WORKING PAPER 1 ON **cassava**

Trends and Prospects for Cassava in India

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TRENDS AND PROSPECTS FOR CASSAVA IN INDIA

by

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FOREWORD

Cassava is a staple food crop cultivated in several developing countries, largely by small farmers. It is a source of subsistence and of cash income for poor farmers as well as a source of rural employment, particularly of women. During the past 20 years, production of cassava has expanded rapidly in Asia, particularly in Thailand in response to expanded demand for its import in the European Community, where it is used as livestock feed. There are concerns, however, about the likely decline in demand for cassava as food as incomes rise in developing countries and also about the stability of the European demand. To assess the prospects for cassava in the future, IFPRI has examined the trends and prospects for production, utilization, and trade of cassava in Third World countries under a special project partially funded by the International Development Research Centre (IDRC) of Canada.

In addition to the analysis of international data at the global and regional levels, case studies were taken up in six countries: India, Indonesia, the Philippines, and Thailand in Asia and Nigeria and Zaire in Sub-Saharan Africa. The results of these studies were discussed at a workshop in Washington, D.C. in August 1987, where project researchers, selected cassava scientists, and representatives of international organizations participated. The report on the proceedings of the workshop will be published separately. The results of the individual case studies are being published as a series of working papers. *Trends and Prospects for Cassava in India*, by *P. S. George*, is the first in the series.

J. S. Sarma
Project Leader

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N. G. Pillai and T. K. Pal at the Central Tuber Crops Research Institute, Trivandrum, were helpful in locating relevant reference materials, and many others helped in gathering both secondary and primary sources of data. I have also received a high degree of cooperation from a number of organizations connected with cassava production, processing, and marketing. Finally, I received valuable support from the CDS community in processing the data and in typing the draft versions of the paper.

P. S. George

1. INTRODUCTION

Cassava has been grown in India for more than a century. It was either introduced into India by the Portuguese during the seventeenth century or brought from South America in 1840. However, the spread of cassava cultivation is attributed to a famous nineteenth century ruler of the former Travancore State, now a part of Kerala, who had encouraged cultivation of popular varieties from Malaya and other places to overcome rice shortages, especially among the low-income group consisting of small farmers and laborers engaged in hard physical labor. Since cassava is somewhat drought resistant, its spread was mainly on unirrigated rainfed land without the application of chemical fertilizers.

During 1983/84, the area under cassava in India was 304,700 hectares and its production was 5.8 million metric tons.[1] For all of India, the area under cassava was less than 0.2 percent of the total cropped area and the rice equivalent of cassava production (2.6 million tons) was about 6 percent of the total production of rice in the country.[2] Though the area under cassava and its production do not occupy an important position in the Indian agricultural economy, because of the geographical concentration of production, it is an important crop in the agricultural economy of a few states, particularly Kerala and Tamil Nadu. Kerala, where the crop was first introduced in India, accounted for about 76 percent of the area under cassava, and the neighboring state of Tamil Nadu accounted for another 16 percent.[3] The shares of Kerala and Tamil Nadu in all-India production were 57 percent and 26 percent, respectively. In Kerala the area under cassava accounted for about 8 percent of the total cropped area of the state; converted to its rice equivalent, cassava production in the state equaled about 145 percent of rice production. The importance of cassava in the agricultural economy of the different regions can be visualized from Table 1.

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[1] In this report, all tons are metric tons.

[2] The calorie value of 2.22 tons of raw cassava is considered to be equivalent to 1 ton of rice.

[3] A part of the area in Tamil Nadu belonged to the former Travancore State before the reorganization of states in 1956.

Table 1--Area and production of cassava, Kerala, Tamil Nadu, and all-India, 1983/84

	India	Kerala	Tamil Nadu
Area (1,000 hectares)	304.7	233.0	48.1
Production (1,000 tons)	5,800.2	3,903.2	1,500.4
Yield (kilograms/hectare)	19,036	16,751	31,193
Share of cassava area			
Foodgrain area (percent)	0.30	27	0.93
Foodcrop area (percent)	0.25	13	0.86
Total cropped area (percent)	0.18	8	0.66
Rice equivalent of cassava production as a share of rice production (percent)	5	145	15

Source: Kerala, Department of Economics and Statistics, Statistics for Planning, 1986, and Agricultural Situation in India, August 1985.

USES OF CASSAVA

The major uses of cassava include human consumption, the manufacture of starch, and an ingredient in animal feed. Cassava is consumed mainly as baked tubers. Small quantities are used in the form of chips, flour, and sago.[4] As mentioned earlier, cassava spread in Kerala mainly because of its use in supplementing the foodgrain available in the state. Cassava used to be the main staple diet for many low-income households. Though dependence on cassava by the poor has somewhat declined with relatively easy access to rice, cassava continues to be an important item of consumption for many low-income families. Available data on cassava use in Kerala indicated that during 1971 about 60 percent of the raw tubers were consumed as food

[4]Sago is wet starch (containing about 40 percent moisture) rolled into small globules in a special machine. These are classified in a way that separates oversized and undersized material. It is then roasted, dried, and finished, mostly by small industry.

and the remainder was marketed for other uses.[5] In Tamil Nadu, domestic consumption was estimated at 48 percent.[6]

Industrial use of cassava started during the Second World War when manufacture of starch and flour was initiated to overcome the nonavailability of maize and potato starch from the western countries and cassava starch from Indonesia for the textile mills. When the government of Travancore introduced controls over exports of cassava products to ensure their availability as cereal substitutes, some areas in Tamil Nadu developed cassava processing. Gradually, cassava cultivation expanded around these regions. Limited quantities of cassava were used in different products such as dextrines, manioc meal, and glucose. Starch is also used in the manufacture of sago, mostly in Tamil Nadu. However, there are wide variations in the estimates of cassava use for starch and sago. These range from about 41 percent of total cassava production in 1961[7] to about 75 percent of cassava production in Tamil Nadu.[8] Data on starch production also indicate a range. Total starch production in India during the early 1980s was estimated by the Government of India to be about 140,000 tons. Srivastava and Phandis estimated cassava starch production in India to be about 200,000 tons.[9] Considering the installed capacity of starch manufacturing units and their capacity utilization, Ghosh has estimated that the present cassava starch production (including sago) should be more than 300,000 tons.[10]

Studies based on composition of animal feeds have indicated that dried cassava could replace at least 20 percent of the cereals now used for poultry feed and even more than that for cattle and pig feed. However, use of cassava in compound feeds is very limited. At the same

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[5]Kerala, Department of Food, Report of the Subcommittee of Tapioca Market Expansion Board (Trivandrum: Department of Food, 1972), p. 63.

[6]Tamil Nadu, Agriculture Department, State Marketing Officer, Report on the Marketing of Tapioca in Madras State (Madras: Agriculture Department, 1965). In India, cassava is commonly known as tapioca.

[7]Ibid.

[8]S. P. Ghosh, "Trends in Disposition of Cassava and Scope for Developing Cassava-based Industry in India," Journal of Root Crops 10 (June 1984): 1-6.

[9]H. C. Srivastava and S. P. Phandis, "Tapioca Starch: Problems and Potentials," Souvenir on Tapioca Starch and Sago Seminar, Salem, Tamil Nadu, March 20-21, 1982.

[10]Ghosh, "Trends in Disposition of Cassava."

time many farmers use cassava chips and other cassava waste for feeding cattle at home.

REGIONAL CHARACTERISTICS

As mentioned earlier, cassava cultivation in India is concentrated in Kerala, with 76 percent of the area under the crop, and Tamil Nadu with 16 percent. During the early 1960s Kerala accounted for 89 percent of the area, Tamil Nadu had about 8 percent, and only 3 percent of the total area was accounted for by the other states. During the past quarter century, there was a substantial increase in the share of area in Tamil Nadu and a marginal increase in other regions at the expense of Kerala's share.

The area under cassava is not uniformly distributed within Kerala and Tamil Nadu. Of the 12 districts in Kerala, 3 districts (Trivandrum, Quilon, and Kottayam) accounted for 57.4 percent of the area under cassava and 59.7 percent of the production during 1983/84.[11] Similarly, in Tamil Nadu the districts of Salem and Kanyakumari accounted for 78 percent each of the area and production of cassava in the state. While Trivandrum district accounted for only about 7.9 percent of the total cropped area in Kerala, it had 23.7 percent of the cassava area and 27.3 percent of the production in Kerala. Similarly, Quilon district with 10.2 percent of the cropped area in the state accounted for 24.2 percent of the area and 21.6 percent of the production of cassava in the state.

Geographically, Kanyakumari district of Tamil Nadu is an extension of the Trivandrum district of Kerala. Cassava yields in Kanyakumari are about 15 tons per hectare, compared to about 21 tons per hectare in Trivandrum and 16 tons per hectare in Kerala. However, yields in Salem district are 37.7 tons per hectare. It may be recalled that the average yield of cassava in Tamil Nadu is more than 31 tons per hectare against 16 tons per hectare in Kerala, and the high yields obtained in Salem district account for the high yields in Tamil Nadu. While cassava cultivation in Kerala and Kanyakumari is mainly for home consumption, a large proportion of the cassava produced in Salem district is used for industrial purposes, especially for starch and sago production. Most of the land used for cassava in Kerala and Kanyakumari is in rainfed areas, but in Salem district irrigated land is used for cassava cultivation.

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[11]These three districts formed part of the former Travancore state. The Travancore region accounted for about 65 percent of cassava in Kerala.

Thus more than half the area and production of cassava in India is concentrated in three districts of Kerala (Trivandrum, Quilon, and Kottayam) and one district of Tamil Nadu (Salem). Table 2 indicates the amount of concentration in these districts.

Table 2--Cassava area and production in four major producing districts

District	Share of District's Cassava-Sown Area			Share of District's Cassava Production		Yield per Hectare
	State Cassava Area	All-India Cassava Area	District Cropped Area	State	All-India	
	.....(percent).....					(metric tons)
Trivandrum	23.7	17.6	23.6	27.3	19.4	20.96
Quilon	24.2	18.0	18.6	21.6	15.4	16.30
Kottayam	9.5	7.0	9.3	10.8	7.7	20.73
Salam	54.8	8.7	5.0	66.4	17.2	37.75

Source: Agricultural Situation in India, August 1985.

SPECIAL FEATURES OF CASSAVA PRODUCTION AND UTILIZATION

Since the major share of cassava production comes from Kerala, some of the special features of cassava production and utilization are presented here to provide an understanding of the environmental factors influencing various cassava options.

- Most of the cultivators in Kerala grow some cassava either as a pure crop or an intercrop on garden patches or plots on the hillsides. In the major cassava-growing areas 70 to 80 percent of growers have less than 0.4 hectares of land.

- Most of the small cassava holders grow cassava for their home consumption. However, in the midland and highland zones of the state, not less than a third of the cultivators depend on cassava as their principal crop.

- Third, there are striking differences between cassava and other cash crops such as pepper, rubber, and coconuts cultivated in Kerala. These are summarized in Table 3.

Table 3--Differences between cassava and other cash crops

Type of Difference	Cassava	Rubber and Pepper
Between crops	Short period crop to be raised every season (about 9 months)	Perennial crop (continues for many years)
	Can be raised on owned or leased land	Mostly grown on own land
	Raw tubers can be kept for 3 to 4 days and chips for 3 to 4 months	Can be kept for long duration without decaying
	Annual swing in prices	Major shifts in prices occur only once in few years
Between producers	Mostly small holdings	Comparatively large holdings
Between consumers	Staple food for large number of consumers	Small quantities, small portion of family budget
	Price important (poor consumers will suffer if price rises)	Price not important

- A consumer survey conducted in 1972 indicates that nearly all householders in Kerala used cassava as a supplement to their rice diet or as a side dish. During periods of food scarcity cassava is used as a substitute for rice by the low-income group. The average per capita daily consumption in Kerala was estimated to be 0.2 kilograms in rural areas and 0.1 kilograms in urban areas. The nonavailability and high cost of rice has induced consumers, especially in the central and southern parts of Kerala, to use cassava as an ingredient in the diet.

- Demand by those who prefer cassava because it is a sustaining diet enabling them to do hard physical labor is on the decline as the incomes of such laborers have increased.

- The growing demand for cassava from the middle-class, fixed-income group also reached a peak during the early 1970s.

- While the demand for cassava for human consumption is unlikely to rise, there has been limited industrial use of cassava in Kerala. Restrictions imposed during the sixties on processing and exporting cassava and its products from Kerala have induced the growth of cassava-based industries in Tamil Nadu. Attempts to expand the industrial use of cassava in Kerala have not achieved much success. However, this is not so in Tamil Nadu, particularly in the Salem district, where it is primarily an industrial raw material.

