

"The sample contains fairly good amounts of food ingredients, but the fibre content is a little too high. Probably, it is this factor that makes it more favoured by buffaloes than by cows. The weed is particularly rich in lime content".

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Cardamom Cultivation in the Bodi Hills.

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During 1937 there was a severe infestation of *Taenothrips cardamomi* on most of the cardamom estates in the Bodi Hills. The planters suffered a heavy loss. Some of them appealed to the Deputy Director of Agriculture, Madras for help early in 1938. In response to their request, the author was deputed to investigate this pest. This opportunity was taken to study cardamom cultivation as practised in these areas and the study continued as and when opportunities occurred. The materials gathered are summarised below.

Cardamom—(*Elettaria Cardamomum*, Maton) is a valuable spice. The plants are found growing luxuriantly in a wild state in elevated sheltered areas, scattered in the thick humid ever green shola regions of the Western ghats, with an annual rainfall ranging from 100 to 150 inches. There are only limited areas satisfying the above conditions and these are confined to the Western ghats in parts of Mysore, Coorg, Cochin, Travancore and Madras Presidency. According to an official estimate the total area under cardamoms in South India is about 86,134 acres but there are reasons to believe that the area is at least 100,000 acres.

The description of the plant *Elettaria Cardamomum*, as given by Fischer¹ is given below,—

Elettaria Cardamomum, Maton. Western ghats, wild and cultivated, 2500—4500 ft. The Cardamom.

Leafy stem 6—10 ft. high; leaves linear—lanceolate acuminate, sessile or very shortly petioled, glabrous above, softly pubescent beneath, 1—2 ft. long, 2—3 in. wide; panicles several upto about 2 ft. long, erect or prostrate; bracts 6—7 flowered, linear oblong, obtuse, about 15 in. long, corolla tube shortly exerted, lobes 0.5 in. long, lip longer, white striped with violet; capsule sub-trigonal, about 0.4 in. long, striate.

Var. *major*, more robust, leaves broader bracts more distant, 2—4 flowered; capsules 1" or more long. In the same localities.

The seeds of both used as condiments and medicinally.

There are 2 cultivated varieties, the Mysore and the Malabars. The chief characteristics of these varieties are given below :

	Malabar.	Mysore.
Suitable elevation :	2000 to 5000 ft.	3000 to 4000 ft.
Rainfall :	60 to 100 in.	Withstands heavier rainfall and wind
Height—leafy stems.	6 to 9 ft. light green.	More robust and taller darker green.
Tillering :	10 to 30 tillers in well grown mature clumps.	Tillers more profusely.
Leaves :	2 to 2½ in. broad. 1—1½ ft long, tips pointed upper surface smooth and the lower surface velvety or smooth.	3 to 6 in. broad. 2 to 3 ft. long. Smooth on the upper surface and glabrous below.
Racemes :	1 to 2 ft. long trailing along the ground.	2 to 3½ ft. long, erect.
Spikelets :	11 to 22 on each of the racemes.	22 to 48 on each of the racemes.
Fruits :	Light green 1/5 to 9/10 inches long, angular with 18 to 23 black seeds closely packed. Fruit coat thin. The floral racemes and the flower bearing shoots die, soon after the season's pickings are over.	Darker green, bigger in size globose with 22 to 32 seeds. This gives about double the yield of Malabars. The racemes continue to live and bear fruits in the succeeding season also.

Cardamoms may be propagated either by rhizomes popularly called "bulbs" or by seeds. The common method of propagation is through 'bulbs'. Bulbs 1½ to 2 years old with at least two tillers from individual clumps which are healthy, high yielding and regular bearing. These are forked out and separated from the mother plants, taking care to see that the rhizomes are intact and uninjured. The roots are clipped leaving a length of about 6 inches before planting. Five such bulb plants are planted in each of the pits in the field. Bulb plants begin to yield earlier. Hence it is easier to start and maintain a plantation with bulbs. But these are said to be short-lived and less vigorous and hence have to be replanted after about 15 years. Of late, owing to the difficulty in getting mosaic-free bulbs for planting, some of the more experienced growers are raising seedlings for planting. The seedlings being free from mosaic to start with, yield better and remain healthy for a longer period; hence seedling planting has come into vogue, and is extensively practiced in some of the important estates in the area.

Selection of seeds. Well ripe plump fruits from healthy robust and disease-free clumps are gathered in September and air-dried in the shade. A few days before sowing the seeds are separated. These seeds are soaked in water over night, rubbed gently between the hands to remove the sugary coating on them; else, ants are likely to invade the nursery and remove the seeds causing gaps and uneven germination.

