1 PLANTATION CROPS IN INDIAN AGRICULTURE — AN OVERVIEW

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Introduction

Plantation crops play a vital role in the economy of the country though they occupy only 3.2 m. ha or 1.82 per cent of the gross cultivated area. The cultivation of plantation crops is largely restricted to the tropics mostly between 20° North and 20° South of the equator. As a group of crops these have been successfully used to boost the economy of several tropical countries and hold a special place in the Indian economy. Almost all these crops are perennial in nature, and demand employment of labour around the year. Among the plantation crops, except perhaps arecanut, other crops enter international trade and all of them have a long juvenile period. Coconut, arecanut, pepper and cashew are cultivated by individual land owners who are not organised to the same extent as the planters of tea, coffee and rubber (Bavappa and Nair, 1988). Coconut, arecanut, cardamom and pepper are being cultivated in India from time immemorial. Tea, coffee and rubber have comparatively large scale plantations which started fairly recently with the arrival of Europeans.

Commercial planting of tea was started in India in Assam from 1835 onwards. Coffee is believed to have been introduced in India and Sri Lanka towards the end of 17th century. Bava Budan, a Muslim pilgrim is believed to have brought coffee with him from Arabia around 1616 AD and planted it in Chickmangalore, Karnataka. African red oilpalm was introduced in Maharashtra in 1949 but its commercial cultivation started in the 1960s to a small extent and in 1970s to a larger extent in Quilon district of Kerala and in the Little Andamans.

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Plantation Crops in India's Agricultural Economy

Though the total cropped area under plantation crops is small (1.82% of total crop land), the export earning from plantation crops during 1986-87 was Rs. 15,993 million or about 12.72 per cent of total export earnings from all commodities. The trend of export earnings from plantation crops in the last three decades is presented in Table 1.

Table 1: Trends in the export of plantation crops from India

Crops	Period	Quantity (000 tonnes)	Value (Rs. million)	Unit value (Rs/kg)
Cardamom	1960-61	2.0	36.7	18.07
	1970-71	1.7	112.2	65.78
	1980-81	2.4	358.8	148.50
	1986-87	1.4	185.0	132.10
Black pepper	1960-61	17.2	85.0	4.90
	1970-71	17.3	152.0	8.90
	1980-81	26.1	378.0	14.50
	1986-87	38.4	2082.0	54.20
Cashew	1960-61	43.6	189.1	4.34
	1970-71	50.3	520.7	10.35
	1980-81	32.8	1408.5	42.94
	1986-87	44.5	3356.0	75.40
Coconut (Coir & coir products	1960-61	70.9	70.2	0.99
	1970-71	52.2	138.7	2.66
	1980-81	28.6	255.5	8.93
	1986-87	23.2	314.0	13.53
Coffee	1960-61	19.7	72.2	3.66
	1970-71	32.2	251.1	7.80
	1980-81	89.0	2150.0	24.16
	1986-87	86.2	3675.0	42.60
Tea	1960-61	193.0	1199.0	6.21
	1970-71	199.0	1482.0	7.44
	1980-81	232.0	4353.0	18.78
	1986-87	204.0	6190.0	30.39

Source: CPCRI, Kasaragod.

India is the leading producer of cashew, tea, arecanut and cardamom, third in coconut and its position in pepper fluctuates from first to fourth from year to year. In terms of volume of international trade and their importance in national economy, plantation crops compare well with all other crops taken together.

In addition to the primary products from these crops which are largely exported, the by-products from many of these crops also have considerable industrial and commercial importance. Coir, wood and shell products from coconut (Thampan, 1981), leaf sheath in arecanut (Nayar and Annamalai, 1982), cashewnut shell liquid and *fenni* (an alcoholic beverage) from cashew apple are some of the by-products which have made considerable impact in the industrial field.

Most of the plantation crops introduced into India received little attention with respect to scientific management and research till the 1950s. Stagnation of yield has set in crops like coconut, cashew, cardamom and pepper mainly due to lack of systematic replanting programme. Crop-based research and developmental efforts and large size holdings in tea, coffee and rubber have helped to obtain increased production and productivity in them. The plantation crops support vast section of farm labour and plantation crops based industries, in addition to generating self-employment for thousands of people.

Area, Production and Yield of Plantation Crops

Coffee, tea, rubber, coconut, arecanut, pepper and cashew together occupy 3.22 million ha. (Fig. 1) The latest state-wise area and production data of major plantation crops are given in Table 2.

Arecanut: Area under arecanut has increased from 113,000 ha. in 1961-62 to 176,300 hectares during 1986-87. The production also showed a stready rise from 95,170 tonnes to 209,400 tonnes during the same period. The productivity increased during the period by about 28 per cent from 850 kg/ha to 1188 kg/ha. Kerala, Karnataka and Assam account for 90% of the area and 96 per cent of the arecanut production (Bavappa and Nair, 1988; Velappan and George, 1982).

