairly well to liberal watering drainage is of paramount importance as the plant is very sensitive to water stagnation.

After Care. The garden is weeded as often as necessary and thus clean cultivation is universally adopted by the growers. Besides, the basin beds round the plants are hoed twice during the year to keep this soil loose for the irrigation water to percolate easily and at the same time to maintain retentivity of the same. No other inter cultivation is ordinarily given.

Thinning of Fruits. In the pure female plants (dioecious pistillate) flowers are borne on short peduncles in the axils of leaves. The number of flowers on each peduncle varies from 3 to 4, the terminal one being the largest and the oldest. Normally only this develops and the others drop off. Yet it is not uncommon to find two or more developing in one axil of the leaf leading to over crowding of fruits in the limited space. In the early stages when the plant is making vigorous growth, the internodal space is moderately sufficient to accommodate all the fruits that have set in. But as the plant grows older the limited internodal space is hardly accommodative for each fruit to develop to its normal size. As a result of this, normal development of all the fruits is prevented resulting in small compressed fruits of little value. Thinning becomes one of the important operations and this can best be done when the fruits are young and small. This is not practised locally as growers are under the wrong impression that their fruit yield will be reduced. They are only guided by the number of fruits harvested and not by the size, uniformity and weight of the individual fruits that fetch better price. It is always economical from many points of view to thin out the excess of fruits and to allow only one fruit per leaf axil to reap bumper harvests.

Harvest and Yield. The plant begins to flower by the end of November, i.e., $4\frac{1}{2}$ to 5 months from the date of transplanting under the conditions obtaining in the district. Fruit setting commences 1 to $1\frac{1}{2}$ months later. It takes nearly two months to develop and attain maturity. Thus the actual harvest of the fruit commences after nine to ten months from the time the plants are set in the garden. The yields are low during the months of April and May, harvest being done once a week. With the advance of age of the plants the yield increases and it reaches a peak during the period of August to November, necessitating harvest even on alternate days. During the first year the tree will not attain a height of more than 8' to 10' enabling easy harvest of the fruits. Well developed fruits are carefully plucked cut from the tree. The maturity is reached with the development of a light yellowish colour admixed with green. On pressing the skin of the fruit with the thumb a light impression should be left on the fruit. The fruit

will be ready for the table after 3 or 4 days. Fruits can as well be allowed to ripen on the plant itself but the damage from crows disallows this practice.

The yields are very varying from plant to plant depending on a variety of conditions. In the first year of its fruiting each tree on an average gives 40 fruits. Taking 600 plants to be fruiting in the garden (average for the area) nearly 24,000 fruits weighing about 72,000 lb. can be obtained from an acre and this is an average yield. Under favourable growing conditions brought about by such factors as liberal irrigation during summer months, judicious manuring and clean cultivation the plants will continue to give the same yield, in the second fruiting season also. But under neglected conditions 18 to 20 thousand fruits can be expected.

Age of Gardens. This fruit crop is a short duration one and does not last long. The period of economic productivity is not more than three years. In this area the gardens are retained only up to a total period of nearly three years, during which two crops are harvested. Though the plants bear fruits even after this period for another couple of years the size of the fruit as well as the yield becomes considerably small. Further the trees grow to a height of over 20' and harvest becomes very difficult. It appears to be economical to have a new plantation altogether after a period of three years from the date of planting. In the Bombay Presidency the old plantations are renewed by heading back the old trees, when small branches are given out at a height of 6' from the ground. The branches bear fruit in the usual way and satisfactory results were obtained at Modibag* of the Bombay Presidency.

Inter Cropping. It is a common practice in the area to raise low growing crops like chillies, onions, tomatoes, etc., in gardens where papaya is the main crop. This can only be practised for a period of about eight months when the trees grow bigger rendering the interspace unfit for the purpose. The papaya itself is raised as an inter crop in mango and citrus gardens provided irrigation facilities are satisfactory.

Pests and Diseases. In the West Godavari District there cannot be a better example of a fruit crop than the papaya which is almost free of insect pests and fungoid diseases. Even foot rot has never made its appearance in the gardens of the area.

Quality and Varieties. The quality varies with the variety of the fruit. The oblong Washington and the round Gujerat are the common varieties grown locally. Of these two the Washington is more popular being free from the characteristic flavour which is not tolerated by some. One or two non-descript varieties also exist in the area but they are regarded as inferior.

* Bulletin No. 162 of 1930 "Papaya cultivation in the Bombay Presidency (excluding Sind) By G. S. Cheema and P. G. Dani of the Department of Agriculture, Bombay."