ROLE OF CASSAVA IN FOOD SECURITY

As has already been pointed out, in the major cassava-growing areas, cassava is used mainly for human consumption. This dependence on cassava as a supplementary food has a historical origin. In 1901, the population of Travancore-Cochin (which later merged with some other areas to form Kerala) was 3.77 million, with a density of 412 persons per square mile. In 1951 the population had increased to 9.29 million, with a density of 1,015 persons per square mile. The growth in rice availability (both local production and imports) lagged severely behind the growth of the population.

The role of cassava in supplementing the foodgrain deficit has been growing since 1880. At first it was only used by the poorer people to supplement their rice diet during periods of scarcity, but gradually it became a subsidiary food even in normal years. In areas without rice cultivation, it became the staple diet for the poor. During food scarcity periods, it played a major role in averting famines. It has been pointed out that, while more than 1.5 million people died of starvation in 1943 in Bengal, which normally has abundant supplies of rice, people were maintained in normal comfort in Travancore-Cochin, where not even half of the rice requirements are locally produced.

The availability of most food items in Kerala is at a minimum during July and August, and these months are the worst period for the poor. Since cassava can be planted at different periods and since there is some flexibility in the harvesting period (even to the extent of harvesting before the tuber is fully mature), many poor households survive on a cassava-dominated diet during these months. Though the harvesting of the principal crop at maturity is scheduled only in February, there is a minor crop season in which the harvesting period coincides with the scarcity period of July-August.

The extent of dependence on cassava in the food balance sheet of Kerala can be visualized from Table 4.

Table 4--Per capita availability of food in Kerala

Food	1982	1983	1984
		(grams/day)	
Rice produced in the state	127	122	121
Rice from outside the state	124	135	136
Total rice	251	257	257
Wheat from outside the state	7	2	1
Total foodgrains	258	259	258
Rice equivalent of cassava within the state	134	135	143

Source: Kerala, State Planning Board, Economic Review (Trivandrum: State Planning Board, 1984).

OBJECTIVES OF THE STUDY

The main objective of the study is to analyze the production and utilization patterns of cassava in India in order to make an assessment of its future potential. In particular, the following objectives were kept in mind. First, to analyze past trends in area, yield, and production as well as in domestic utilization of cassava for various purposes. Second, to give a general indication of the supply and demand prospects of cassava in 1990 and 2000, and lastly to suggest appropriate policies for realizing the full potential of cassava production, utilization, and trade in India.

DATA BASE

Data on area, yield, and production of cassava are obtained regularly through the land utilization surveys and crop-cutting surveys conducted by the concerned government departments.[12] Prior to the introduction of these measures in the 1960s, the state revenue department was responsible for data collection. Since cassava was not an important crop from the revenue point of view, the data gathered by the lower revenue staff might have been based on general impressions. In

[12]Crop-cutting experiments on cassava have been conducted on a regular basis since 1964/65.

addition to the available data on area, yield, and production by district, data are also available on the farm harvest prices of cassava. However, there is little information on the existing marketing and utilization patterns of cassava. Though a few studies were initiated in the 1960s and early 1970s to determine the cassava utilization pattern, no systematic attempt was made to maintain continuity, with the result that little information is available on this aspect for the last 15 years. Even on items such as production of cassava starch, the data available from different sources diverge substantially from each other.

2. TRENDS IN AREA, YIELD, AND PRODUCTION

AREA

The area under cassava in India increased rapidly from the mid-1960s to the mid-1970s, when a decline set in. Cassava area was 274,000 hectares in 1960/61, increased to 347,100 hectares by 1967/68, reached a peak of 392,000 hectares by 1975/76, and then declined to 340,700 hectares in 1983/84.

The changes in area under cassava in India were greatly influenced by the changes in area in the major producing state of Kerala, where the 1960/61 area of 242,200 hectares reached a peak of 327,000 hectares in 1975/76 and then declined to 233,000 hectares in 1983/84, which was even below the 1960/61 level (see Figure 1). However because the area in Tamil Nadu was somewhat steady, the all-India area declined at a slower rate.

The changes in area over the years have also affected the relative importance of Kerala and Tamil Nadu in the all-India area under cassava. While Kerala remained dominant over the entire period, its share declined from 88.4 percent in 1960/61 to 76.5 percent in 1983/84. However, the share of Tamil Nadu in the all-India cassava area increased from 9.0 percent in 1960/61 to 15.6 percent in 1983/84 (Table 5).

The all-India annual growth rate of area under cassava between 1960/61 and 1983/84 was 1.32 percent (Table 6). Most of the increases in area occurred during the 1960s when the annual growth rate was 4.08 percent. While the growth rate was still positive (0.25 percent) during the 1970s, because of the fall in area in the late 1970s and the 1980s, the growth rate for the period 1970/71 to 1983/84 was negative (-1.20 percent). The growth rate in Kerala was highly positive in the 1960s but negative for both periods starting in 1970/71. The overall growth rate of area for Kerala for 1960/61 to 1983/84 was only 0.68 percent. The growth rates of area for all periods remained positive in Tamil Nadu, though the rate of growth in recent years does not match the rate of growth of the earlier period.

YIELD

The all-India yield of cassava increased from 7.2 tons per hectare in 1960/61 to 19.0 tons per hectare in 1983/84. There was a sudden increase (which may be partly due to the change in estimation procedures) from 7.1 tons in 1962/63 to 11.6 tons in 1963/64. The increase

Figure 1--Area under cassava

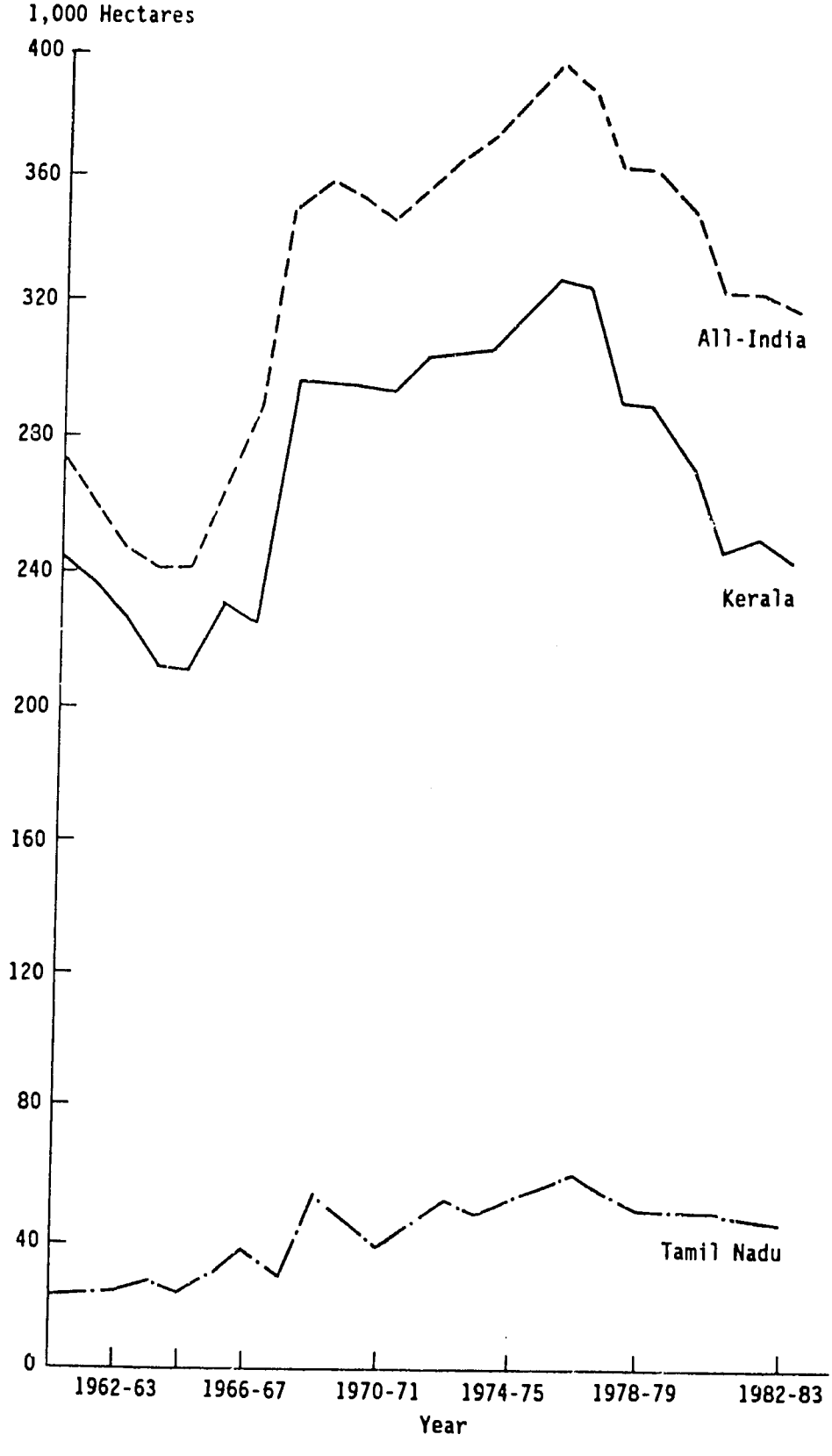


Table 5--Area under cassava in Kerala, Tamil Nadu, and all-India, selected years

Year	Kerala		Tamil Nadu		All-India
	Area	Share of Total	Area	Share of Total	Area
	(1,000 hectares)	(percent)	(1,000 hectares)	(percent)	(1,000 hectares)
1960/61	242.2	88.4	24.6	9.0	274.0
1967/68	297.6	85.8	29.5	8.5	347.1
1970/71	293.6	85.1	38.6	11.2	345.2
1975/76	326.9	83.4	50.1	12.8	392.0
1983/84	233.0	76.5	48.1	15.8	304.7

Source: Compiled from various issues of Agricultural Situation in India.

Table 6--Growth rates of area under cassava, Kerala, Tamil Nadu, and all-India, selected periods

Period	Kerala	Tamil Nadu	All-India
		(percent)	
1960/61-1969/70	3.12	9.38	4.08
1970/71-1979/80	-0.61	3.50	0.25
1970/71-1983/84	-2.27	1.30	-1.20
1960/61-1983/84	0.68	2.93	1.32

Source: Calculations made by the author.

Note: These growth rates were obtained from a semi-logarithmic regression equation of the form $\log A_t = a + b_t + e_t$.

was then more or less gradual until it reached another peak of 17.5 tons per hectare in 1972/73.

The all-India yields reflect two distinct phases in Kerala and Tamil Nadu. In the first phase, lasting until 1974/75, yields in Tamil Nadu remained more or less stagnant around 10 tons per hectare, and during most of these years, Kerala had much higher yields. However, in the second phase, starting in 1975/76, yields in Tamil Nadu showed a substantial increase, and the tempo was maintained till the end of that decade. At the same time, yields in Kerala were either stagnant or declining. The direction of change in yields can be observed in Figure 2.