Black Pepper: The present official area estimate is 136,600 ha. with a production of 33,000 tonnes. However, the official estimate has been questioned mainly based on the annual export ranging between 35,000-

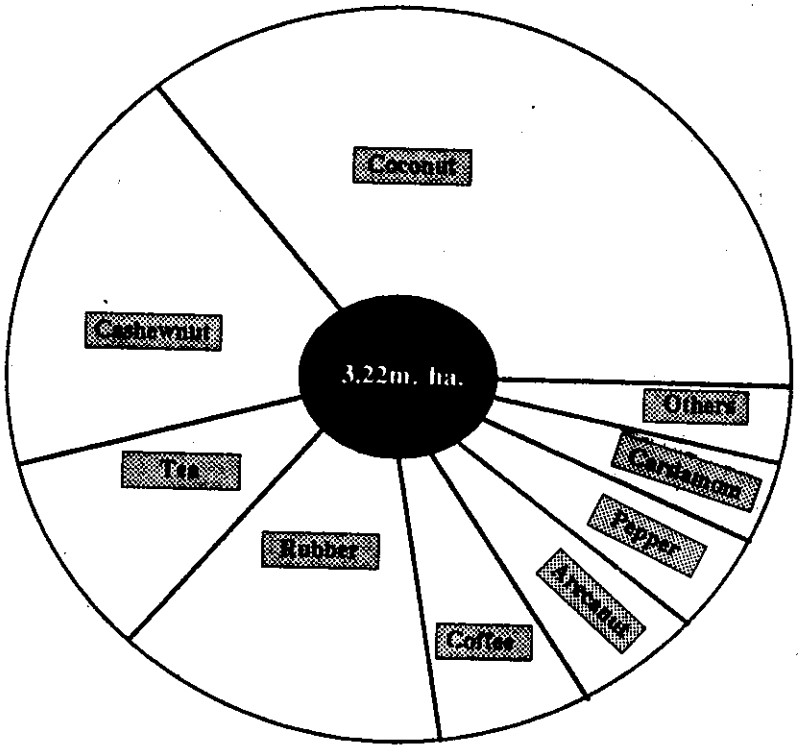

Fig.1. Crop-wise share of the area under plantation crops in India

40,000 tonnes during the last decade and the trade estimate of production during 1986-87 is around 60,000 tonnes. This emphasises the need for having an accurate estimation of area and production in the country. Kerala state contributes to 95 per cent of the area and production. The average estimated yield in the country is only 261 kg/ha. though a realistic estimate puts the productivity at close to 500 kg/ha.

Cardamom: Of the total estimated 94,000 hectares of cardamom in India, about 60 per cent of the area is confined to Kerala, 30 per cent is in Karnataka and about 6 per cent in Tamil Nadu. In terms of production, Kerala leads with 3,100 tonnes of dried capsules followed by 1,600 tonnes from Karnataka. The maximum productivity however is in Tamil Nadu at about 93 kg/ha and lowest in Kerala at 30 kg/ha. Unofficial estimate indicates that some of the plantations in Karnataka and Kerala show wide

Table 2: Statewise area and production of plantation crops in India (1986-87)

State	Coconut		Arecanut		Cashew		Cardamom		Pepper		Tea		Coffee		Rubber	
	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P
1. Andhra Pradesh	48.1	198.8	0.2	0.2	86.3	29.1	—	—	—	—	—	—	7.6	0.4	—	—
2. Assam	8.0	54.3	50.7	60.1	—	—	—	—	—	—	216.1	336.0	1.3	N	—	—
3. Karnataka	207.7	1078.4	60.6	89.0	82.7	22.0	27.7	1.6	2.6	0.7	1.9	3.8	127.9	145.0	11.2	4.1
4. Kerala	683.8	3068.0	45.9	40.9	164.8	130.9	60.7	3.1	133.1	31.9	34.8	48.6	65.6	33.0	326.7	184.6
5. Maharashtra	7.0	81.2	1.6	2.0	22.7	19.1	—	—	—	—	—	—	N	N	0.7	N
6. Meghalaya	—	—	6.6	6.3	—	—	—	—	—	—	—	—	—	—	—	—
7. Orissa	27.6	134.9	—	—	72.2	18.6	—	—	—	—	—	—	1.0	0.1	—	—
8. Tamil Nadu	171.9	1423.3	4.2	3.4	94.8	11.9	5.9	0.5	0.9	0.2	37.0	86.7	32.9	13.8	16.7	11.0
9. Tripura	2.7	2.1	0.7	1.1	0.8	0.1	—	-	—	—	—	—	—	—	8.2	0.2
10. West Bengal	17.0	186.6	4.4	5.2	6.7	2.4	—	—	—	—	98.0	142.8	N	N	—	—
11. A & N Islands	28.7	33.8	—	—	—	—	—	—	—	—	—	—	N	N	0.8	0.5
12. Goa, Diu & Daman	22.9	106.3	1.3	1.1	44.1	11.3	11.3	—	—	—	—	—	—	—	—	—
13. Lakshadweep	2.8	24.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14. Mizoram	—	—	0.1	0.1	—	—	—	—	—	—	—	—	0.8	N	—	—
15. Pondicherry	1.6	18.1	—	—	0.4	0.2	—	—	—	Neg.	—	—	—	—	—	—
16. Others	—	—	—	—	—	—	—	—	—	—	12.1	6.3	—	—	5.0	0.1
India	1229.8	6404.4	176.3	209.4	575.5	245.6	94.3	5.2	136.6	32.9	399.9	624.2	240.6	192.3	369.3	200.5

A = Area in '000 ha. P = Production 000 tonnes Coconut in million nuts, Tea data for 1986, N = not available.
Source : Statistics Unit: CPCRI, Kasaragod.

variations in yield from year to year and a production of about 300 kg/ha is not uncommon.

Cashew: With an estimated area of 575,500 hectares under cashew during 1986-87 and an annual production of 245,600 tonnes, India ranks first in the world. Kerala has 165,000 ha. and produces 131,000 tonnes of cashewnut annually. In terms of area though Tamil Nadu comes next to Kerala with 95,000 hectares, the production there is only 11,900 tonnes. However, Andhra Pradesh is next to Kerala in terms of production with 29,000 tonnes per annum. An analysis of cultivated area in the country shows an increase of about 42 per cent during the last decade while the production of nuts has increased only by 17 per cent. However, during the next 2-3 years the production level is expected to substantially increase since a vigorous area expansion programme combined with planting of high yielding clonal materials has been undertaken by the developmental agencies in the recent years.