Nursery. During February—March seed nurseries are prepared near channels or springs to facilitate watering. Raised beds 1 yd. × 15 yds. are formed from the top soil, which is usually very rich in humus. Stems, broken twigs and other hard materials found there are removed. These beds are watered once a fortnight. Weeds are removed as soon as observed so that they are eliminated to a great extent before sowing. On such carefully prepared beds, good seeds are sown in August. About half a pound of seeds is sown in three beds, to get enough seedlings to plant one acre. After sowing, fine sand is sprinkled over and the beds gently stirred or worked with hands to cover the seeds. A layer of straw or dry grass is spread over these beds to prevent erosion of the soil particles and to hasten germination. These beds are gently watered twice a day with rose-cans, till the seeds begin to germinate i. e., 30 to 40 days, care being taken to see that the surface soil is moistened and wetted and no water stagnates on the surface even for a short time. Nurseries are usually located in open areas near dwelling quarters for proper supervision and maintenance of the tender seedlings. The beds are protected from the direct sun by wicker *pandals* erected over them. Growers believe that the morning sun is injurious and the mild evening sun beneficial to the growth of the seedlings. As such the beds are usually given a western aspect. When the seeds have germinated and the seedlings are two inches or so high, the covering over the *pandals* is reduced, so that the seedlings receive just a little of the sun. As the seedlings grow older, the top of the *pandal* is gradually cleared so as to allow more sun on them and thus become hardened under natural field conditions.

First transplanting. Seeds sown in August germinate by the middle of October. By the following May i. e., 8 to 9 months after sowing, the seedlings grow about one foot. These tender seedlings are then carefully forked out and transplanted in singles 6 to 8" apart in fine nursery beds, prepared in shady parts. The transplanting is finished by the end of June before the Monsoon sets in. If planted during the rains, the rhizomes may rot and the seedlings die out. Hence the transplanting is done before the rains.

Second transplanting. By the following April—May i. e., 1 year and 9 months after sowing, when the seedlings have grown to a height of 2 to 2½ feet with 2 or 3 tillers, they are replanted in the field 3 feet apart.

Third transplanting. During the next pre-Monsoon season, they are again replanted in the field 5 to 6 feet apart (2 year 9 months). By the following May—June, these transplants being 3 year and 9 months old, some of the vigorous ones begin to flower. Now these are ready for final planting.

Fourth and final planting. These seedlings are planted in the field finally during the succeeding April—May in pits that are previously prepared and kept ready for planting. At the time of each planting, the seed

lings are carefully examined and the diseased ones discarded choosing only the healthy plants for replanting. As the age of the seedlings advances, the height of the plant and the number of tillers increase and hence the distance between plants is increased at every successive replanting to allow room for the tillers that grow. These seedling plants are planted in singles with all the tillers intact. In some of the estates, the seedlings are planted 10 feet apart in the field at the time of second planting when they are $1\frac{1}{2}$ to 2 years old to save another transplanting charges the expenditure in maintaining a larger area properly is heavier.

Transplanting in the field. The area to be planted is carefully surveyed and roads traced according to the contour of the land.

Planting distance. The distance between plants varies according to the natural fertility of the soil and the variety. In richer soils the average spread of each Mysore-clump is about 6 feet. On such rich soils, they may be planted 12 feet apart. In poorer soils they may be planted closer. Similarly the Malabars may be planted 10 feet apart in richer soils and closer in poorer soils. But usually in most of the plantations they are planted 11 feet apart which is the average distance irrespective of the variety and soil.

Lining. Lines are marked along convenient angles 11 feet apart, both lengthwise and cross-wise, and stakes driven at the intersection of these lines. On the marked spots, pits are dug 2 feet square and 1 foot deep on the lower slope. The bottom of the pits should be level and even. The depth on the lower slope alone is to be considered when measuring the depth of individual pits. The dug out soil is heaped over on one side of the pit, so that when the pits are to be filled up before planting, only good rich surface soil around the pits may be used. The pits are dug out in February - March, allowed to weather for about two months and then filled up with surface soil. About 360 pits are dug to an acre.

Filling pits. The rich surface soil on the top and two adjacent sides to a depth of about six inches together with the accumulated leaf mold is gathered and the pits filled up. When the pits are filled up, the rich soil is heaped on the top, to allow for sinking later on. Then the surface is made even by spreading the dug out soil from deeper layers. After a month these pits are reopened, undecomposed twigs, small stones etc., are removed, the whole soil is thoroughly mixed, and refilled. A stake is fixed in the centre of the top margin of these pits to indicate where the seedlings are to be planted. By the middle of May, these operations are finished and the pits kept ready for planting. The seedlings are finally transplanted during April-May.