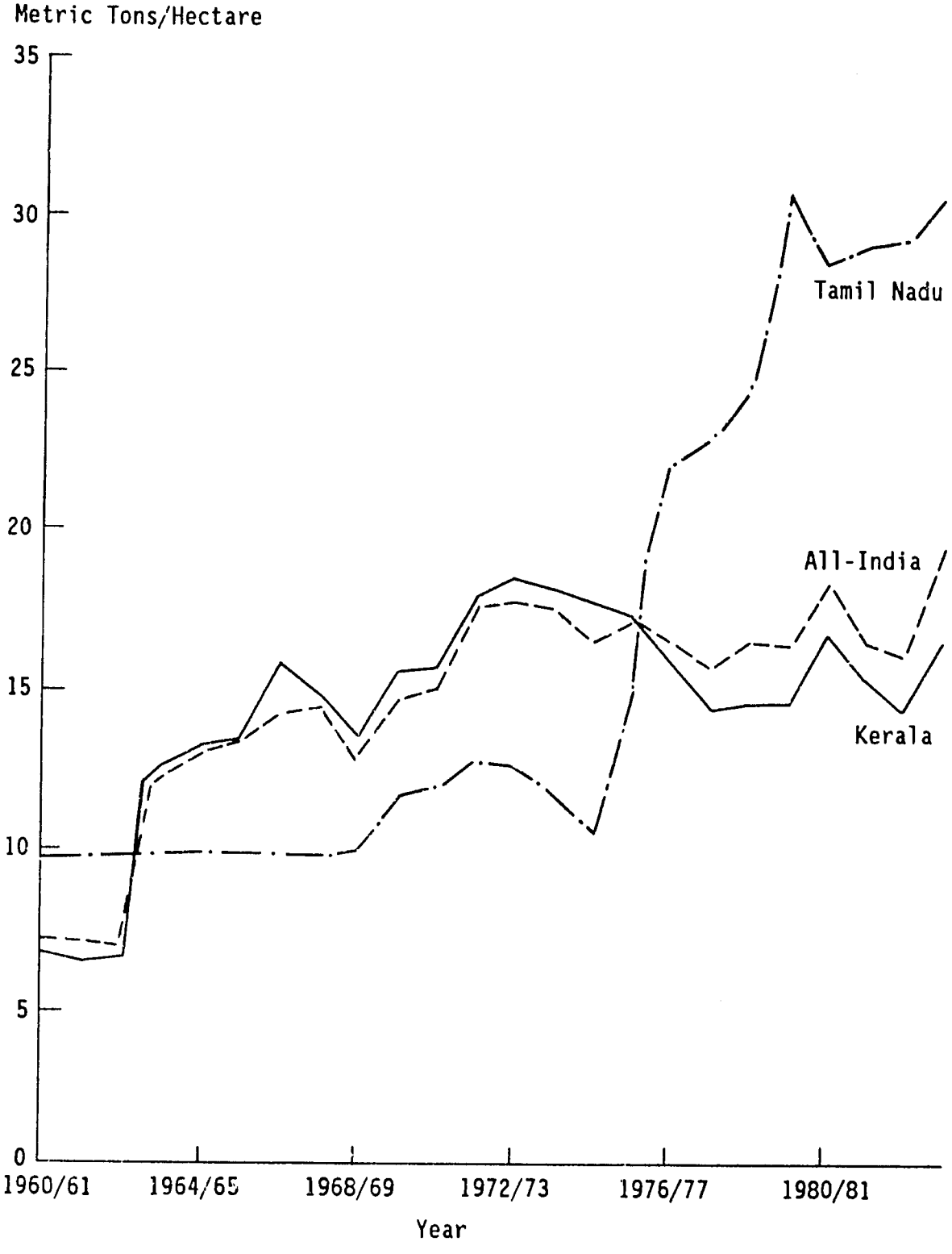
The increased yields of Tamil Nadu after the mid-1970s had kept all-India average yields above the yields in Kerala. In 1983/84, the Tamil Nadu yield of more than 31 tons per hectare was substantially higher than the yields in Kerala (16.8 tons per hectare). The actual yields for a few years are available in Table 7.

Table 7--Yield and growth rates of cassava, Kerala, Tamil Nadu, and all-India, selected years

Year/Period	Kerala	Tamil Nadu	All-India
		(kilograms/hectare)	
Yield			
1960/61	6,949	9,638	7,186
1963/64	12,023	9,604	11,556
1970/71	15,726	12,088	14,860
1974/75	17,695	10,719	16,321
1975/76	16,489	22,272	16,934
1983/84	16,752	31,193	19,035
		(percent/year)	
Growth rates			
1960/61-1969-70	10.50	2.17	8.61
1970/71-1979/80	-2.31	11.79	0.15
1970/71-1983/84	-1.01	8.64	0.47
1960/61-1983/84	2.88	7.20	3.36

Sources: Data from various issues of Agricultural Situation in India and Kerala, Department of Economics and Statistics, Statistics for Planning. The growth rates were derived by the author.

Figure 2--Yield of cassava



The all-India annual growth rate of yield from 1960/61 to 1983/84 was 3.36 percent, most of which can be attributed to growth during 1960/61 to 1969/70. While the growth rate for 1960/61 to 1969/70 was 8.61 percent, it was only 0.15 percent during 1970/71 to 1979/80, and slightly higher, 0.47 percent, during 1970/71 to 1983/84. Most of the yield increase during 1960/61 to 1969/70 was accounted for by the high growth rate of yield in Kerala. For the period beginning 1970/71 the growth rate of yield in Kerala was negative but the high positive growth rate in Tamil Nadu kept the all-India growth rates positive (see Table 7).

PRODUCTION

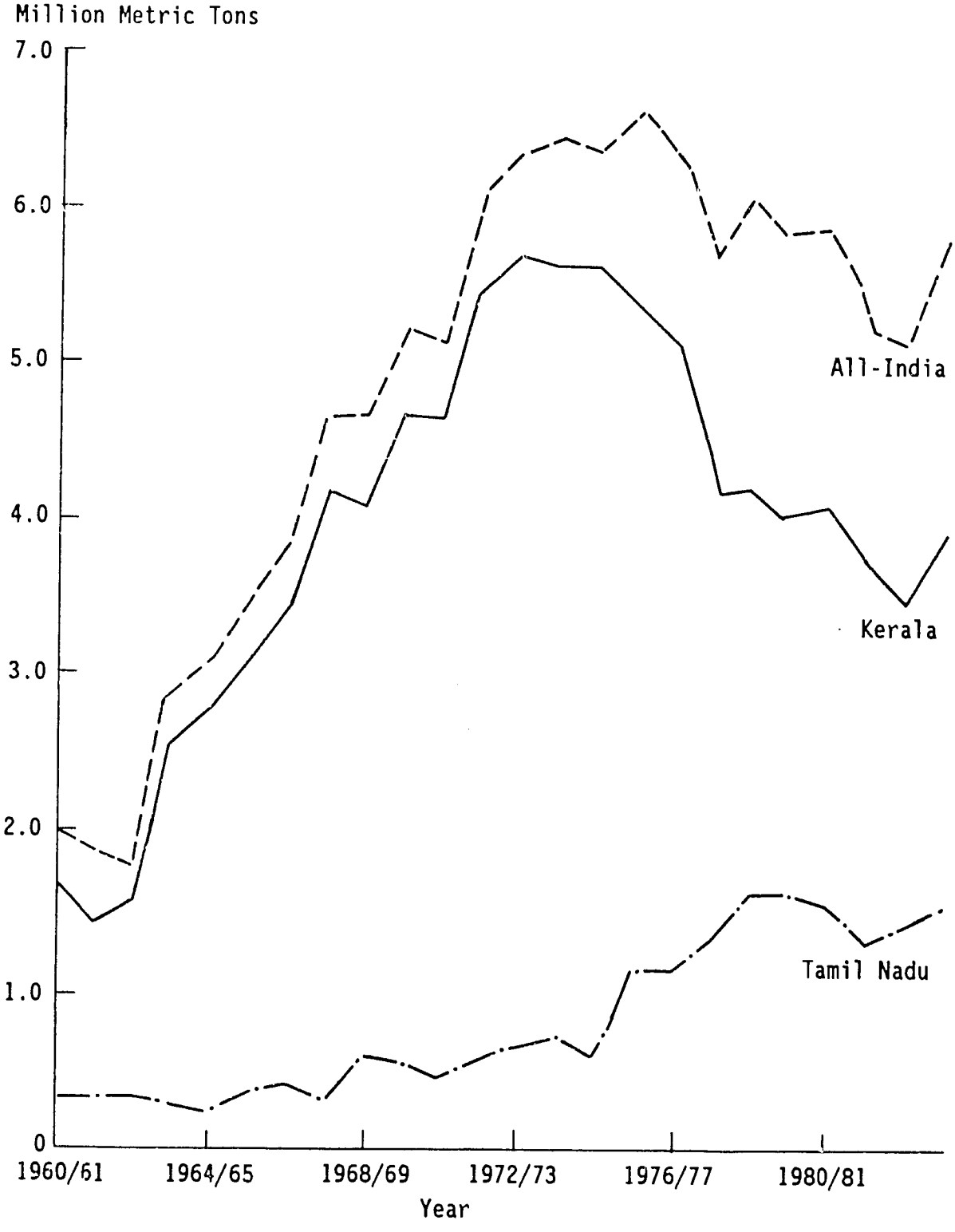
The changes in area and yield mentioned earlier had resulted in an increase of cassava production from nearly 2.0 million tons in 1960/61 to 5.8 million tons in 1983/84. The production increase was rapid from 1960/61 and 1969/70 (from 2.0 million tons to 5.2 million tons), and then there was a somewhat gradual increase until 1975/76, when production reached an all-time record of 6.6 million tons. After 1975/76, there were some annual fluctuations in production, but the 1975/76 level was never achieved.

During the 1960s, all-India production of cassava was closely linked with production in Kerala. Production of cassava in Kerala was 1.7 million tons in 1960/61, increased to 5.7 million tons in 1972/73, and then declined to 3.9 million tons by 1983/84. However, there was a steady increase in production in Tamil Nadu, where cassava production increased from 0.2 million tons in 1960/61 to 1.5 million tons in 1983/84. The trends in the growth of cassava production in India and in the major producing states are shown in Figure 3.

The changes in production levels also affected the relative shares in the producing states. During 1960/61, Kerala accounted for 86.8 percent of the cassava production in India and Tamil Nadu accounted for 12.0 percent. By 1983/84 Kerala's share had declined to 67.3 percent and Tamil Nadu's share had gone up to 25.9 percent. As indicated earlier, the changes in area and yield in these states were important in shifting the production pattern. The levels of production and the share of Kerala and Tamil Nadu in the total production for a few years are available from Table 8.

The all-India growth rate of production of cassava from 1960/61 to 1983/84 was 4.68 percent. Most of the increase in production occurred during the 1960s when the annual growth rate was as high as 12.69 percent. The growth rates during the 1960s were consistently high in both Tamil Nadu and Kerala. However after 1970/71, the growth rate of production in Kerala was negative. In spite of the negative growth rate of production in Kerala during 1970/71 to 1979/80, the high growth rate of about 15 percent in Tamil Nadu during this period enabled the all-India growth rate of production to have a small positive value.

Figure 3--Production of cassava



However, during the period 1970/71 to 1983/84 the positive growth rate in Tamil Nadu was not sufficient to offset the negative growth rate of Kerala, with the result that the all-India rate of growth of production turned out to be negative (Table 9).

Table 8--Production of cassava, Kerala, Tamil Nadu, and all-India, selected years

Year	Kerala		Tamil Nadu		All-India
	Production	Percent	Production	Percent	Production
	(1,000 metric tons)		(1,000 metric tons)		(1,000 metric tons)
1960/61	1,683.0	85.5	237.1	12.0	1,969.0
1970/71	4,617.2	90.0	466.6	9.1	5,129.6
1975/76	5,390.2	81.2	1,115.8	16.8	6,638.3
1980/81	4,097.8	69.8	1,539.3	26.2	5,868.1
1983/84	3,903.2	67.3	1,500.4	25.9	5,800.2

Sources: Various issues of Agricultural Situation in India and Kerala, Department of Economics and Statistics, Statistics for Planning.

Table 9--Growth rates of production of cassava, Kerala, Tamil Nadu, and all-India, selected periods

Period	Kerala	Tamil Nadu	All-India
		(percent)	
1960/61-1969/70	13.62	11.55	12.59
1970/71-1979/80	-2.92	15.29	0.40
1970/71-1983/84	-3.28	9.94	-0.73
1960/61-1983/84	3.56	10.13	4.68

Source: Derived by the author.

The trends show that the mid-1970s represented a turning point in cassava area, yield, and production in Kerala. As indicated earlier, the role of cassava as a cereal substitute was highlighted during the period prior to 1974/75, but this aspect was not given adequate emphasis on the subsequent period. This has a bearing on the availability of rice from within the state and imports from outside. Though cassava is not a major competitor for rice in terms of area allocation, the competition on the demand side is reflected in the allocation of other resources for cassava production. For example, about three-fourths of the gross irrigated area in Kerala was accounted for by rice, about 40 percent of the rice area was covered by high-yielding varieties (HYVs), and a major portion of the fertilizer used in Kerala was accounted for by rice.[13] In contrast, less than 3 percent of cassava area was irrigated, leaving 97 percent to be grown on rainfed area.[14] Though HYVs of cassava have been introduced by the Central Tuber Crops Research Institute since 1963, there has not been much effort to spread them.[15] An evaluation study by the State Planning Board had indicated that 64.5 percent of rice was treated with fertilizers, while the corresponding percentage for cassava was only 15.1.[16]

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[13]India, Department of Statistics, National Sample Survey Organization, Fertilizer Use in Agricultural Holdings, South Zone Rural Sector, 26th Round (July 1971 - September 1972) (New Delhi: Controller of Publications, March 1976).

[14]India, Ministry of Agriculture and Rural Reconstruction, All-India Agricultural Census, 1976-77 (New Delhi: Controller of Publications, 1981).

[15]K. N. Ninan, Cereal Substitutes in a Developing Economy (New Delhi: Concept Publishing Company, 1986).