Coconut: India ranks third in the world in the area and total production of coconut. Present estimated area is 1.23 million hectares with an annual estimated production of 6404 million nuts. Kerala state accounts for 56% area and 48% production of nuts. Though Karnataka with 207,700 ha., is second in area to Kerala, in terms of production Tamil Nadu ranks next to Kerala with 1,423 million nuts. An analysis of area, production and productivity of coconut during the last two decades shows that though there has been a marginal increase in total area under the crop, the production and productivity have been showing a declining trend. This is mainly due to the devastating root (wilt) disease in major coconut growing districts of Kerala.

Coffee: Cultivation of coffee is confined mostly to Karnataka, Kerala and Tamil Nadu which together account for 94.1 per cent of the area cultivated. Karnataka has 54 per cent of the coffee area and contributes 75% of the production mainly due to the higher productivity. Arabica coffee occupies 52 per cent of the area and 48% is under Robusta type. While the area expansion has been only 54 per cent during the last 25 years, the production has increased by 100 per cent primarily due to high yielding varieties and adoption of better agro-techniques for scientific management.

Rubber: Out of a total estimated area of 0.369 million ha. under rubber, Kerala accounts for 88%. Tamil Nadu, Karnataka and Andaman &

Nicobar Islands are the other rubber growing states/union territory in India, though in recent years the Rubber Board has launched an expansion programme of cultivation of rubber to the non-traditional areas such as the north-east. The annual production of natural rubber in India is estimated to be 200,500 tonnes and average yield at present is about 542 kg/ha though as high yield as 4,600 kg/ha has been achieved.

Tea: The production of tea in India has increased by more than 100 per cent within the last 30 years. The production which was 229 million kg during 1945 has increased to 570 million kg during 1980-81. According to the latest available figure, tea production is 625 million kg for the year 1986-87. While the national productivity is 1560 kg/ha made tea, the average productivity in the three southern states viz., Karnataka, Kerala and Tamil Nadu is much higher at 1913 kg/ha.

Time-Series Trends

The trend of production and productivity of 10 major plantation crops is given in Table 3. An overall analysis indicates that there has been a steady increase in area and production in almost all these crops. However, the productivity of these crops has not kept pace with or reflect the research achievements in recent years. In the case of coconut the trend has been rather alarming since there has been a steady decline in productivity during the last quarter of the century. Spread of root (wilt) disease, expansion of area to the marginal and unsuitable lands, inadequate inputs and poor management of plantations have been the major constraints in coconut production.

The trend is almost similar in black pepper mainly due to the devastating wilt diseases and inadequate management practices. Though improved varieties in coconut as well as in pepper have been released, there is dearth of availability of planting materials and farmers traditionally cultivate low yielding varieties. Cashew has traditionally been cultivated on marginal lands without any input and only during the last few years scientific cultivation of cashew has been initiated with adequate nutrient input and pest management. it is expected that the productivity of cashew will show an increasing trend within the next few years.

A steady increase in the production and productivity of tea, coffee and rubber can be attributed to vigorous developmental programmes including liberal subsidy to the farmers for adopting improved management practices.

Table 3: Trend of area, production and productivity of plantation crops in India

Crops	1950-51			1960-61			1970-71			1980-81			1984-85		
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Coconut	622	3582	5759	717	4639	6470	1046	6075	5811	1083	5720	5280	1183	6913	5844
Arecanut	NA	NA	NA	113	96	849	167	141	844	185	196	1059	186	219	1177
Cashewnut	NA	NA	NA	176	111	631	303	177	584	465	185	398	510	221	433
Cacao	—	—	—	—	—	—	—	—	—	—	—	—	23	6	261
Cardamom	48	2	42	56	3	54	75	3	41	88	6	63	115	9	76
Tea	314	275	876	331	321	971	354	419	1182	382	570	1491	398	645	NA
	(241)			(312)			(323)			(346)			(NA)		
Coffee	91	25	298	114	43	448	135	110	NA	208	119	624	NA	190	NA
	(82)			(96)			(NA)			(190)					
Rubber	58	14	342	129	25	354	203	92	653	278	153	788	350	187	886
	(41)			(72)			(141)			(194)			(211)		
Black Pepper	80	21	263	103	28	272	107	24	219	109	30	270	107	21	194

A = Area (in 000ha) P = Production (in 000 tonnes) Y = Productivity (kg/ha). Coconut production in million nuts and yield in nuts/ha. Figures given in brackets are plucked area for Tea and Coffee, and tapped area for rubber. NA = Not applicable or not available

Future Projections of Area and Production

The plantation crops have restricted geographic distribution and as such the possibility of area expansion in the traditional zones is also limited specially in the case of coconut, cardamom, cashew and rubber. However, there is immense potential for increasing the area under pepper and cocoa. Research conducted by Central Plantation Crops Research Institute (CPCRI) has indicated a compatibility of these crops in coconut and arecanut — based farming systems without being detrimental to the production of coconut and arecanut (Nelliat *et al.* 1979). Expansion of cultivation in coffee and tea has also got its limitations owing to the rigidity of our land policy and also stringent laws to ensure environmental protection and preventing deforestation.