Nutritive Value. The papaya is a highly nutritious and most delicious fruit and is a cheap source of vitamins A and C. Dr. Aykroyd in *Health Bulletin* No. 23, published by the Government of India, gives the composition of the ripe fruit as below.

Moisture	89.6 %	Phosphorus	0.01 %
Protein	0.5 "	Iron (mg.)	0.4 "
Fat (ether extractives)	0.0 "	Calorific value per 100 gms.	40.0
Mineral matter	0.4 "	Carotene (International vitamin	
Carbohydrate	9.5 "	A units per 100 gms)	2,020
Calcium	0.01 "	Vitamin C, mgs. per 100 gms.	46

The ripe fruit is commonly used in the district at the table and the raw one as a vegetable and in the preparation of soups of the Indian diet. Besides, candied papaya is a product of pleasing taste and of high palatability. Still there are many other preparations of papaya that are of great relish to one and all. Many of these preparations can be made cheaply with no elaborate equipment.

Marketing of Fruits. The marketing season commences with May and usually extends up to November. The season of peak harvest and sales of the fruit is August to October.

Markets. At present, as the production of the fruit is very limited and is just sufficient to meet the internal demand of the district, it is not available in any large quantities for export to distant places. The fruit finds a quick sale in the markets of Tanuku, Bhimavaram, Nidadavole, Kovvur and Tadepalligudem of the West Godavari District. Fruit grown in Dharmajigudem of Chintalapudi Taluk finds a sale in the Ellore markets.

Demand. In view of the limited production the supply and demand are just counter balancing. But with increased production it must find a market outside the district. It may be pointed out here that even within the district only the educated class, who are aware of its value as a health food, consume it. A few dislike it on account of its peculiar characteristic light flavour and a major part are ignorant of its health promoting value. It is therefore necessary to educate the public on the value of the fruit to create a keen demand for it.

Prices. The prices are very variable depending on the variety, season and demand. Generally a rise in prices begins from November and this reaches a maximum in April when the fruits become rare. The prices are at their lowest during August—October. The local fruit vendors purchase gardens from the owners. The growers also sell the fruit in hundreds at the garden. The price per hundred varies from Rs. 2 to 3 depending on the uniformity of the size of the fruit, variety, season and demand in the local markets. In retail a well sized fruit of 3 lb. or more in weight of the Washington or the Gujerat variety is sold for one to one and a half annas.

Grading. No grading of the fruit is attempted by the growers but the retail fruit vendors make a rough classification only according to the size as big, medium and small.

Marketing difficulties. The marketing of the papaya fruit to distant places presents certain difficulties in that it is not easily portable and requires careful handling. The losses of fruit during the transit depends on the condition (ripeness) of the fruit. Only fruits with fairly firm skin and just commencing to turn yellow should be used for sending to distant markets. Generally the fruit is carried in bamboo baskets in country carts. The fruit hardly keeps good condition for more than five days. Unless the fruit is packed with care in a soft medium, its marketable value will not be appreciable to be of any reasonable profits

Papain—Extraction and Preparation. The milky juice (latex) that exudes when the skin of a well developed fruit is lanced contains the enzyme papain. Papain, as its product is commonly termed, is similar to pepsin and has become an incalculable aid for certain digestive ailments. At the present time, Ceylon is the only country producing papain on a commercial scale.

The preparation of papain from the latex of these fruits is a simple and profitable process. The latex containing maximum papain is best obtained from well developed fruits immediately before they are ripe, by making 2 to 4 longitudinal incisions $\frac{1}{8}$ " deep and $\frac{1}{2}$ " apart. Early mornings should be preferred for this process as the flow at that time is more profuse. The juice is collected in a glass or porcelain saucer held conveniently under the lanced fruit. Lancing is best done with any sharp edged tool of bone, horn, ebonite, ivory or glass or even sharp edged piece of bamboo but iron or ordinary steel must not be used as the resulting product attains an undesirable tint. A part of the exuded juice is caught in the saucer and a part that remains coagulated on the fruit can be removed with a fine brush. The latex soon coagulates into a white curd possessing a pungent characteristic smell. Drying must be effected as speedily as possible to prevent deterioration through decomposition. For manufacture on a moderate scale sun drying can be adopted. The coagulated latex is spread on a glass placed on iron sheets and covered by a glass leaving sufficient room for ventilation. This can easily be powdered in a glass mortar and pestle and after bottling it up it is rendered fit for the market as crude papain. The process can be repeated once in 3 or 4 days till the fruit is covered with incisions 1 cm. apart. Ordinarily 3 to 4 tappings can be done.

As regards yields little information is available. In Ceylon an yield of 175 lb. per acre is regarded as satisfactory, and an average yield can be reckoned to be 100 lb. per acre.