[16]Kerala State Planning Board, Extent of Adoption of Improved Agricultural Practices, An Evaluation Study (Kerala: State Planning Board, n.d.).

3. CASSAVA UTILIZATION AND PRICES

There is no systematic procedure for obtaining data on domestic utilization of cassava for different uses, and therefore it is not possible to obtain reliable time series data on cassava utilization in India.[17] Though the Food and Agricultural Organization of the United Nations (FAO) has brought out such time series data, they are based on some unrealistic assumptions. The FAO data for 1961 to 1983 indicate that for the whole period 5 percent of the production is waste and 95 percent is processed. Of the quantities processed during this period, 96 percent was converted to flour, 1 percent was converted to tapioca, and 3 percent was dried. Since data based on the assumption of constant proportionality over the years in deriving the domestic utilization pattern indicate only production changes, they are not reported here. Instead, whatever fragmentary evidence is available from various sources is brought together to give some idea of the domestic utilization pattern.

FOOD

The role of cassava in supplementing foodgrain production in Kerala began more than a century ago. While rice imports were also possible in the early periods following cassava's introduction, there was an increased dependence on cassava when rice imports were cut off during World War II. The importance of cassava in the Travancore-Cochin portion of Kerala is evident from the fact that during 1950, the total supply of rice and wheat available for a population of 9.3 million persons was only about 560,000 tons (of which only 270,000 tons were produced within the state), while the total supply of dried cassava came to about 750,000 tons.[18]

In the early period, cassava was used only by the poorer segments of the population to supplement their rice diet during times of scarcity. Subsequently it became an important subsidiary food even in normal years. In areas where little rice is grown it became a substitute for rice, providing the staple diet of the low-income consumers.

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[17]Though cassava leaves can be used to feed cattle, this possibility is left out of the current discussion, which concentrates on the use of cassava roots.

[18]Travancore-Cochin, Final Report of the Tapioca Enquiry Committee (Trivandrum: Travancore-Cochin, 1952), p. 33.

The social stigma attached to cassava consumption was removed when the middle-class population with fixed incomes started consuming cassava during periods of high inflation.

A family budget survey of laborers in 1950 indicated that all persons in Travancore-Cochin used cassava to supplement their rice diet.[19] During periods of food scarcity, cassava was used as a substitute for rice by the lowest-income groups. An average labor household had a per capita daily consumption of a pound of raw cassava (or half a pound of dried cassava). The per capita consumption was higher in some groups, especially among those engaged in hard physical labor. The conclusions of the survey included the following:

- The fairly large consumption of cassava in Travancore-Cochin has been mainly due to nonavailability (and high prices) of rice.
- The demand from those who prefer cassava because it forms a sustaining diet to do hard physical labor is on the decline.
- The growing demand for cassava from middle-class families with fixed income has reached its maximum.
- Considering all these aspects, it is possible to conclude that there cannot be any further expansion of the demand for cassava as food.

Another consumer survey was conducted in 1971 by the subcommittee of the Tapioca Market Expansion Board in Kerala.[20] This survey, with coverage throughout the state, indicated that nearly all households used cassava either to supplement their rice diet or as a side dish. The average per capita daily consumption of cassava in Kerala was estimated to be 0.2 kilogram in rural areas and 0.1 kilogram in urban areas. Thus an average rural family of five members consumed 1 kilogram of cassava daily, and an urban family consumed half this quantity. The conclusions of the survey were similar to those obtained from the earlier survey. The per capita daily consumption in the different districts is shown in Table 10.

The 32nd round of the National Sample Survey (NSS) (1977/78) indicated that the average cassava consumption per person for 30 days was 5.55 kilograms in rural areas and 2.59 kilograms in urban areas (Table 11). This is consistent with the results from the 1971 survey.

The NSS data from the 17th round (1961/62) and 28th round (1973/74) based on consumer expenditure surveys indicate that over this

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[19]Ibid., p. 37.

[20]Kerala, Department of Food, Report of the Subcommittee of the Tapioca Market Expansion Board.

Table 10--Per capita daily consumption of cassava in Kerala, by district, 1971

District	Raw Cassava		Processed Cassava	
	Rural	Urban	Rural	Urban
	(kilograms/day)			
Trivandrum	0.23	0.17	...	...
Quilon	0.33	0.26	0.07	...
Alleppey	0.30	0.21	0.03	...
Kottayam	0.07	0.07	...	0.06
Ernakulam	0.09	0.10	0.05	0.02
Trichur	0.10	0.04	...	...
Palghat	0.03	...	...	...
Malappuram	0.11	...	...	...
Calicut	0.15	0.15	..	...
Cannanore	0.15	0.04	0.14	...

Source: Kerala, Department of Food, Report of the Subcommittee of the Tapioca Market Expansion Board (Trivandrum: Department of Food, 1972).

Note: The ellipses (...) indicate a nil or negligible amount.

Table 11--Monthly per capita consumption of cassava in Kerala, 1977/78

Expenditure Group	Rural	Urban
(Rs)	(kilograms)	
0 - 10	1.24	0.06
10 - 15	3.45	1.87
15 - 20	3.18	1.91
20 - 30	4.16	2.48
30 - 35	4.53	3.07
35 - 40	5.01	3.33
40 - 50	5.76	2.46
50 - 60	6.17	2.98
60 - 70	5.75	3.72
70 - 80	5.82	2.67
80 - 100	7.06	2.55
100 - 150	5.60	2.30
150 - 200	4.74	1.84
200 - 300		1.29
More than 300	5.24	1.22
All groups	5.55	2.59

Source: India, Department of Statistics, National Sample Survey Organization, The National Sample Survey, Thirty-second Round, 1977-78 (New Delhi: Controller of Publications, 1985.

period rice consumption in Kerala declined, but cassava consumption increased. The daily per capita consumption of rice was 1,136 calories in 1961/62, and it declined to 840 calories in 1973/74. During the same period the consumption of cassava increased from 182 to 278 calories per day. These estimates were somewhat consistent with estimates for rice from food balance sheets, but they turned out to be underestimates for cassava.[21] The per capita consumption of rice did not indicate much variation between urban and rural areas, but there had been large variations in cassava consumption. For example, the 28th round of NSS indicated that per capita consumption of rice was 845 calories in rural areas and 840 calories in urban areas; for cassava it was 366 calories in rural areas and 190 calories in urban areas. In the two lower expenditure groups of the rural areas, calories from cassava exceeded calories from rice (Table 12).

A food habits survey conducted by the Operations Research Group (ORG) during the early 1970s indicated that the average daily consumption of tubers and roots (mostly cassava) by adults, school children, and preschool children were 175.3 grams, 120.8 grams, and 30.9 grams, respectively. The distribution according to sex and urbanization is shown in Table 13.

The ORG study also showed the calories consumed from rice and cassava according to income groups. While the calories from rice increased with income, calories from cassava declined. A study by the International Food Policy Research Institute (IFPRI) shows the same trend of increased calories from rice and reductions in calories from cassava with increased income (Table 14).

A few studies, especially in the 1950s and early 1970s, attempted to estimate the utilization of cassava production for various purposes. The findings from these studies are summarized in Table 15. Whereas in Kerala about 70 percent of the total production is used for human food, in Tamil Nadu about 25 percent of the production is used for direct consumption.[22]

The utilization pattern indicated in Table 15 indicates that about 3 million tons of cassava were used for human consumption in 1981.

The expenditure elasticity for cassava in Kerala was obtained from three rounds of NSS data (see Table 16). The estimates from the 1970/71 survey give an expenditure elasticity of 0.289 for rural areas and -0.156 for urban areas. The expenditure elasticities from the

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[21]Estimates from the Centre for Development Studies, based on food balance sheets, indicate that the average per capita availability of calories from 1961/62 to 1970/71 was 920 calories from rice and 628 calories from cassava.

[22]Ghosh, "Trends in Disposition of Cassava."

Table 12--Monthly calorie consumption per person of cassava and rice, Kerala, 1961/62 and 1973/74

Monthly Per Capita Expenditure Groups	September 1961 - July 1962				October 1973 - June 1974			
	Rural		Urban		Rural		Urban	
	Rice	Cassava	Rice	Cassava	Rice	Cassava	Rice	Cassava
(Rs/month)	(1,000 calories)							
0 - 13	21.0	8.0	18.9	2.0	6.8	7.9	No sample	
13 - 15	45.3	3.8	31.6	1.0	6.1	13.1	12.5	0.3
15 - 18	32.1	11.9	31.8	0.6	11.8	7.3	5.8	19.6
18 - 21	41.3	5.9	37.4	6.1	11.0	11.9	10.2	5.1
21 - 24	33.0	11.1	35.8	2.4	15.0	10.1	14.6	4.8
24 - 28	43.6	6.2	45.7	1.1	17.2	8.1	14.1	8.8
28 - 34	42.5	7.9	42.1	2.5	17.5	11.8	19.4	4.8
34 - 43	60.9	14.2	39.0	1.1	20.9	10.2	19.3	6.4
43 - 55	43.9	3.3	49.7	1.1	25.1	12.2	27.0	6.3
55 - 75	38.7	0.2	46.3	5.1	29.2	11.3	25.3	7.4
More than 75	45.0	5.2	36.0	2.1	40.7	11.3	33.1	4.1
All groups	34.0	8.1	34.2	2.2	25.4	11.0	25.0	5.7

Sources: India, Cabinet Secretariat, The National Sample Survey: Integrated Household Survey (Schedule 27), Tables with Notes on Expenditures, Seventeenth Round, September 1961 to July 1962, No. 184, (New Delhi: Controller of Publications, 1974) India, Department of Statistics, National Sample Survey Organization, The National Sample Survey: Tables on Consumer Expenditure, Twenty-eighth Round, October 1973 to June 1974, No. 240, (New Delhi: Controller of Publications, 1977).

Table 13--Per capita consumption of roots and tubers, 1971

Group	Male	Female	Rural	Urban	Total
			(grams/day)		
Adults	222.9	133.9	n.a.	n.a.	175.3
School children	117.5	122.9	126.9	87.7	120.8
Preschool children	31.0	30.8	32.4	24.3	30.9

Source: Protein Foods Association of India, Operations Research Group, Food Habits Survey (Baroda: Protein Foods Association of India, 1972).

Note: Where n.a. appears, data were not available.

Table 14--Consumption of rice and cassava, by income group

Study/ Income Group	Rice	Cassava
	(calories/capita/day)	
ORG study		
Annual per capita income		
Less than Rs 100	810	291
Rs 101-200	1,031	265
Rs 201-500	1,068	180
More than Rs 500	1,213	139
IFPRI study		
Monthly per capita income		
Less than Rs 15	396	1,013
Rs 15-24	616	898
Rs 25-34	750	819
Rs 35-49	777	817
Rs 50-75	839	729
More than Rs 75	970	213

Source: Protein Foods Association of India, Operations Research Group, Food Habits Survey (Baroda: Protein Foods Association of India, 1973); Shubh K. Kumar, Impact of Subsidized Rice on Food Consumption and Nutrition in Kerala, Research Report 5 (Washington, D.C.: International Food Policy Research Institute, 1979).

Table 15--Utilization of cassava, Travancore-Cochin, Tamil Nadu, and Kerala, selected years

Period	Region	Retained by Producers for Domestic Consumption	Consumed Raw for Household Purposes	Converted into Chips	Industrial Purposes
			(percent)		
1950/51-1952/53	Travancore-Cochin	31.5	40.9	27.2	0.4
1950/51	Tamil Nadu	12.7	46.0	15.2	26.1
1952/53	Tamil Nadu	19.6	43.1	8.6	28.7
1960/61	Tamil Nadu	8.3	42.3	n.a.	49.4
1971	Kerala	60[a]	...	n.a.	40
1981	Kerala	70[a]	...	n.a.	30
1981	Tamil Nadu	25[a]	...	n.a.	75

Source: India, Ministry of Food and Agriculture, Directorate of Marketing and Inspection, Report of the Marketing of Tapioca in India, Marketing Series 88 (New Delhi: Ministry of Food and Agriculture, 1955), p. 10.

Note: Where n.a. appears, the data were not available.

[a] This is the sum of both the cassava retained by producers for domestic consumption and the cassava consumed raw for household purposes.