Arecanut: The present production is more than adequate to meet the internal demand of about 185,000 tonnes. During the last 2-3 years there has been a steady decline in price of arecanut mainly due to the increased production. It is also estimated that during the last five years there has been a steady expansion of area by converting fertile lands into arecanut plantations and the production is further estimated to increase substantially during the next 2-3 years. In the absence of availability of an effective alternate use of arecanut and limited export potential, the national policy has to be for concentrated developmental efforts in the more favourable areas of arecanut. This can be done through investment oriented programmes with all input components such as high yielding variety, optimum fertilizer application, irrigation and plant protection measures while discouraging new planting and incentives to convert unproductive plantations to more profitable crops.

Pepper: It is estimated that the international demand for pepper will go up at the rate of 4 per cent per annum. To keep pace with this growing international demand and to meet the domestic requirement, it is estimated that India will need to produce more than 80,000 tonnes of pepper annually by 2000 AD. Thus the need to increase the pepper production and productivity in the shortest possible time is obvious. Both short-term as well as long-term policies are to be adopted to meet this goal.

The existing productivity gap between the national average of 0.26 kg and the average yield of 1 kg per vine with the adoption of scientific cultivation methods could be bridged by transferring the available technology such as application of recommended fertilizer, control of 'pollu' beetle

and prophylactic measures against the wilt diseases. The possibility of increasing the yield of pepper by 66 per cent through fertilizer alone has been indicated by results of research at the CPCRI. As a long term measure, a vigorous replanting programme is to be under-taken with the improved varieties and elite planting materials adopting the rapid multiplication programme. A Centrally Sponsored Scheme is in operation during VIIth 5-year plan ending 1989-90 to produce an estimated 8 million rooted cuttings annually.

It is estimated that 50 per cent of the existing gardens require replanting and gap filling. This implies that within the next 5-10 years, a programme is to be developed to replant about 60,000 hectares and new planting of about 10,000 ha. The planting materials required for this (about 94 million rooted cuttings) are being made available in a phased programme by the Centrally Sponsored Scheme. This is to be coupled with a scheme for providing subsidies to small and marginal farmers in order to meet at least the cost of planting materials and standards.

While the scope for pepper as a monocrop in Kerala is limited due to the pressure on cultivated land, there is immense scope for growing pepper vines in coconut and arecanut gardens. The practice of growing pepper as a mixed crop in coconut and arecanut gardens is slowly catching up and this immense potential is to be exploited suitably with a vigorous expansion programme.

Cardamom: The yield of cardamom in India fluctuates depending on the climate and this is reflected in its international price level. The economic life of a cardamom plantation is 7-15 years depending on the cultivar. Most of the existing plantations have never been replanted and some of them are as old as 40 years or more (Mukherji, 1973). Systematic replanting is seldom undertaken by growers. Ecological imbalances due to continuous deforestation are also responsible for declining of cardamom plantations.

The demonstration of scientific cultivation has indicated the possibilities of increasing the productivity to 300 kg/ha or even more. Scientific cultivation of cardamom with periodic replanting using high-yielding clones, fertilizer application and shade regulation is necessary for increasing the productivity in order to compete in the international market. The production cost is to be brought down and this is possible only if productivity is increased by adapting scientific cultivation methods. The scope for area expansion is limited.

Cashew: The scope for expansion of area in the traditional state of Kerala is practically nil at present. However, there is potential for area expansion in Orissa, Karnataka, Andhra Pradesh, Bastar district of Madhya Pradesh and Tripura. It is estimated that expansion of cashew to these states could bring an additional 50,000 hectares under cultivation. Epicotyl grafting and soft-wood grafting standardised by CPCRI have increased the scope for increasing the productivity. Large-scale budwood orchards are being established with the co-operation of the developmental agencies and plantation corporations.

Cocoa: Though cocoa was found to be most compatible as a mixed crop in coconut and arecanut plantations, the area expansion programme received a setback during the last decade mainly due to the marketing problem and the pricing policy. However, the trend is now steadily changing due to establishment of processing factories including one in the co-operative sector offering an effective competition to the multi-national company which was operating alone earlier. Cocoa cultivation as a mixed crop in coconut and arecanut plantations has caught the imagination of cultivators in Kerala, Karnataka and Andhra Pradesh and the production is expected to meet the existing demand in the near future.

Coconut: There has been a steady increase in area in the case of coconut since 1955-56. It has been estimated that there is still scope for an additional 0.4 million ha. particularly in, Tamil Nadu, Andhra Pradesh, Orissa,Maharashtra, Gujarat and Andaman & Nicobar Islands. Further, the government of India through its Coconut Development Board is vigorously exploring the possibilities of expansion of area to the non-traditional states like Bihar, Madhya Pradesh, Eastern Uttar Pradesh, Assam, Tripura and Manipur. Even if only 50 per cent of the estimated 0.4 million ha. are brought under cultivation, there is scope for increasing the production by about 0.2 million tonnes of coconut oil within the next 10 years.

The Indian Council of Agricultural Research (ICAR) is aware of the limitations of the planting materials and through CPCRI with the active support of the Coconut Development Board, a programme to establish seed gardens in almost all these states to produce quality planting materials has been initiated. At present there are 12 seed gardens in the country and some more are being established to meet the need of quality planting materials.

Coffee: Like in manyother plantation crops, the scope for area expansion is limited and the possibilities of increasing the production by high yielding San Ramon derived varieties and scientific management must be the only strategy at present.