Planting. The seedlings are forked up carefully, the individual clumps separated and the roots pruned to 3 or 4 inches, care being taken not to injure the rhizomes. Healthy plants are gathered and taken to the area where they are required for planting. The seedlings are placed on the

right of the individual pits, the bulbs on the lower side and the shoots above, with the upper surface of the leaves facing the Sun.

A central line is drawn along the middle of the pits from side to side and a small trench 6 inches deep is made above this line, and the earth collected on the right margin. Either seedlings or bulbs, whichever is selected are planted in these pits, the tallest tiller is arranged in the centre with the small ones on the sides so as to form a sort of symmetry. These are made to lean on the soil. If planted erect, they are likely to be uprooted by the strong Monsoon winds that follow closely the planting season. The soil around is pressed down and leaves and leaf moulds are spread over the pits so as to form a thick mulch.

Shade regulation. Planting over, the area is surveyed with a view to regulate shade. The Mysorees are hardier and can withstand a little more sunning than the Malabars. The Mysorees require about four hours of sun and the Malabars about three hours of sun every day. During the sunny part of the day, the more shady trees are marked and these are confirmed or modified after subsequent observations and the marked trees felled or the branches lopped off, so as to get the optimum amount of sun-light for the plants beneath. If too shady, the central branches are removed to have open crowns and the lateral branches induced to grow better.

While thinning, the following species of trees and shrubs are eliminated as they are unsuited either being thorny, or in some cases the Cardamoms are observed not to thrive well under the shades of these trees:— *Eriodendron* sp. *Grewia tiliaefolia*. *Symphorema involucratum*, *Salix tetrasperma*, *Kydia calycina*, *Macaranga Roxburghii*, *Acacia lucophloea*, *Wrightia tinctoria*, *Semecarpus*, sp. *Solanum pubescens*.

As far as possible the following trees are not to be removed while thinning, even though some of these may be mere saplings.

Chuckrasia sp. *Vateria indica*, *Jak*, *Acrocarpus fraxinifolius*, *Cullenia excelsa*, *Pithecolobium subcoriaceum*, *Mango*, *Mesua ferrea*, *Nephelium longana*.

If more shade is required, some of the quick growing trees such as *Acrocarpus fraxinifolius*, *Nephelium longana* and *Mesua ferrea* may be planted. The thinning out of the existing plants and the planting of fresh ones is adjusted to suit the variety planted. The leaves from the felled trees are carefully conserved for forming mulch over the newly planted area.

Time of felling trees. For shade regulation, trees and branches in the denser parts are removed in April. By May—June, plantings may be over and shade regulation work commenced immediately and finished by September. If the shade is not regulated within two years after planting, the plants will not yield properly at the end of the third year.

After-cultivation. The newly planted field is weeded as often as is necessary to keep the pits free from weeds. During the first two weedings, the weak and dead plants are replaced. About four weedings are necessary during the first year, three in the second year and two in the succeeding years between July and November. During weeding, the dead leaves and shoots are cut and scattered around the plants to provide mulch. The dead leaf sheaths, shoots and flower stalks are not to be pruned too close to the root, as the rhizomes are likely to dry up if done so.

Flowering, fruiting and picking. By the following pre-Monsoon season i. e., 5th year from sowing—the plants will begin to flower here and there. More plants will flower in the sixth year i. e., two years after final planting and regular yields may be expected from the third year onwards. Simultaneous with the development of a flowering raceme, at the base of each mother shoot, two more ordinary leafy shoots develop. When the mother shoots die out after the season's picking, these secondary shoots take their place and when two years old, in their turn develop the flowering racemes. Increased yields are obtained as the plantation gets older, as more tillers and racemes are formed with the age of the plants. But the clumps get displaced, every year and the regular lines on which they were originally planted get obliterated. So, in general the planting is renewed every 15 years or so according to the condition of the plantation and the displacement of the shoots from the original place of planting.

In a plantation flowers and fruits may be observed almost throughout the year. But the optimum flowering period is during the dry pre-Monsoon period i. e., May to July. It takes about four to four and a half months for the flowers to develop into fruits ready for picking and consequently the peak of harvesting is from September to November.