Table 16--Expenditure elasticities for different expenditure groups in Kerala, 1970/71, 1977/78, and 1983

Expenditure Group	1970/71		1977/78		1983	
	Rural	Urban	Rural	Urban	Rural	Urban
1	2.519	2.673	2.304	5.725	2.347	3.249
2	1.693	1.752	1.058	2.787	1.601	2.156
3	1.275	1.427	0.770	1.789	1.210	1.477
4	1.039	0.958	0.522	0.956	0.953	1.074
5	0.833	0.745	0.402	0.511	0.789	0.786
6	0.671	0.462	0.342	0.327	0.629	0.536
7	0.546	0.254	0.279	0.119	0.498	0.310
8	0.437	0.095	0.220	-0.076	0.377	0.115
9	0.323	-0.072	0.177	-0.219	0.269	-0.064
10	0.209	-0.251	0.149	-0.318	0.175	-0.216
11	0.101	-0.407	0.118	-0.423	0.092	-0.358
12	0.007	-0.542	0.075	-0.568	0.036	-0.447
13	-0.124	-0.765	0.039	-0.682	-0.080	-0.628
14	...	...	-0.001	-0.766	...	...
15	...	...	...	-0.853	...	...
Average	0.289	-0.156	0.145	-0.457	0.253	-0.086

Sources: India, Department of Statistics, National Sample Survey Organization, The National Sample Survey, Twenty-fifth Round, 1970-71 (New Delhi: Controller of Publications, 1976); India, Department of Statistics, National Sample Survey Organization, The National Sample Survey, Thirty-second Round, 1977-78 (New Delhi: Controller of Publications, 1985); India, Department of Statistics, National Sample Survey Organization, The National Sample Survey, Thirty-eighth Round, 1983 (New Delhi: Controller of Publications, 1986).

Note: The 1st expenditure group has the lowest expenditures; the 15th group has the highest.

1977/78 survey are 0.145 for rural areas and -0.457 for urban areas, and the estimates from the 1983 survey are 0.253 for rural areas and -0.086 for urban areas. When the expenditure elasticities for different expenditure groups were estimated, the following tendencies emerged.[23] First, the elasticities for the bottom expenditure groups were greater than one. They declined with increases in expenditures and turned out to be negative beyond certain expenditure levels. The rate of decline in urban areas was faster than in rural areas. Second, in the lower expenditure groups, the expenditure elasticities for urban areas exceeded those for rural areas. However, this relationship was reversed in the higher expenditure groups. Lastly, there was a general decline in the elasticities from 1970/71 to 1977/78, but from 1977/78 to 1983 there was an increase in the values (see Table 16).

INDUSTRIAL USE

Cassava is a raw material for a number of processed products such as starch, sago, glucose, and dextrine. However, because diversion of cassava for industries adversely affected the food position in Kerala, the state government imposed a number of constraints on its industrial use. In 1942, the state government imposed a ban on export of cassava in any form from the state without a valid permit. In 1943, there was another order prohibiting the manufacture of starch from cassava. In spite of this order, it is estimated that 18,000 tons of cassava starch was manufactured in 1943. Controls were also introduced on wholesale transactions of cassava, interregional movement within the state, and storage of cassava. With such stringent controls on cassava-based industry in Kerala, Salem in Tamil Nadu has emerged as a major center for the cassava-processing industry.

It is said that a trader from Salem who came to purchase dried cassava from Kerala started making starch in Salem and later switched to sago. Soon a number of sago-making units were started in Salem and a virtual monopoly position was created. Though cassava was smuggled from Kerala in the early period, later on cassava cultivation was introduced in Salem, replacing sugarcane in many areas. Even when restrictions on cassava utilization were removed in Kerala, cassava-producing units were not able to compete effectively with those in Salem.

According to the Government of India's Report on the Marketing of Tapioca, in 1950/51, 27.2 percent of the production in Kerala was con-

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[23]Expenditure elasticities for different expenditure groups were obtained from regression equations of the form

$$\log y = a + \frac{b}{x} + c \log x.$$

verted to chips and 0.5 was converted to starch.[24] However, in Tamil Nadu 15.2 percent was converted into chips, 12.1 percent was processed into sago, and 14.0 percent was processed into flour. Tamil Nadu, which had 40 manufacturing units in 1950 producing 6,000 tons of sago, witnessed a rapid increase in sago production, so that by 1955 there were 109 units producing 22,000 tons. By 1960/61, the total availability of cassava in Tamil Nadu was about 388,000 tons, including 125,000 tons imported from Kerala. About 41 percent of the total available quantity was used for the preparation of sago, 5 percent for starch, and 12 percent for flour. In 1960, Salem district accounted for 150 units producing 40,000 tons of sago and 5,000 tons of starch. By 1985, Salem district had about 699 units. During 1984/85 these units sold 87,700 tons of sago and 36,700 tons of starch valued at Rs 315.4 million.

The available data on starch production indicate a wide range. The Director General of Technical Development's estimate of starch production in India for 1980 and 1981, based on the actual production of 10 major units, was 140,000 and 138,000 tons. These are considerable underestimates, as they exclude a number of units.[25] The Indian Textile Bulletin shows that between 1977 and 1981 maize starch dominated the starch industry approximately in the ratio of 10:1 for maize and cassava. In 1980 and 1981, against maize starch production of about 105,000 tons, cassava starch production was around 10,000 tons. An estimate of Srivastava and Phandis indicates that cassava starch production in 1982 was about 200,000 tons (about double the maize starch production).[26] According to the Salem Sago and Starch Manufacturers' Association, about 175,000 tons of sago and starch were produced in 1980. Since Salem production accounted for about 60 percent of the Indian production, Ghosh estimated that the present production of cassava starch in India should be more than 300,000 tons (including sago). Considering a recovery rate of 23 percent for sago and starch, this would imply that about 1.3 million tons of cassava (about 37 percent of the production in 1982) was used for starch and sago.[27]

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[24]India, Ministry of Food and Agriculture, Directorate of Marketing and Inspection, Report on the Marketing of Tapioca in India, Marketing Series 88 (New Delhi: Ministry of Food and Agriculture, 1955).

[25]Ghosh, "Trends in Disposition of Cassava."

[26]Srivastava and Phandis, "Tapioca Starch: Problems and Potentials."

[27]Ghosh, "Trends in Disposition of Cassava." Starch yield was about 21.4 percent by weight and sago yield was about 25 percent by weight.

The concentration of starch production in Salem district is significant. Production of about 175,000 tons of sago and starch in Salem implies that about 760,000 tons of cassava (or about 80 percent of the total production in Salem district) was used for this purpose. At the same time, in Kerala the 76 units manufacturing cassava starch had produced only 14,400 tons during 1980/81. Other estimates of cassava starch production in Kerala indicate the figures of 54,000 tons and 30,000 tons.[28] These estimates imply that starch production in Kerala accounted for between 1 and 4 percent of the total cassava production in the state.

ANIMAL FEED

Feed manufacturers do not use cassava as a main ingredient in feeds even though technical feasibility has been established. At the same time, it is common practice for cassava growers in Kerala to use dried cassava chips as cattle and poultry feed. It is estimated that about 27 percent of the cassava produced in Travancore-Cochin during 1950/51 to 1952/53 was converted to cassava chips. However, a survey conducted in 1976/77 indicated that only 5 percent of the cassava produced on the farms was processed into chips.[29] The survey further indicates that about 72.7 percent of the cassava output was marketed and the rest retained at home. On average, about 70 percent of cassava retained by the producers was set apart for their own consumption, 17 percent was used as cattle feed, and 13 percent was given to wage labor and farm servants. The distribution of farmers according to size of holdings indicates that farmers with holdings of 2-4 hectares used 36.6 percent of their retentions for feeding livestock. This is probably on account of the awareness of the beneficial effects of giving limited quantities of cassava as feed to livestock.

TRADE

At present there are no imports of cassava to India. Prior to 1950, small quantities of cassava products such as sago and flour were imported to India. Separate data for these are not available. With the ban on imports of cassava products in January 1950, imports have completely stopped.

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[28]J. K. Lynam, A Comparative Analysis of Cassava Production and Utilization in Tropical Asia" in International Centre for Tropical Agriculture, Cassava in Asia: Its Potential and Research Development Needs (Cali: CIAT, 1986), pp. 171-195; Srivastava and Phandis, "Tapioca Starch: Problems and Potentials."

[29]Ninan, Cereal Substitutes in a Developing Economy, p. 215.

Prior to 1952/53, there had been no exports of cassava or cassava products from India. During 1952/53 a small quantity (only about a ton) of cassava flour was exported to New York. Between 1955 and 1965 small quantities of cassava chips from Kerala were exported to West Germany, Holland, and Belgium for conversion to animal feed. In the subsequent period exports were also negligible, accounting for a small portion of the total production. Since 1978/79, exports have been either nonexistent or negligible (Table 17). Belgium, Netherlands, and Federal Republic of Germany were the major countries to which cassava chips were exported.

Table 17--Exports of cassava products from India, 1973/74-1978/79

Year	Sago and Substitutes		Cassava Chips		Starch	
	Quantity	Value	Quantity	Value	Quantity	Value
	(metric tons)	(Rs 1,000)	(metric tons)	(Rs 1,000)	(metric tons)	(Rs 1,000)
1973/74	18.2	39.7	1.7	3.0	37.1	69.9
1974/75	9.3	27.8	0.8	19.3	3.0	8.8
1975/76	11.7	34.4	...	...	100.0	225.9
1976/77	...	...	...	...	...	...
1977/78	...	...	19.2	17.0	...	...
1978/79	...	...	52.8	42.0	...	...

Sources: Government of India, Directorate of Commercial Intelligence and Statistics, Monthly Statistics of the Foreign Trade of India, various issues.

Note: The ellipses indicate a nil or negligible amount.

PRICES

In Kerala during the 1950s about a third of production was sold directly to the consumers and the rest assembled by the village merchants who carry the produce to the nearest market center. Ninan's study indicated that during 1976/77, 36.3 percent of sales went directly to village consumers, 34.3 percent to village traders, and 29.4 percent to the agents.[30] In Tamil Nadu direct sales to consumers are negligible, and the bulk of the produce is assembled by the village merchants. Sometimes a small number of producers sell their standing

[30] Ibid.

crop at a stipulated price to the village merchants who make their own arrangements for harvesting, transport, and marketing. In the Salem district, some village merchants take contracts on the standing crop for sales to sago factories.

In the 1940s, the Travancore-Cochin Government imposed price controls on cassava, and a license system was introduced for wholesale transactions in some areas. Purchase, sale, or storage for sale in wholesale quantities was prohibited except with a license from the government. There were no price controls in Madras (Tamil Nadu) State but restrictions were imposed on movements in the Malabar region, which later became a part of Kerala.

Since data on all-India prices of cassava are not available, it is possible to analyze only the price trends in the major production areas, especially Kerala. The farm price of cassava in Kerala increased from Rs 7.85 per quintal in 1960/61 to Rs 70.02 per quintal in 1983/84 (1 quintal equals 100 kilograms). The increase during 1964/65 and during 1973/74 over the prices of the immediately preceding year were substantial. While the overall tendency for prices to increase was maintained throughout the period, between 1960/61 and 1983/84, there were nine years when farm prices fell from the previous year's prices. In fact, the tendency for a year of high prices to be followed by a year of declining prices was noticed even in the 1950s. The Tapioca Enquiry Committee attributed this to the farmers' behavior. They tended to plant additional land with the crop the year following a high price, and to take the additional land out of cassava cultivation when prices declined in the following year, as the result of increased production.

Actual wholesale prices and retail prices are available for different locations, and an annual index of wholesale and retail prices of cassava is available for the state. The index of wholesale prices for 1982 (with 1961 = 100) stood at 729.

In the absence of state average wholesale and retail prices, it is not possible to obtain an estimate of the marketing margins involved. However, an analysis of wholesale and retail prices in certain regions indicates that the retail prices of fresh cassava were 16 to 60 percent higher than the wholesale prices, though in a majority of cases it was less than 35 percent.

It is also useful to compare the changes in cassava and rice prices. As pointed out earlier, in recent years easy availability of rice in Kerala has resulted in a fall in the demand for cassava for human consumption. The availability of rice is also reflected in the prices. The retail price ratio of rice to cassava was as high as 7.2 in 1966/67, but it had gradually declined except for a period during the mid-1970s. It may also be recalled that the mid-1970s saw a peak of cassava production and a high price of rice.

The retail price of cassava and the ratio between the rice and cassava retail prices in the Kottayam district are provided in Table 18 to indicate the nature of changes.