Oilpalm: At present oilpalm is grown in 3705 ha. in Kerala by Oilpalm India Limited and 1593 ha. in Andaman & Nicobar Islands by the Andaman & Nicobar Islands Forest and Plantation Corporation Limited. Recently a Central Working Group constituted by the Government of India has identified 0.575 million ha. for oilpalm cultivation under the major irrigation project areas of different states (Anonymous, 1988). Andhra Pradesh and Karnataka have greater potential than other states for oilpalm. In East and West Godavari and Krishna districts of A.P. where there is potential for irrigation, it is possible to introduce the crop in about 0.25 million ha. in a phased manner. Similarly Thungabhadra, Upper Krishna, Bhadra and Cauvery basin projects have a potential of another 0.25 million ha. for oil palm cultivation. Tamil Nadu, Maharashtra, Orissa, West Bengal, Assam and Tripura are the other states where oilpalm can be taken up as irrigated crop. If this project is implemented right now, it is possible to produce a million tonnes of palm oil and 0.10 million tonnes of kernel oil by 2010 AD.

Rubber: Surveys and trial plantations carried out in non-traditional areas such as in North-Eastern Region, Orissa, Goa and Maharashtra have revealed that commercial planting can be successfully undertaken on an extensive scale. In the non-traditional areas of Tripura, Meghalaya, Assam, Andaman & Nicobar Islands, Mizoram, Nagaland, Goa, Maharashtra and Manipur, an area of about 14750 ha has been brought under rubber in recent years. Marginally suitable areas like Konkan region of Maharashtra and certain parts of Andhra Pradesh, Orissa, West Bengal and Madhya Pradesh can also be brought under rubber. Cost of cultivation in the marginal areas will be comparatively less and labour will be comparatively cheaper. Therefore the lower yields realised would to a great extent be compensated by reduced cost.

Tea: The cost of production of tea is highest in the world mainly due to the increased labour cost. As indicated earlier, 40 per cent increase in productivity of tea plantation has been achieved in the southern states during the last 25 years. As in cardamom, the only possibility seems to be to increase the productivity to higher levels in order to offset the increase in labour cost.

Constraints in Increasing Production

While the production and productivity of crops like tea, rubber and arecanut has increased substantially, these have remained stagnant or even declined in crops like coconut, pepper and cashewnut. Though technologies to increase the production are available, a break-through has not been achieved in transferring them to the farmers in most of these crops. The long pre-bearing period and time lag between input application and response are also among the constraints for adopting the improved technologies in most of plantation crops.

Most of the holdings in many plantation crops are small and marginal (Table–4) and the performance of large and small holdings differs substantially.

Table–4. Holding size distribution of some plantation crops

Holding size	Rubber	Cardamom	Coconut
2 ha and below	87.4	68.0	98.8
2–4 ha	7.9	17.3	
4–20 ha	4.3	13.2	1.2
20–40 ha	0.2	0.9	
Above 40 ha	0.2	0.6	

Contrary to the assumptions that small plantations are more productive because of the personalised attention, larger plantations under the corporate sector show better productivity. The average yield of corporate sector tea plantations in the Nilgiris is much higher than what it is in small holdings. The small holder farmers fail to give appropriate attention to the crop in time because of long pre–bearing period, uncertainity of the returns and the slow response to improved management practices. Whenever there is a slump in the price for a particular commodity, the small farmers divert their resources to another crop which is more remunerative at that time. This is very common in coconut, tea and cardamom. In perennial crop s such irregular input management will reflect on the yield of subsequent years.

Being perennial crops, regular replanting, underplanting and also removal of senile trees are seldom attended to. This is true in coconut wherein the senile or unproductive palms are not removed regularly and replanted. Sometimes closer planting results in plant canopy competition and root

competition and thereby reduced productivity.

Sometimes marginal and sub–marginal lands are used for the plantation crops and these lands with improper input management result in low productivity. Most of the plantation crops depend on monsoon rains. Uneven distribution of rains, long dry spells coupled with high temperature in summer resulting in drought condition affect the productivity of these crops.

Inadequate availability of quality planting materials in the plantation crops is the major constraint. Quality planting materials are vital for better production. A mistake of planting inferior seedlings cannot be rectified at the fruiting age as by then considerable wastage of time, money and energy would have occured.

Control of pests and diseases is yet another constraint in the production. Though most of the pests and diseases can be controlled by proper and timely application of plant protection chemicals and adoption of other proven means, it could not be done by all farmers simultaneously due to large number of small holdings and lack of collective approach of tackle the problem. This is true in the case of leaf eating caterpiller, red palm weevil and rhinoceros beetle of coconut where even though definite integrated control measures are available, these are not implemented properly. Root (wilt) disease of coconut caused by Mycoplasma like organism; Thanjavur/Ganoderma wilt disease of coconut; Yellow leaf disease of arecanut; quick and slow wilt diseases of pepper; 'Katto' disease of cardamom; stem borer of cashew and coffee; shoot hole borer of coffee; tea mosquito in cashew etc. are some of the perennial problems which affect the productivity of plantation crops.

Though the plantation crops can be compared to industry with regard to the investment and return, there are differences also. In industry, the sons or close relatives take over the management from the founder. They are educated and trained to get expertise in specific areas related to the concerned industry. In the farming, this is not the case. The brilliant young men and women in the family go for white collar jobs. Smart ones take up business or trade. It is only the drop outs from school who take to farming in majority of the cases by force without any aptitude. Hence there is reluctance on the part of such people to change over to improved crop production technology. This is one of the main reasons for low productivity and returns from plantation crops. Unless plantation crops farming is considered as business and managed with adequate and timely inputs, it will not be a profitable venture.

Lack of credit facilities on easy terms, deficiencies in input supply, uncertain markets and crop prices, lack of necessary institutional infrastructure and socio-economic and cultural problems are some of the other constraints.