Well ripe fruits are light green and the seeds inside are hard, greyish black and very fragrant. In a spikelet, fruits of different maturity may be observed to develop at a time. Only ripe fruits must be picked. While curing, the unripe fruits shrink considerably as the seeds inside are juicy and not hard. If fruits are not picked in time, these are shed and lost or greedily devoured by animals. The over ripe fruits get split while curing and the seeds which are shed from the capsules are not much valued in the market. Hence the fruits must be picked at the right time. During the heavy picking season, coolies are sent round the estate once in about ten days and the ripe fruits are collected.

Curing and grading. The fruits when picked are juicy. These are cured—dried—before they are ready for the market. Formerly they were cured by a tedious process of bleaching with sulphur, washing and drying until the required colour is obtained and the fruits dried sufficiently. This is now replaced by flue-curing which process is easier and can be wellcontrolled irrespective of the prevailing weather conditions.

The cured fruits are cleaned. Flower stalks, immature and split fruits are separated along with those that are diseased or scabby. These are sold as "thakkolam." The seeds are collected and removed. Good entire fruits are graded and marketed separately.

Yield. The plants usually begin to yield from the third year of planting. During the third year 10 lbs. of cured fruits may be expected per acre. The yield increases year by year and from the fifth year onwards 120 to 200 lbs. of cured fruits may be obtained from an acre, according to the condition in which the plants are maintained, for about fifteen years. Then the yield decreases gradually. In well-maintained estates, in good localities and in favourable years, yields higher than 200 pounds are obtained. There are some plantations which are more than 25 years old giving an average yield of 200 lbs. per acre. But these are exceptional.

Pests and diseases. Some of the important pests and diseases of cardamoms are noted below :—

Nursery :	Cut worms Root grubs Grass-hoppers	} destroy seedlings and young plants.
Plantation :	Eupteroid.	
	Dicocrocis. Tineid. <i>Taenothrips cardamomi</i> :-Sucking flowers and causing warts on fruits.	Caterpillars descending in numbers by silken-threads from shade trees and attacking cardamom plants and destroying them completely in certain years. Stem borer. Root borer.
	Rats, squirrels, frogs, elephants, wild boars, porcupines, and monkeys.	

Disease. Mosaic or Marble disease.

Of the above mentioned pests and diseases, thrips and mosaic are most dreaded and are present in most of the estates. Consequently the average yield in some of the estates has decreased considerably and in some of the estates the ill-effects of these are so bad, that they have been neglected in despair by the owners.

Trials were conducted in two estates :— (1) Sathurāngapara estate and (2) Gandhipara estate to control thrips (*Taenothrips cardamomi*) during 1938 season, in consultation with the Government Entomologist, Coimbatore. The following observations were made regarding this pest :—

The extent of loss due to thrips havoc is estimated to be about fifty per cent. These insects live mostly inside the flower bracts and leaf sheaths. In badly infested spikes, the blossoms wither and are shed before the seeds set, and the fruits if developed are malformed and warts are developed.

Opportunity was taken to see whether this pest could be controlled by the use of the following methods :—

Dusting (1) Tobacco powder mixed with 4 times the quantity of road dust,

(2) Lime sulphur—4 of lime and 1 of sulphur

Spraying (1) Tobacco decoction

(2) Phenyle—diluted to about 50 times with water.

The dustings were not satisfactory whereas the sprayings with tobacco decoction and phenyle proved to be effective and a large number of thrips were killed. The sprayings could not be carried on regularly, owing to the receipt of frequent rains but they were not sufficient to wash down the insects. In the case of sprayed plants, the shedding of buds and blossoms were greatly minimised and the fruits well developed without warts or malformations, whereas the reverse was the case among the untreated plants.

Economics. The cost of starting and maintaining an area of 50 acres till it begins to yield normally for seven years is given in the appendix.

A capital investment of about Rs. 25,000 is required to start and maintain a cardamom estate of 50 acres in a virgin area upto its seventh year when the yield becomes regular. From the seventh to the fifteenth year for about nine years, a high average is maintained, and from the sixteenth year onwards the yield gradually decreases until about the twentieth year or so when the plantation has to be renewed. From the third to the seventh year of planting, it yields about 33,500 lbs. of capsules valued at Rs. 41,875. Deducting the amount invested there is a net balance of Rs. 16,759 for the seven years. From the 7th to the 15th year there is a net gain of Rs. 10,000 per year or Rs. 200 per acre.

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Appendix.

Economics of starting and maintaining a Cardamom Plantation of
50 acres upto its 7th year.