Table 18--Wholesale and retail prices of cassava and the ratio of retail prices of rice and cassava in Kottayam district, 1961-83

Year	Wholesale Price of Cassava	Retail Price of Cassava	Ratio of Retail Rice Price to Retail Cassava Price
		(Rs/kilogram)	
1961	0.08	0.14	4.4
1962	0.10	0.16	4.4
1963	0.10	0.15	4.4
1964	0.15	0.18	5.3
1965	0.21	0.27	5.1
1966	0.18	0.26	6.5
1967	0.25	0.30	7.2
1968	0.27	0.34	5.9
1969	0.24	0.31	5.4
1970	0.28	0.34	4.6
1971	0.25	0.35	4.4
1972	0.29	0.35	5.1
1973	0.39	0.45	6.8
1974	0.48	0.56	6.2
1975	0.51	0.59	5.3
1976	0.43	0.57	4.4
1977	0.33	0.50	4.5
1978	0.41	0.55	3.8
1979	0.44	0.63	3.6
1980	0.46	0.66	3.6
1981	0.55	0.75	4.2
1982	0.66	0.89	3.8
1983	0.73	1.01	3.2

Source: Kerala, Department of Economics and Statistics, Statistics for Planning, various issues.

4. TRENDS IN LIVESTOCK PRODUCTS AND FEED AND PROJECTIONS TO 1990 AND 2000

Data on milk, meat, and eggs are available from different sources, but there appears to be some question about their reliability. Commenting on the data on milk production in 1985, the Jha Committee observed that "inadequacy and unreliability of the available statistics have come in the way of our making as precise an assessment of the progress in milk production enhancement as we would have liked to make."[31] The data on meat and egg production would also invite similar comments. However, to give a rough idea of the trend in the production pattern, the available information is used.

MILK PRODUCTION

Estimates of milk production available from the national Ministry of Agriculture indicate that production of milk in 1984/85 was 38 million tons. The target for milk production in 1990 is 52 million tons and for 2000 the target is 65 million tons. The estimates for different years are reproduced below.

Year	Production (million metric tons)
1971/72	22.5
1980/81	31.5
1981/82	32.9
1982/83	34.6
1983/84	36.3
1984/85	38.0
1989/90 (projected)	52.0
2000	65.0

It is generally believed that enhancement activities during the last 10 years have accelerated the growth rate of milk production and it is expected that the recent trend will continue. A study on milk production in India during the last 20 years indicates that the annual

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[31]This committee, named for its chairman, L. K. Jha, was appointed to evaluate Operation Flood, a large-scale program aimed at increasing milk production (India, Ministry of Agriculture, Report of the Evaluation Committee on Operation Flood II [New Delhi: Ministry of Agriculture, 1985], p. 35).

compound growth rate for 1964-83 was 2.6 percent but that it was at the much higher rate of 4.1 percent during 1974-83.[32] When those two growth rates were used, the projected production estimates for 2000 were 50.48 million tons and 69.03 million tons. Projected milk production for 1990 and 2000 is given below:

Rate	Projected Milk Production	
	1990	2000
	(million metric tons)	
1964-83 rate	38.69	50.48
1974-83 rate	45.67	69.03

According to government estimates of milk production, the 1990 projected production based on the 20-year growth rate has already been achieved. At the same time,the 1990 production based on the 10-year growth rate (45.67 million tons) is less than the seventh plan projection of 52 million tons. Assuming that the trend in milk production during 1974-83 is likely to be maintained,it is possible to expect 1990 production to be around 45 million tons.

The government projection of 65 million tons for 2000 is below the projections obtained from the 10-year growth rate (69 million tons). Assuming that the tempo during the last 10 years might decline, it is possible to estimate that milk production in 2000 will be between 60 and 65 million tons.

These estimates are consistent with the supply projections obtained by the National Commission on Agriculture (NCA) whose estimates of milk production for 1985 and 2000 were 44.2 million and 64.4 million tons, respectively.[33]

The NCA also obtained two estimates of demand for milk:

Year	Estimated Demand		Supply
	Low	High	
	(million metric tons)		
1985	33.4	44.2	44.2
2000	49.4	64.4	64.4

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[32]Singh et al., "An Economic Analysis of Inter-state Disparities in Milk Production and Institutional Facilities in India," Agricultural Situation in India, January 1986.

[33]India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture, vol. 3 (New Delhi: Controller of Publications, 1976).

The high estimate of demand is consistent with the supply projections and any shortfall in this demand might lead to excess production.

MEAT AND EGGS

Estimates of meat production, by type of meat, were also made by the NCA. They are given in Table 19. Aggregate consumer demand for meat was expected to range between 1.1 and 1.4 million tons in 1985 and between 1.6 and 2.1 million tons in 2000 (Table 20).

Table 19--Meat production, India, 1971, 1985, and 2000

Type of Meat	1971	1985	2000
Mutton and goat	0.37	0.60	1.11
Pork and pork products	0.05	0.09	0.17
Buffalo meat and beef	0.18	0.35	0.52
Poultry meat	0.09	0.15	0.30
Total	0.69	1.19	2.10

Source: India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture (New Delhi: Controller of Publications, 1976).

Table 20--Supply-demand balance of meat and eggs, 1971, 1985, and 2000

Product/ Year	Supply	Demand	
		Low	High
	(million metric tons)		
Meat			
1971	0.69	n.a.	n.a.
1985	1.19	1.05	1.40
2000	2.10	1.57	2.11
	(million eggs)		
Eggs			
1971	6,040	n.a.	n.a.
1985	15,775	10,217	15,292
2000	27,882	17,419	28,513

Source: India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture (New Delhi: Controller of Publications, 1976).

Note: n.a. indicates that data were not available.

The NCA estimates that in 1985 production of eggs from 177.5 million layers was 15,775 million and production in 2000 was estimated to be 27,882 million from 179.4 million layers. The demand estimates for eggs indicates that the supply was slightly below the high estimate of demand (Table 20).

STRUCTURAL CHANGES

It is anticipated that the structure of dairying in India might undergo some change by 2000. According to the Chairman of the National Dairy Development Board, the estimated production of 65 million tons of milk in 2000 can be achieved by looking after dairy animals better and by putting to practical use certain scientific and technological innovations in feeding, breeding, and disease control of the milch stock. Dairying shall continue to be a subsidiary or side occupation of most farms and a major source of income for the landless. The competition between man and animal for land will dictate ever-increasing use of crop residues for cows and buffalo. By 2000 the number of primary societies are expected to be about 100,000, as against 28,000 during the mid-1980s.[34]

Improved fowl are expected to produce the bulk of the eggs. The distribution of total egg production in 2000 among improved fowl, local (*desi*) fowl, and ducks is expected to be as follows:

Source of Eggs	Number	Eggs
	(million)	
Improved fowl	136.4	24,552
Local (*desi*) fowl	35.0	2,450
Duck	8.0	880

CEREAL AND OTHER FEEDS

There exists no systematic procedure for estimating changes in feed availability over time. Most of the existing data on feed availability are indirect estimates based on area under fodder crops and

[34]Primary societies are organized at the village level with milk producers as members. These societies organize the supply of inputs for milk production and the collection of milk.

forest, food crop yields, and production of residues and by-products of main crops.[35]

According to Nair, the main source of growth in feed supply in India during the past has been the increase in crop production, especially of foodgrains and oilseed.[36] The estimates of feed availability from these sources shown in Table 21 were obtained using the following assumptions:

Table 21--Estimated annual average feed supply in India, 1961-66 to 1977-82 average

Period	Roughages	Concentrates
	(million metric tons)	
1961-66	273.5	12.5
1962-67	272.0	11.5
1963-68	279.0	11.2
1964-69	285.1	12.4
1965-70	293.8	11.5
1966-71	316.8	13.2
1967-72	318.7	13.7
1968-73	323.7	13.6
1969-74	281.5	14.2
1970-75	311.3	15.0
1971-76	317.1	15.0
1972-77	323.7	14.3
1973-78	370.1	15.9
1974-79	385.9	16.6
1975-80	390.1	17.4
1976-81	388.1	16.9
1977-82	384.3	17.8

Source: K. N. Nair, "White Revolution in India, Facts and Issue," Economic and Political Weekly, June 22-29, 1985, p. A-91.

[35]See R. D. Whyte and M. L. Mathur, The Planning of Milk Production in India (Calcutta: Orient Longman, 1968); Indian Council of Agricultural Research, Human Nutrition Vis-à-Vis Animal Nutrition in India (New Delhi: ICAR, 1954); Central Council of Gosamvardhana, Report of the Committee on Livestock Feeds and Fodder (New Delhi: Central Council of Gosamvardhana, ICAR, 1965); V. N. Amble, "Milk Production of Bovines in India and Their Feed Availability," Indian Journal of Veterinary Science and Animal Husbandry 35 (September 1965): 221-33; and K. N. Nair, "White Revolution in India, Facts and Issue," Economic and Political Weekly, June 22-29, 1985, pp. A89-A95.

[36]Nair, "White Revolution in India."

- Estimates of roughages are obtained by applying the straw-grain ratio to the estimated production of crops.
- Estimates of rice, wheat, and other bran are obtained by applying the bran content in each grain.
- The production of oilcake is obtained from the oilcake content of crushed oilseeds after making allowance for export of oilcake.
- Coarse grain use in cattle feed was assumed to be 2 percent of total grain production.

Based on the FAO data, IFPRI had obtained the trends in cereal feed use of different commodities. These estimates for 1966-70 and 1976-80 are summarized in Table 22. Comparable data are not available from other sources. Though data on production of concentrates of plant origin are available, the proportion of the production actually used for cattle feed has not been clearly established. In 1974 the Committee on Livestock Feeds and Fodder of the Ministry of Agriculture and Irrigation obtained the estimates for 1971/72 shown in Table 23. The availability of 11 million tons estimated for 1971/72 was much lower than the estimated 17.4 million tons of concentrates being consumed.[37] The NCA had found it difficult to understand the divergence between data on availability and use.

Table 22--Estimated cereal and other feed use

Feed	1966-70 Average	1976-80 Average
	(million metric tons)	
Cereals	7.65	10.07
Pulses[a]	0.95	1.10
Groundnuts[a]	1.37	1.95

Source: J. S. Sarma, Cereal Feed Use in the Third World: Past Trends and Projections to 2000, Research Report 57 (Washington, D.C.: International Food Policy Research Institute, 1986).

[a] These figures are given in cereal equivalents.

[37] Amble, "Milk Production of Bovines in India."

Table 23--Availability of feeds based on total production of foodgrains and oilseeds, 1971/72

Feed	Total Production	Available for Feed
	(million metric tons)	
Coarse grains[a]	24.49	0.49
Edible oilcakes[b]	3.42	2.77
Cotton seed	1.98	1.78
Rice and wheat bran	4.85	4.68
Pulse by-products	11.09	1.33
Total	...	11.05

Sources: India Ministry of Agriculture and Irrigation, Report of the Committee on Livestock Feeds and Fodders (New Delhi: Manager of Publications, 1974).

[a] This is feed availability based on 2 percent of coarse grain production.

[b] The availability of edible oilcake depends on the conversion rate and the export policy of the government, both of which change periodically.

The NCA also obtained feed requirements for livestock in 2000. It was visualized that the feed requirements of nondescript cattle differed considerably from those of crossbred and improved cattle. The feeding requirements also changed according to the type of cattle, age group, lactation stage, and other such characteristics. The estimated requirements for concentrates, green fodder, and dry fodder for the projected numbers of various categories of animals in 2000 are available in Table 24.

On the basis of the concentrate feeds required for livestock feeding in 2000, the requirements of coarse cereal foodgrains have been estimated on the assumption that pig and poultry rations should contain up to 50 percent coarse cereals and the other livestock rations should contain, on an average, 25 percent coarse cereals. Thus the coarse grain requirement for livestock feed in 2000 is estimated to be about 24 million tons.