Nutritional Aspects of Plantation Crops

Majority of the soils under plantation crops being located in humid tropics are laterites and lateritic types, red or red gravelly sandy loam and coastal sandy soils. Being coarse textured, they are well drained and are considered ideal soils for plantation crops. However, these soils have inherent drawback of being poor in native fertility and nutrient retention capacity except for phosphate fixation. Excessive rainfall in humid tropics further aggravates the problem by way of leaching of nutrients such as N and K from soil. Thus, almost all the soils in this region are low or medium in major or minor elements. The subject of nutrient management is discussed in detail in the next chapter.

New Developments in Plantation Crops Research

Research on all plantation crops except tea, coffee and rubber is being done by the ICAR through Central Plantation Crops Research Institute, Kasaragod, its regional stations and research centres, National Research Centres for Spices at Calicut and Cashew at Puttur, and under the three All India Co–ordinated Research Projects on Palms, Cashew and Spices. Coffee research is being carried out by the Central Coffee Research Institute, Balehonnur (Coffee Board); tea research by (i) UPASI Tea Research Institute, Valparai, and (ii) TRA's Tocklai, Tea Experimental Station, Jorhat; and rubber research by Rubber Research Institute of India, Kottayam (Rubber Board). Adaptive research on cardamom is also being undertaken by Indian Cardamom Research Institute, Myladumpara (Spices Board). These Institutes have developed production technologies including development of cultivars/hybrids for increasing the productivity of plantation crops.

Germplasm: Germplasm accessions in plantation crops available in the country at present are given in Table–5. Breeders working on plantation crops were able to exploit the germplasm available to evolve high yielding varieties combined with resistance in the case of tea, coffee and rubber through either selection or hybridization. High yielding varieties/

hybrids in coconut, arecanut and pepper were also released from time to time. However, sources of resistance to the major diseases and pests in these three crops are yet to be located/isolated among the germplasm accessions.

Table–5: Germplasm assemblage in plantation crops in India

Crop	Exotic	Indigenous
Coconut	86	41
Arecanut	29	23
Oilpalm	14	1
Cashew	5	216
Cocoa	82	—
Black pepper	2	839
Cardamom	—	405
Clove	2	150
Nutmeg	—	303
Cinnamon	14	156
All Spices	—	4
Tea	200	—
Coffee	416 arabica 18 robusta 18 diploids	—

Varietal Improvement: The main thrust towards increasing the productivity of coconut plantation has been on the production and planting of hybrid seedlings. Hybrid COD x WCT gives 42% more yield than West Coast Tall (WCT) by 18th year and 32% more nuts thereafter annually. Two other hybrids LO x COD and LO x GB released recently give 19.4% and 25.8% higher yield than WCT. In addition, high-yielding selections viz. Laccadive Ordinary and Benalium are also available for planting.

In arecanut, the first improved variety 'Mangala' with 70 per cent more yield than the local cultivar was released towards the end of 1960s. Recently two other high yielding varieties 'Sumangala' and Sreemangala' were also released which can give 53% and 39% more yield respectively than that of Mangala.

In cashew, sixteen varieties and hybrids evolved have the yield potential of about 15 kg of nuts/tree/year at the age of 10 years. Vegetative propa-

gation techniques have been standardised for rapid multiplication of these varieties/hybrids by establishing clonal orchards.

Panniyur-I, a pepper hybrid released in the early 1960s has a yield potential of 5 kg of dried pepper/vine/year. Karimunda, Kottanadan and Narayakodi are some of the high-yielding cultivars available with adaptability to varying agro-climatic conditions. Systematic screening of the large number of germplasm accessions has resulted in identification of lines with high yield, quality and tolerance to disease. A number of such promising lines are in the advanced stage of yield evaluation.

In cardamom, high yielding clones capable of yielding about 500-800 kg of green capsules/year/ha have been identified and are under pre-release evaluation.

The Central Coffee Research Institute has evolved eleven arabica selections with high yield, leaf rust tolerance/resistance, good cup quality and adaptability to different agro-climatic zones. Selections from various *Arabica* varieties for yield, resistance to leaf blight and size and quality of beans have formed the nucleus of material for release for cultivation. CCRI No. 880, a collection from East Africa is reported to give 6,000 kg/ha in its 25th year in contrast to 520 kg/ha produced by local types (Visheswara, 1975). Cogenesis x robusta, an inter-specific hybrid with compact size permitting close planting has also been released.

In tea, 24 promising clones were released for commercial cultivation during 1969-73 and were very widely accepted by the planters.

The evaluation of 414 cocoa trees has resulted in the selection of 17 high yielding trees which had desired bean weight of more than 1 g. Among 31 accessions from Nigeria, eight elite trees were identified based on number of pods, pod value and bean weight. Twelve cross combinations involving ICS 1,6 & 89, SCA 6 and 12, NA 31 and 33 and IMC 67 are under yield evaluation trials.

The CPCRI Research Centre at Palode has identified 53 *Dura* and 37 *Pisifera* palms and is now capable of producing about 4 lakh *Tenera* hybrids every year.

The varieties and hybrids released in plantation crops with their yield potential are given in Table-6.