A small curiosity trial conducted by an enthusiastic grower of the area gave 2 lb. of crude papain from six selected trees lancing being done thrice. The cost of labour amounted to Rs. 3 for 12 men engaged for the entire process. The cultivation expense for the six trees is estimated to be Rs. 1—8—0. Thus the cost of production comes to Rs. 2—4—0 per lb. The marketable value of papain is reported to be Rs. 6 per lb. This leaves

a net gain of Rs. 3—12—0 per lb. of the product. To this Rs. 3 realised by sale of the fruit of these six trees can be added. It was not possible for the writer, with the limited facilities on hand, to investigate in greater detail the true economic picture of the problem. It is now left to the enthusiastic fruit growers of the area to carry it on a wide scale as the profits are apparently attractive to raise their interests and thus give their aid to those unfortunates whose weak digestion cries out for help. A problem that still awaits solution is the absence of a wide market for the lanced fruit as they present an unattractive appearance in contrast with the unlanced fruit, in spite of the quality remaining the same.

Economics of Cultivation. The cost of cultivation (as detailed in appendix) comes to Rs. 150 for the first season (May to December of the following year) and Rs. 110 for the second season (January to January of the next year). Calculating at Rs. 2 per 100 the gross income from an acre will be Rs. 480 in the first season and Rs. 400 in the second season. The net gain will thus be Rs. 330 and Rs. 290 respectively. In the first season an additional net income of Rs. 20 can be realised by way of intercrops. There is a contract system of disposing of the crop in which case the contractor has to pay Rs. 350 to 450 per acre depending on the crop, the charges for watching being borne by the contractor himself.

Conclusion. The highly profitable nature of the cultivation of this fruit crop is widely known among the farmers of the area. There is slow but steady increase in the area under this fruit crop consistent with the demand. Instances are not wanting wherein farmers have cleared off their liabilities and brightened their economic status through the cultivation of this crop. The average holding of an individual farmer is one to two acres and the entire production is in the hands of *Kammas*, an important agricultural community of the tract. A few who have cultivated a taste for the fruit attain self sufficiency by raising it on a small scale in their back yards. The extension of cultivation of this valuable fruit, in the near future, seems to depend upon the demand which the public display towards the fruit and the provision of transport facilities for its export to distant markets outside the production zone.

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(APPENDIX)

Cost of Cultivation per acre—details.

First Season (May 1939 to December 1940),

Preparatory cultivation :—

8 Ploughings @ Rs. 1—4—0 per ploughing	...	...	Rs. 10 0 0
Levelling the field	...	...	2 0 0

Manures and Manuring :—

Cattle penning or 15 Cartloads of cattle manure @ 8 as per cartload and application charges	10 0 0
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700 baskets of cattle manure @ 50 per rupee	14 0 0
Application of manure—16 men	4 0 0
<i>Seeds and Sowing :—</i>			
$\frac{1}{2}$ lb. of seed	...	...	1 0 0
Cost of raising the nursery to plant an acre	...	...	5 8 0
Transplanting—2 men to pull and 12 to plant	...	...	3 8 0
<i>Irrigation :—</i>			
8 pot waterings for the young plants—42 women	...	...	4 0 0
15 waterings with a mhote @ Rs. 2—8—0	...	...	37 8 0
<i>After care :—</i>			
Preparing basin beds round the plants—15 men	...	...	3 12 0
Weeding thrice—24 women	...	...	4 8 0
Hoeing round the plants twice—30 men	...	...	7 8 0
<i>Harvest :—</i>			
Watch for eight months @ Rs. 4 per month, harvest attended by the watchman	...	...	32 0 0
Assessment of the land	...	...	5 0 0
Miscellaneous expenditure	...	...	5 12 0
Total cost of cultivation for the season	...	...	150 0 0
Yield 24,000 fruits valued at Rs. 2 per 100	...	...	480 0 0
Net revenue from inter crops	...	...	20 0 0
Net gain per acre in the first season	...	...	350 0 0

Second Season (January 1941 to January 42).

<i>Manures and manuring :—</i>			
700 baskets of cattle manure @ 50 per rupee	...	...	14 0 0
Application of the manure—16 men	...	...	4 0 0
<i>Irrigation :—</i>			
15 irrigations with mhote @ Rs. 2—8—0	...	...	37 8 0
After care as in the first season	...	...	15 12 0
Watch assessment as in the first season	...	...	37 0 0
Miscellaneous expenditure	...	...	1 12 0
Total cost of cultivation for the second season	...	...	110 0 0
Yield 20,000 fruits valued at Rs. 2 per 100	...	...	400 0 0
Net gain per acre in the second season	...	...	290 0 0