Particulars.	Units of labour.	Rate. Rs. a. p.	Total expenditure. Rs. a.	Yield in lbs.	Value Rs.
<i>I Year.</i>					
Clearing	... 2250	0 5 4	675 0		
Lining	... 400	0 4 0	100 0		
Marking pits and gathering leaves	400	0 4 0	100 0		
Digging pits (360 per acre)	... 725	0 6 0	261 14		
Shade regulation	... 150	0 6 0	56 4		
Filling pits	... 400	0 4 0	100 0		
Removal of twigs, stones, etc., from filled up pits and refilling	... 200	0 4 0	50 0		
Planting, carrying seedlings, etc.	... 550		200 0		
Trashing	... 200	0 4 0	50 0		
Felling trees, etc.	... 150	0 6 0	56 4		
Weeding 4 times	... 1600	0 4 0	400 0		
Cost of seedlings at Rs. 35 per 1000 at 5% for filling up gaps (21000) seedlings (If bulbs 100,000 @ Rs. 10 per 1000).			705 0		
<i>II Year.</i>					
Weeding 3 times	... 1200	0 4 0	300 0		
<i>III Year.</i>					
Weeding 2 times	... 800	0 4 0	200 0		
Pruning	... 200	0 4 0	50 0		
Picking @ 10 lbs. per acre at Rs 2 per 20 lbs. valued @ Rs. 1/4.	... 200	0 4 0	50 0	500	625
<i>IV Year.</i>					
Weeding 2 times	... 400	0 4 0	100 0		
Pruning	... 200	0 4 0	50 0		
Picking, curing, etc. @ Re. 1 per 10 lbs. yield 60 lbs per acre.	...			3000	3750
<i>V Year.</i>					
Weeding 2 times	... 300	0 4 0	75 0		
Pruning	... 400	0 4 0	100 0		
Picking, curing, etc @ Re. 1 per 10 lbs. Yield 200 lbs. per acre	...		1000 0	10000	12500
<i>VI Year.</i>					
Weeding etc. as in the 5th year	700	0 4 0	175 0	10000	12500
			1000 0		
<i>VII Year.</i>					
Weeding etc., as in the 5th year	700	0 4 0	175 0	10000	12500
			1000 0		

Particulars.	Units of labour.	Rate. Rs. n. p.	Total expenditure, Rs. n.	Yield in lbs.	Value Rs.
<i>Supervision charges for 7 years.</i>					
1 Manager on Rs. 50 p. m.	...	50 0 0			
2 Fieldmen on Rs. 25	50 0 0			
4 Maistries on Rs. 15	60 0 0			
Total per month Rs. 160					
For 7 years 160 x 84	...		13440 0		
Tools and sundries	...		1000 0		
Land tax @ Rs. 5 per acre per year			1750 0		
			23519 6 or		
			23600 0		
Interest on capital at 6%	...		1516 0		
			25116 0 or		41875
			500 0 per acre.		837
Net profit for 7 years for 50 acres. (Rs. 41875 less 25116)					16759 or 337 per acre.

Note. The cost of building quarters for the Manager, and his assistants and the erection of cooly lines have not been included.

SELECTED ARTICLE

Roots

By H. C. Sampson, C. I. E.

The study of the root systems of crops grown in the tropics and sub-tropics is a branch of agricultural research which has not received the attention which it deserves, in fact, so little information has been published on the subject that one is forced to fall back on inferences rather than to depend on concrete knowledge. This study is more important in the tropics than in temperate regions, because the range of environment is so much greater, and there is no doubt that environment has a considerable influence on the root development and root system of any particular species, or of any cultivated race of a species. For example, the work which has been done at East Malling in examining the root systems of different races of fruit stocks has shown clearly that these vary both with the stock and with the type of soil on which they are grown.

A striking example of the influence of environment on the root system of a species is the case of the Neem tree (*Azadirachta indica*), which has been introduced into the Gold Coast within the last twenty years. Its native habitat is in India, where it is generally found growing in open country in the drier parts of the country. It is not exacting in the type of soil on which it grows except that it is not seen on deep black cotton soils. Under Indian conditions the tree makes a strong tap root which penetrates vertically into the ground for a considerable depth, and it shows little tendency to form strong branch roots near the surface. In the Gold Coast the tree is now a common feature in roadside, town and village planting, and it is not unusual to see trees where the root system has been exposed by erosion. The most striking feature shown is the tangled mass of stick surface branch roots extending laterally quite close to what must have at one time been the surface of the ground. In fact, one may say that all the common exotic species of trees which are grown in West Africa develop under that environment a shallow root system. This adaptation of the root system to suit a particular environment may explain why it is that trees found useful in