Table 6 : Varieties /hybrids released in plantation crops

Crop	Variety/hybrid released	Mean annual yield	
		Nuts/palm	Copra/nut(gm)
Coconut	Chandra Kalpa (Laccadive Ordinary)	100.0	172.0
	Chandra Sankara (COD x WCT)	104.8	208.0
	Chandra Laksha (LO x COD)	102.0	195.0
	Laksha Ganga (LO x GB)	134.6	195.0
	Veppankulam Hybrid Coconut		
	i) VHC–1 (ECT x MGD)	98.0	147.0
	ii) VHC–2 (ECT x MYD)	107.0	155.0
	Banawali Green Round (Pratap)	151.0	151.0
Arecanut	Mangala (VTL–3)	8.8 kg	ripe nuts/yr.
	Sumangala (VTL–11)	14.4	"
	Sree Mangala (VTL–17)	11.0	"
Oilpalm	Tenera (Dura x Pisifera)	4.6 ton	oil/ha/yr
Cocoa	Pre–release variety/hybrids	3.9 kg	beans/tree
Pepper	Panniyur–1	5 kg	dried berries per vine/year

Crop	Variety/hybrid	Mean annual yield		
		nut/tree (kg)	Nut weight (gms)	Shelling %
Cashew	Anakkayam (BLA 139–1)	35	6	28
	BLA 39–4	13.8	6.8	26.8
	K 22–1	13.2	6.2	22.7
	NDR 2–1	17.14	7.3	26.2
	Vengurla – 1	23.0	6.0	31.0
	Vengurla – 2	24.0	4.0	32.0
	Vengurla – 3	—	9.0	27.0
	Vengurla – 4	—	8.0	31.0
	Vengurla – 5	21.0	4.5	30.0
	Ullal – 1	19.0	7.0	31.0
	Ullal – 2	18.0	6.0	30.0
	Vridachalam (VRI–1)	7.4	5.0	28.0
	Vridachalam (VRI–2)	6.0	5.0	28.0
	Bapatala (BBP–1)	17.0	5.0	27.5
	Bapatala (BBP–2)	19.0	4.0	26.0
	Bapatala (BBP–3)	16.0	6.0	28.0
	Bapatala (BBP–4)	12.5	6.0	23.0

Table contd../-

Crop	Variety/hybrid	Mean annual yield		
		nut/tree (kg)	Nut weight (gms)	Shelling%
	Bapatala (BBP–5)	42.0*	5.2	24.0
	Bapatala (BBP–6)	42.0*	5.2	24.0
		Mean Yield kg/ha	Year of tapping	
Rubber	RR 11 – 105	2031	3rd	
	PR 11 – 118	2063	6th	
	PRIM – 600	2212	6th	
	PRIM – 623	2174	11th	
	GT–1	2134	10th	
	PB5/51	2074	8th	
	PB – 86	2017	6th	
	GT–1	2125	11th	

*At the 50th Year

Crop Management: In coconut, management techniques like (i) establishing coconut plantation successfully in coastal sandy soils with the addition of organics; (ii) fertilizer schedule for young and adult palms; (iii) rejuvenation of neglected gardens by manuring; (iv) increasing the production by manuring and irrigation; (v) inter, mixed and multi-storeyed cropping in palms have been developed for increasing the production and income per unit area. Palm-based multi-species cropping system is the recent innovation wherein compatible annual, biannual and perennial crops are cultivated to utilise the horizontal and vertical space, land and sunlight continuously for the production of biomass such as food, fuel, fodder etc. having economic value and diverse end uses relevant to the farmer and society (Bavappa, 1986). Such a cropping system provides more employment opportunities and income, spread over time (Table-7). The yield of coconut also increased considerably due to favourable microclimatic condition which exist in such a cropping system.

Cocoa as a mixed crop in arecanut and coconut plantations has proved to be successful. Vegetative propagation in cashew and nutmeg and rapid multiplication method in pepper are the latest developments for quick multiplication of quality planting materials. Fertilizer schedules, shade management, nursery techniques, pruning, tipping and plucking techniques are also available for a profitable tea culture.

Table -7: Economics of coconut based farming systems (one ha.)

Item	Multistoreyed cropping system	Mixed farming system
Inputs		
Labour (Mandays)		
Family labour	200	730
Hired labour	135	120
Total	335	850
Fertilizer cost for the system	Rs. 2,100	Rs. 2,300
Plant protection cost	Rs. 1,000	Rs. 500
Cattle cost	—	Rs. 12,600
Yield		
Coconut (nuts)	15750	15900
Pepper	141	218
Cocoa (wet beans in kg)	1750	—
Milk (litres)	—	7500
Subsidiary crops	—	Rs. 4,500
Total cost	Rs. 23,700	Rs. 56,500
Total return	Rs. 46,900	Rs. 71,100
Net return	Rs. 23,200	Rs. 14,500
Earnings by family labour wages	Rs. 5,600	Rs. 20,500
Total returns to the family	Rs. 28,800	Rs. 35,000

Rs 14 = 1 US $ approximately

In rubber, nursery and planting techniques, manurial schedule under different situations, estalishment of legume cover crop viz. *Puraria phaseoloides*, *Calapogonium nuconoides*, *Controsome pubescens* and *Mucuna bracteata* for suppression of weeds, conserving soil and improving fertility, weed management through manual and chemical methods, are the management practices available for increasing production and productivity.

A package of programmes viz. manuring, soil management, foliar nutrition, amelioration of soil through liming, correction of zinc deficiency, irrigation method and its schedule, weed control, raising quality nursery, use of growth regulators for promoting fruit set, controlling berry drop, toning up vegetative vigour and increasing the yield were developed for profitable coffee cultivation.

The next chapter is devoted to fertiliser management in plantation crops.

Post Harvest Technology: Research on harvest and post harvest technology aspects of plantation crops is aimed at developing devices and machinery for the benefit of small and marginal farmers. Various types of copra dryers using solar energy, an electronic copra moisture meter, MC Tear Rotor Vane, Tocklai Continuous Tray Tea Drier, Disc Roller and Crushing Tearing Curing (CTC) machines are some of the more important equipments and devices developed and being used by planters and farmers.