Against the requirements of 373 million tons of dry fodder, the amount of dry fodder available from grain, pulse, and oilseed crops is estimated to be 356.8 million tons. In 2000 the area under fodder

Table 24--Requirements for livestock feeds and fodders, 2000

Livestock	Concentrates	Green Fodder	Dry Fodder
	(million metric tons)		
Cattle			
Males, working and breeding	6.66	133.3	146.7
Females, milch and dry			
Nondescript	1.56	38.9	31.2
Improved indigenous	4.82	39.6	24.1
Crossbred	18.97	136.1	41.4
Young stock			
Crossbred	8.75	58.3	11.7
Others	4.84	48.4	14.5
Buffalo			
Males, working and breeding			
Females, milch and dry	2.37	12.7	12.7
Nondescript	2.37	23.7	23.7
Improved	9.64	64.3	38.5
Young stock	0.70	34.8	13.9
Total for bovines	58.82	590.1	358.4
Improved poultry	8.06	...	...
Improved sheep	6.57	1.6	8.8
Improved goats	4.38	...	5.8
Improved pigs	4.65	3.1	...
Horses and ponies	0.15	...	...
Camels	0.18	...	...
Total	82.81	594.8	373.0

Source: India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture (New Delhi: Controller of Publications, 1976), 7:390.

crops is estimated to be 16.5 million hectares, including 6.5 million hectares of irrigated land, and fodder production is estimated to be 575.0 million tons. In addition to cultivated green fodder, grazing in forest land, monsoon grasses, and tree leaves also would be available. It is estimated that 25 million tons of coarse cereal grains would be available for feeding livestock, along with about 52 million tons of other ingredients for concentrates (Table 25). Thus the availability of concentrate feeds of plant origin in 2000 for feeding livestock is estimated to be short of the estimated requirements by 5.76 million tons. It can be further observed that the estimates of 25 million tons of coarse grains available for livestock feed in 2000 may be an over-

Table 25--Availability of concentrate feed of plant origin, 2000

Feed	Quantity
	(million metric tons)
Coarse cereal grains	25.00
Bran from wheat and rice	5.67
Pulse products	4.38
Oilcakes	42.00
Total	77.05

Source: India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture (New Delhi: Controller of Publications, 1976) 7:395.

estimate. As pointed out in Table 23, during 1971/72 the amount of coarse grains used as cattle feed was only 0.49 million tons or about 2 percent of the coarse grain production of 24.5 million tons. The NCA estimate of coarse grain production in 2000 is 65 million tons, and the estimated 25 million tons used for cattle feed would imply that about 40 percent of production would be used as cattle feed. Furthermore, on the basis of production growth during the past, the 65-million-ton production target itself may be beyond reach. Production increased from 24.5 million tons in 1970/71 to 32 million tons in 1984/85, and the target production for the end of the seventh plan (1989/90) is only between 34 and 35 million tons, with an estimated annual growth rate between 1.2 and 1.8 percent. If this growth rate is maintained during the period 1990 to 2000, coarse cereal production in 2000 is unlikely to exceed 40 million tons. At this level of production, the projected use of coarse cereals in cattle feed would imply that about 62 percent of production is used for cattle feed.

Coarse grain use for human consumption was about 24 million tons in 1970/71 and a conservative estimate of consumption in 2000, assuming an inferior goods status for coarse grain, would be around 30 million tons. This would leave only about 10 million tons of coarse grain production available for cattle feed. Thus the demand-supply gap for concentrates would be around 20 million tons even if the projected availability of bran, pulses, and oilcakes is achieved.[38]

[38]It should be pointed out that projected production of pulses in 2000 (35 million tons) is also unlikely to be achieved. Against the 22 million tons projected for 1985, the actual production was only 13 million tons and the 1989/90 targeted production is only 16 million tons.

5. RESEARCH, TECHNOLOGY, AND YIELD

RESEARCH

Research on cassava is carried out primarily at the Central Tuber Crops Research Institute (CTCRI) and the agricultural universities of Kerala and Tamil Nadu. The CTCRI was set up in July 1963 in Trivandrum as a national center for conducting and coordinating research on all aspects of tuber crops such as cassava, potato, and yam. The Institute has an area of 21 hectares of hill-slope land and its objectives include breeding high-yielding, better-quality, disease-resistant and pest-resistant varieties of tuber crops, concentrating on cassava and sweet potato; determining the best practices for cultivation, manuring, and storage, with particular reference to the soils of Kerala; survey and analysis of possibilities for control of major diseases and pests; production, multiplication, and distribution of disease-free planting materials based on improved varieties; and carrying out fundamental research on the breeding and genetic patterns of tuber crops and their agronomic, chemical, technological, and nutritional features.

The activities of the Institute are organized into seven divisions: Genetics, Crops and Soils, Crop Physiology, Plant Pathology, Entomology, Extension, and Technology. Until 1970, its annual budget was Rs 300,000 to Rs 400,000. By 1985 this had gone up to Rs 3 million.

The CTCRI has a number of major achievements to its credit. It maintains a total of around 1,350 germ plasm specimens of cassava, the evaluation and documentation of which are in progress. It has evolved HYV varieties of cassava capable of producing about 30-40 tons per hectare. It has brought out a recommended package of practices for cassava for adoption by farmers. About 35 diseases and an equal number of pests have been identified. There has been extensive work on the development of varieties resistant to mosaic, a common virus disease. A tissue culture unit was established to take up meristem culture for developing virus-free plants. Its research found that intercropping cassava with groundnuts gave an additional income of Rs 1,500 per hectare over the Rs 2,100 earned when cassava was grown as a single crop. The institute has developed a standardized process of preparing alcohol from cassava and a process to increase the shelf life of sun-dried cassava chips. It has also developed a manually operated chipping machine. The extension unit trains farmers on various aspects of tuber crop farming, and it has adopted 200 farm families under a lab-to-land program to familiarize them with improved cassava varieties and use of suitable cultivation techniques and practices.

Research studies on cassava at the agricultural universities are concentrated on cropping systems, water management, and fertilizer response. Some of these studies have evolved cassava-based cropping systems, determined the water requirements of cassava in intercropping systems, and established economics of irrigation practices and intercropping patterns.

YIELD

The all-India yield of cassava in 1983/84 was about 19 tons per hectare, which is a substantial improvement over the 1960/61 yield of about 7 tons per hectare. Yields in Tamil Nadu (about 32 tons per hectare) were substantially higher than in Kerala (16 tons per hectare). The difference in yields reflects the nature of land under cassava cultivation and cultural practices. In Kerala, cassava is usually grown on hill slopes, or as an intercrop in garden lands, and chemical fertilizers are seldom applied. In most cases, such lands are not considered suitable for other food crops, and only rarely is cassava competitive with rice for marginal land.[39] In Tamil Nadu cassava is grown on irrigated land and the use of chemical fertilizers is common. The major difference between cassava cultivation in Kerala and Tamil Nadu is that in Kerala it is grown as a cereal substitute and in Tamil Nadu it is an industrial raw material.

Some indications of the variations in yield according to the size of holdings and variety used can be obtained from the results of a survey conducted during the mid-1970s in three villages of Kerala (see Table 26).[40]

The per hectare fertilizer applications on HYVs were 49 kilograms of nitrogen (N), 52 kilograms of phosphorus (P), and 64 kilograms of potassium (K); and for local varieties they were 15 kilograms N, 15 kilograms P, and 22 kilograms K. Among the cultivators 51 percent had used fertilizers. The yield response for fertilizer use followed the pattern in Table 27.

A crop estimation survey conducted during 1978/79 indicated an average yield of 27,384 kilograms per hectare in Tamil Nadu and the range was from 14,395 kilograms per hectare to 32,240 kilograms per hectare in the different districts. A maximum yield of 84,167 kilograms per hectare was obtained from one field. Some production characteristics in Salem and Kanyakumari districts of Tamil Nadu are summarized in Table 28.

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[39]In Kerala, cassava competes mainly with tree crops such as coconuts and rubber.

[40]University of Madras, Agricultural Economic Research Centre, "Study on Tapioca Cultivation in Kerala," Madras, 1976.

Table 26--Yields of high-yielding and local cassava in three Kerala villages by farm size

Size of Holding	Yield		
	HYV	Local	Average
(acres)		(kilograms/acre)	
Less than 1.0	12,000	12,353	12,348
1.0 - 2.5	...	13,128	13,128
2.5 - 5.0	15,000	10,890	11,457
5.0 - 10.0	16,500	9,906	10,950

Source: University of Madras, Agricultural Economic Research Centre, "Study on Tapioca Cultivation in Kerala," Madras, 1976.

Table 27--Yields of high-yielding and local cassava in three Kerala villages by fertilizer use

Fertilizer Used or Not Used	Yield		
	Local	HYV	Total
		(kilograms/acre)	
Users	13,276	15,750	13,839
Nonusers	9,203	12,000	9,207
Total	11,029	15,727	11,579

Source: University of Madras, Agricultural Economic Research Centre, "Study on Tapioca Cultivation in Kerala," Madras, 1976.

Table 28--Some aspects of cassava production in Salem and Kanyakumari

Village	Yield		Share of Farmers Using Input		
	Average	Maximum	Improved Seed	Chemical Fertilizers	Irrigation
	(kilograms/hectare)			(percent)	
Salem	31,540	68,850	7	42	93
Kanyakumari	14,933	56,000	3	12	20

Source: Unpublished materials from the Department of Agriculture, Tamil Nadu State.

The CTCRI conducted field trials for determining the yield response under different soil conditions and fertilizer applications. These results indicated that the yield of cassava ranged from 11.34 tons per hectare on marginal land (without irrigation and fertilizers) to 33.23 tons per hectare on ordinary soil (with irrigation and fertilizer) for the variety H. 1687 (see Table 29).

Table 29--Yields of cassava field trials

Farm Condition	Yield
	(metric tons/hectare)
Marginal land without irrigation and fertilizers	11.34
Ordinary soil with irrigation (20 millimeters/week) and low use of fertilizers (50:100:50)	22.55
Ordinary soil without irrigation and with fertilizer use (100:100:100)	21.67
Ordinary soil with irrigation (20 millimeters/week) and fertilizer use (100:100:100)	33.23

Sources: Central Tuber Crops Research Institute, Annual Report 1977 (Trivandrum: Central Tuber Crops Research Institute, 1978); T. V. R. Nair, B. Mohankumar and N. G. Pillai, "Productivity of Cassava Under Rainfed and Irrigated Conditions," Journal of Root Crops 11 (June 1985).

To accelerate the adoption of research findings by farmers, the CTCRI has launched the Lab-to-Land Programme. Information on cultivation of HYVs and local varieties obtained from the participating farmers indicated that during 1984/85 farmers realized an average yield of 26.28 tons per hectare from HYVs and 14.30 tons per hectare from local varieties, as against 30 tons per hectare of HYVs on the CTCRI farm.

Yields obtained from research stations ranged up to 60 tons per hectare. In an advance trial of cassava at the CTCRI the selection 8/75 gave a tuber yield of 60 tons per hectare, S-'82 gave 51 tons per hectare, and 14/25 gave 44 tons per hectare. Compared to the yield realized from hybrid H.2304 (40 tons per hectare), H.1687 (43 tons per hectare) and the popular cultivar M_4 (30 tons per hectare), these varietal selections at advanced stages hold good potential. The CTCRI

has also conducted trials on cassava-based multiple cropping systems, obtaining a maximum tuber yield of 47.8 tons per hectare when cassava was grown with bananas.

As part of the technology transfer through the Lab-to-Land Programme, 67 field trials were conducted in Salem during 1979-81 using the varieties H.97, H.226, H.1687, and H.2304, along with the local variety Burma, covering an area of about 25 hectares. The variety H.226 recorded the maximum tuber yield of 48.5 tons per hectare (see Table 30).

Table 30--Performance of high-yielding varieties of cassava under irrigated conditions in Salem, 1979/80

Variety	Tuber Yields	
	Average	Maximum
	(metric tons/hectare)	
H 97	20.25	30.25
H 226	33.25	48.50
H 168	725.75	36.25
H 230	427.75	37.00
Local (Burma)	19.00	25.00

Source: Central Tuber Crops Research Institute, Summary Report--Lab to Land Phase I (Trivandrum: Central Tuber Crops Research Institute, 1987).

The Kerala Agricultural University conducted some experiments to determine the nutritional requirements of cassava-based intercropping systems. In an experiment run from July 1980 to April 1981 to select leguminous component crops suitable to be grown as intercrops and to study the effects of different NPK ratios on the growth and yield of different crops in the system, 15 major treatments and two subplot treatments were used. The cassava yields as influenced by intercropping with different levels of fertilizer use are given in Table 31.

Considering the slow progress in adoption of HYV and the relatively low importance placed on cassava development, one can speculate that the all-India cassava yields in 1990 may be 20 tons per hectare and by 2000 they might go up to 25 tons per hectare.

Table 31--Yield of cassava as influenced by intercropping with different levels of fertilizer use

Main Plot Treatment			Sub-Plot Treatment		
N	P	K	Cassava and Cowpeas	Cassava and Groundnuts	Mean
(kilograms/hectare)			(metric tons/hectare)		
50	50	50	23.0	20.4	21.7
50	63	63	28.9	22.6	25.8
50	75	75	17.8	17.8	17.8
63	50	63	22.8	21.5	22.2
63	63	50	22.8	21.9	22.4
75	50	75	23.7	20.7	22.2
75	75	50	21.8	19.3	20.6
75	75	75	24.3	19.9	22.1
75	94	94	18.8	21.3	20.0
94	75	94	23.5	25.1	24.3
94	94	75	24.7	24.8	24.7
75	113	113	22.6	20.2	21.4
113	75	113	19.2	22.1	20.6
113	113	75	21.1	23.9	22.5
50	50	50	...	...	35.9
Mean			22.5	21.5	...

Source: Kerala Agricultural University, Research Report 1981/82 (Trichur: Kerala Agricultural University, 1982).