Future Strategies for Increasing Yields

In India, the production and productivity of many plantation crops like coconut, cashew, cocoa, cardamom and pepper has remained static or even shown a downward trend during the last two decades. Taking into account the future demand (Table-8), it is necessary to develop production technologies suited to the small and marginal holdings in order to make them as viable production units.

Table-8 Estimated demand for plantation products in India

Crop	Demand by 2000 AD	('000' tonnes)
Tea	1400	
Coffee	260	
Rubber	750	
Black pepper	75	
Cardamom	9	
Cashewnut	360	
Coconut	12000	(millions nuts)

Source: Bavappa (1985)

Biomass Production: The concept of production can be based on energy on one side and income on the other side. Since conversion of energy into biomass is the primary function in any production activity, a critical analysis of the area is worth–while. The potential yield increase which can be achieved by increase in biomass alone in major plantation crops is given in Table-9. More studies have to be undertaken to elucidate the

mechanism so that the productivity per unit land per unit time can be increased .

Table-9: Estimated potential dry matter production

Crop	Dry matter* t/ha/year	Yield** t/ha/year
Coconut	51	5.8
Oilpalm	44	6.0
Cacao	56	9.8
Rubber	46	5.5

* Bavappa (1985) ** Sethuraj (1984).

Photosynthetic Efficiency: There is need for increasing the harvest indices alongwith biomass production. For this, photosynthetic rates are very important. The energy conversion efficiency of the crops is very low being 1-2%. If this is increased, there is possibility of increasing the dry matter production. Such increase could be achieved by (i) increased rate of crop growth; (ii) improved canopy structure and subsequent increase in light penetration resulting in increasing net assimilation rates; (iii) improved partitioning of assimilates etc. (iv) ways to reduce dark respiration in tropical trees in which 75 to 85% of fixed carbon is lost by respiration.

Recent research has shown that the ability of DxT hybrid coconut to exploit native fertility of the soil as well as to use applied nutrients is higher compared to West Coast Tall (WCT). In a coconut-based cropping system with multi-species crop stands, the need for scaling down the fertilizer input had been indicated for optimum yields. Research to unearth these capabilities will help in conserving the nutrients and thereby economising on the input. Cocoa mix-cropped with coconut in double hedge system has been observed to add 50 kg N, 11 kg P_2O_5 and 35 kg K_2O/ha/year. Much higher efficiency may be possible by appropriate choice of crops and supporting them further with proper biological agents like VA mycorhizae, Rhizobium, free living nitrogen – fixing organisms etc.

Multi-Crop System: It is necessary that the production components such as land, air space, inputs and time be considered together. It is also essential that instead of one crop per unit area and time, more crops are planned to be raised either in sequence or together. A clear understanding

of the optimal exploitation levels of the above basic components by a crop community will enable maximization of production through this pathway. Perennial plantation crops offer better scope for yield maximisation, provided the selection is made on the basis of canopy and root architecture and space to make better use of the incoming solar energy at different strata of crop canopies and producing much higher biomass as well as higher income.

Moisture Dynamics: Since moisture and nutrients have strong interaction and also in view of the fact that moisture availability becomes limiting at least during certain periods of the year, research to identify and develop stress tolerant varieties should receive priority in plantation crops.

Resistance to Diseases and Pests: Since MLO diseases like root (wilt) and Tatipaka of coconut and yellow leaf disease of arecanut cannot be controlled by chemical means, the possible solution may be to identify resistant/tolerant varieties/hybrids. Similarly, quick wilt of pepper, tea mosquito in cashew, 'Katto' disease of cardamom, shot hole borer and collar canker disease of tea are some of the diseases in plantation crops for which developing resistant/tolerant varieties/hybrids is necessary. While search for resistance in the available population should form part of any crop improvement programme, induction of resistance and transfer of resistant genes adopting DNA recombinent technique should also be taken up.

Tissue Culture: Genetic variability of a population sets limitations in obtaining higher yields in the population unless efficient clonal multiplication techniques are available for the large scale propagation of any outstanding high yielding or otherwise desirable plants. Tissue culture technique if perfected will be a handy tool for reducing variability in planting material and for breaking the yield barrier. Research on biochemical control of the process of somatic embryo-genesis in crop plants where the technique is rewarding should be the priority area.

Slow Release Fertilisers: Recent research has shown that in coconut growing sandy and sandy loam soils, upto 80% of the applied nitrogen is lost by leaching. Importance of slow release fertilizers in this context is relevant for reducing the fertilizer input. Research on this aspect should get priority in all the plantation crops.

Product Diversification: Research efforts on product diversification and bye-product utilisation also need to be undertaken.

Harvest and Post-Harvest Technology: Harvest and post-harvest technologies should receive attention to avoid the wastages and also to improve the quality of the products.

Germplasm: Widening the genetic base is of foremost importance in some of the plantation crops like oilpalm, cocoa and tree spices. Efforts should be made to assemble germplasms, catalogue and evaluate the same for better utility.

Tree Spices: The domestic production of tree spices namely clove, nutmeg and cinnamon is inadequate to meet the demand of internal consumption. The requirement being 3000, 1500 and 1500 tonnes of clove, nutmeg and cinnamon, respectively of which 1300, 1000 and 300 tonnes of clove, nutmeg and cinnamon are being produced in the country. Substantial foreign exchange is being spent on their import. Since the slopes of western ghats are climatically well suited to these crops, our research efforts should be oriented to identifying high yielding lines with better quality.

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