CONSTRAINTS FOR INCREASING OUTPUT

The High Level Committee on Land and Water Resources appointed by the Kerala Government identified a number of constraints in increasing output of cassava.[41] These include the prevalence of low-yielding varieties; the slow adoption of modern production technology; a lack of awareness of improved practices; the use of uncertified, diseased planting material; the absence of plant protection practices; an uncertain market with fluctuations in prices; and poor avenues for alternative uses of cassava to expand market demand.

[41]Kerala, State Planning Board, Report of the High Level Committee on Land and Water Resources (Trivandrum: State Planning Board, 1984), p. 43.

Some of these constraints might be overcome through the research conducted at the CICRI, especially through the development of high-yielding, disease-resistant crop varieties, as well as efficient cultural practices, research and extension activities, and proper monitoring devices for the con rol of pests and diseases.

6. SUBSTITUTABILITY OF CASSAVA IN PRODUCTION AND UTILIZATION

PRODUCTION

Cassava grows on diverse soils, and it can produce economic yields on soils that are considered unsuitable for economic cultivation of many other crops. A warm, humid climate with adequate rainfall and sunshine is suitable for cassava cultivation.

Kerala agriculture is characterized by its emphasis on plantation crops, especially rubber and coconuts. Because of the permanent nature of these crops and the high returns from them, cassava does not compete with them. At the same time, with increasing returns for these crops there had been a tendency to bring even somewhat marginal lands under rubber and coconut, so that the area available for cassava might decline. The economics of paddy (the major food crop) and some of the subsidiary food crops like cassava and yams are compared with those of a fodder crop, hybrid napier grass, in a study on the economics of crossbred cattle in Kerala during the mid-1970s.[42] Net income from the cultivation of these crops in the plains and hilly areas of Kerala indicates that income from cassava was less than the incomes from paddy and fodder crops (see Table 32).

An experiment station for cassava located near Salem in Tamil Nadu has released data on the costs of and returns from cassava on rainfed and irrigated areas (see Table 33). The net return per hectare from irrigated area was about double the returns from nonirrigated (rainfed) area.

In some areas of Kanyakumari district, dry land can grow paddy, cassava, and bananas. A sample survey in these areas indicates that returns from bananas would be substantially higher than those from either paddy or cassava. Banana cultivation, however, is highly capital intensive. Between paddy and cassava, net returns from cassava exceeded the returns from paddy. It can also be observed that farmers in this area did not use manures, fertilizers, or insecticides for cassava cultivation (Table 34).

The CTCRI collected information on cultivation of local and high-yielding varieties of cassava from 50 farmers of the villages where the Lab-to-Land Programme was in operation during 1984/85. The data from

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[42]R. K. Patel, Economics of Crossbred Cattle (Karnal: National Dairy Research Institute, 1976).

Table 32--Estimates of income from selected crops, 1973-74

Type of Farm/Crop	Gross Returns	Net Income
	(Rs/hectare)	
Plains		
Paddy (autumn)	3,227	1,386
Paddy (winter)	2,807	840
Yam	934	-462
Cassava	1,253	178
Hybrid napier	1,974	912
Settler farmers		
Paddy (autumn)	4,561	2,147
Paddy (winter)	2,582	892
Yam	981	-546
Cassava	1,379	395
Hybrid napier	3,884	1,512

Source: National Dairy Research Institute, Economics of Cross-bred Cattle (Karnal: NDRI, 1976), p. 85.

Table 33--Cost of cultivation and returns of cassava under irrigated and rainfed conditions, 1982

Cost or Return	Rainfed	Irrigated
	(Rs/acre)	
Cost		
Land preparation	236	324
Farmyard manure	200	200
Chemical fertilizers	150	250
Labor for fertilizer application	36	60
Seed materials and planting	342	291
Weeding and interculture	146	356
Plant protection	70	140
Irrigation charges	...	270
Harvesting	120	170
Total	1,300	2,061
Returns		
Value of tuber	1,750	3,500
Seed material	500	500
Total	2,250	4,000
Net returns	950	1,939
Net returns/hectare	2,090	5,265
Cost (Rs/kilogram)	0.26	0.21

Source: Tamil Nadu, Agriculture Department, Tapioca Experiment Station, Mulluvadi, Attur, Salem District, unpublished note, n.d.

Table 34--Cost structure of competing crops on the paddy fields of Kanyakumari district

Item	Paddy	Banana	Cassava
		(Rs/acre)	
Human labor	797	3,036	464
Bullock	400	...	...
Seedlings	114	304	32
Manure and fertilizers	828	3,056	...
Insecticides and pesticides	84	115	...
Transport to market	...	386	157
Land and water tax	85	85	85
Interest on capital	124	356	36
Rent on land	1,353	2,102	1,300
Gross revenue	3,999	16,001	3,561
Cost A	2,327	6,982	738
B	2,451	7,338	774
C	3,804	9,440	2,074
Net revenue based on Cost A	1,672	9,019	2,823
Cost B	1,848	8,663	2,787
Cost C	195	6,561	1,487

Source: D. Peter, "Economics of Cropping Pattern of Kanyakumari District" (thesis, Kamaraj University, 1979).

Notes: Cost A is based on all cash payments made by the farmer.
Cost B includes Cost A and the rental value of owned land and interest on owned fixed capital excluding land.
Cost C includes Cost B and the imputed value of family labor.

this survey indicate a net return of Rs 2,839 from 1 hectare of local variety of cassava, and it increased to Rs 5,110 by shifting over to HYVs. The net income from the HYVs cultivated at the CTCRI farm was Rs 6,085. The unit cost of production of HYVs was less than the cost per kilogram at the CTCRI farm (Table 35).

The data on costs and returns from different sources indicate the following conclusions: first, cassava does not compete effectively with tree crops such as coconut and rubber or with garden land crops such as bananas. Second, in most cases, cassava is grown in areas where it has some comparative advantage because of its agroclimatic requirements. On the production side, cassava does not normally

Table 35--Costs and returns of cassava production, by variety, 1984/85

Item	Local Varieties	HYV	HYV on CTCRI Farm
		(Rs/hectare)	
Planting material	250	250	250
Labor	3,061	3,599	4,490
Farmyard manure	1,057	1,144	1,250
Fertilizer	249	1,240	1,425
Total	4,617	6,233	7,415
Yield (metric tons/hectare)	14.30	26.28	30.00
Gross return	7,456	11,343	13,500
Net return	2,839	5,110	6,085
Cost (Rs/kilogram)	0.32	0.24	0.25

Source: Central Tuber Crops Research Institute, Summary Report--Lab to Land Phase I (Trivandrum: Central Tuber Crops Research Institute, 1987).

compete for land with food or feed crops with which it competes on the demand side, except in some dry land areas in districts similar to Kanyakumari. Lastly, new varieties offer scope for reducing the unit cost of production. Through adoption of such varieties it may be possible to overcome, at least partially, some of the disadvantages coming from the smaller area used to produce cassava. The potential high yields could contribute to increased production of cassava.

UTILIZATION

The comparative uses of cassava for food and starch were discussed in Chapter 3. However, utilization of cassava in livestock feeds is an important area that has not been systematically explored.

Feed manufacturers are hesitant to disclose information on feed composition and cost of production. However, data from one plant indicates that the two formulations used by the plant include 7-8 percent cassava. The composition of the two formulations follow the pattern in Table 36.

In a linear programming study on optimum feeding practices involving 52 situations (crossbred cows weighing 300 kilograms and yielding 1 to 15 kilograms of milk per day, crossbred cows weighing 350 kilograms

Table 36--Composition of cattle feed in a government feed plant

Component	Formulation I	Formulation II
	(percent)	
Groundnut extraction	10	10
Rapeseed or soybean cake	10	...
Niger or mustard cake	10	5
Ambadi cake	8	5
Groundnut or cottonseed cake	7	15
Common salt	2	1
Afla meal	...	5
Molasses	10	10
Deoiled rice bran	10	10
Wheat bran	25	25
Cassava	7	8
Mineral mixture	1	6
Damaged wheat/rice	...	5

Source: Unpublished material from one cattle feed plant.

Note: Formulations one and two imply different price situations.

and yielding 1 to 15 kilograms of milk per day, and murrah-graded buffaloes weighing 300 and 400 kilograms and yielding 1 to 11 kilograms of milk per day), Dhas determined the composition of feeds for different types of animals in a Tamil Nadu district.[43] Of the 52 combinations, cassava appeared to be a component of the optimum feedmix only for crossbred cows of 300 kilograms yielding 10 kilograms milk. By feeding the optimum mix, farmers could realize a savings of 9 percent over existing feeding practices (Table 37).

In the absence of actual data on feed composition and cost of production, a survey was conducted among the feed manufacturers to obtain some idea of the potential for the use of cassava in feed. Of the 13 manufacturers who responded, 6 used cassava in animal feeds and 1 used it in poultry feed. However, the maximum quantity of cassava used in animal feed was 10 percent of the ingredients and that in poultry feed only 1 percent. Four manufacturers used less than 2 percent cassava and one used 7 percent. All the feed manufacturers were willing to include cassava in animal and poultry feed, provided that

[43]H. A. C. Dhas, "Economics of Milk Production With Special Emphasis on Optimum Feed Compounding" (M.A. thesis, PSG College, Coimbatore, 1984).

Table 37--Existing and optimum feeding schedule for crossbred cows in a Tamil Nadu district

Feed	Quantity		Expenditure	
	Existing	Optimum	Existing	Optimum
	(kilograms/day)		(Rs/day)	
Sorghum fodder	1.00	16.67	0.75	12.50
Groundnut cake	...	1.28	...	3.20
Cassava flour	...	1.01	...	1.92
Rice bran	1.44	0.49	0.72	0.24
Sorghum straw	10.00	...	10.00	...
Napier grass	0.80	...	0.40	...
Cottonseed cake	0.63	...	1.38	...
Coconut cake	1.25	...	5.00	...
Cottonseed	0.25	...	0.55	...
Total	...	...	18.80	17.06

Source: R. A. C. Dhas, "Economics of Milk Production With Special Emphasis on Optimum Feed Compounding" (M.A. Thesis, PSG College, 1984).

Notes: It is assumed that the crossbred cows weigh 300 kilograms and produce 10 kilograms of milk a day.

good quality dried cassava was available throughout the year at an economic price. The cassava would replace maize, jowar, and broken rice in the feeds up to a maximum of 20 percent, but in most cases, only 10 percent of the ingredients in the feed mix.

The manufacturers were also asked to indicate what price would induce them to switch from foodgrains to cassava. They were purchasing maize at prices ranging from Rs 2,400 to Rs 2,600 per ton, jowar at prices ranging between Rs 1,400 to Rs 1,750 per ton, and broken rice at about Rs 1,250 per ton. They indicated that they would switch from feedgrains to cassava at prices ranging from Rs 1,000 to Rs 1,400 per ton. Assuming an average price of Rs 1,250 per ton of dried cassava at the processing plant, and providing an allowance of Rs 250 toward processing charges, transportation charges, and margins to the dealers, this would imply a price of about Rs 1,000 per ton of dried cassava at the farm level. The raw tuber-chips ratio is expected to be in the range of 2.50:1 to 3.00:1. An average ratio of 2.75:1 would imply that the economic price at which feed manufacturers would substitute feedgrains with cassava would be at a farm-level price of about Rs 360 per ton of raw cassava, which is considerably below the price that prevailed in 1983/84. At a price of Rs 360 per ton and with costs and

yields realized by farmers growing HYVs in the CTCRI Lab-to-Land Programme, the net return would be Rs 3,228 per hectare. Although the net return to farmers at this price is much lower than the net return of Rs 5,110 realized for HYVs in 1984/85, it is higher than the Rs 2,839 return realized by farmers growing local varieties of cassava.

Compound Feeds

Data on compound feed production are systematically collected from the members of the Compound Livestock Feed Manufacturers Association (CLFMA). It is estimated that in 1985, production of the members of CLFMA accounted for approximately 60 percent of the compound cattle feed and for 50 percent of poultry feed by the organized sector of the feed industry.

There was a substantial increase in the production of cattle and poultry feed by the members of the association. Between 1970 and 1985, production by the members had increased from 209,000 tons to 1.4 million tons. Although a portion of this increase may be due to an increase in membership, it still represents a major improvement in production. In 1970, the production of cattle feed was 125,000 tons, but by 1985 this had risen to 867,000 tons. Between 1970 and 1985, poultry feed production rose from 84,000 to 502,000 tons (Figure 4).

The 69 ordinary members of the CLFMA had 100 production units with an installed capacity of 2.3 million tons. Production in 1985 indicated a capacity utilization of about 80 percent.

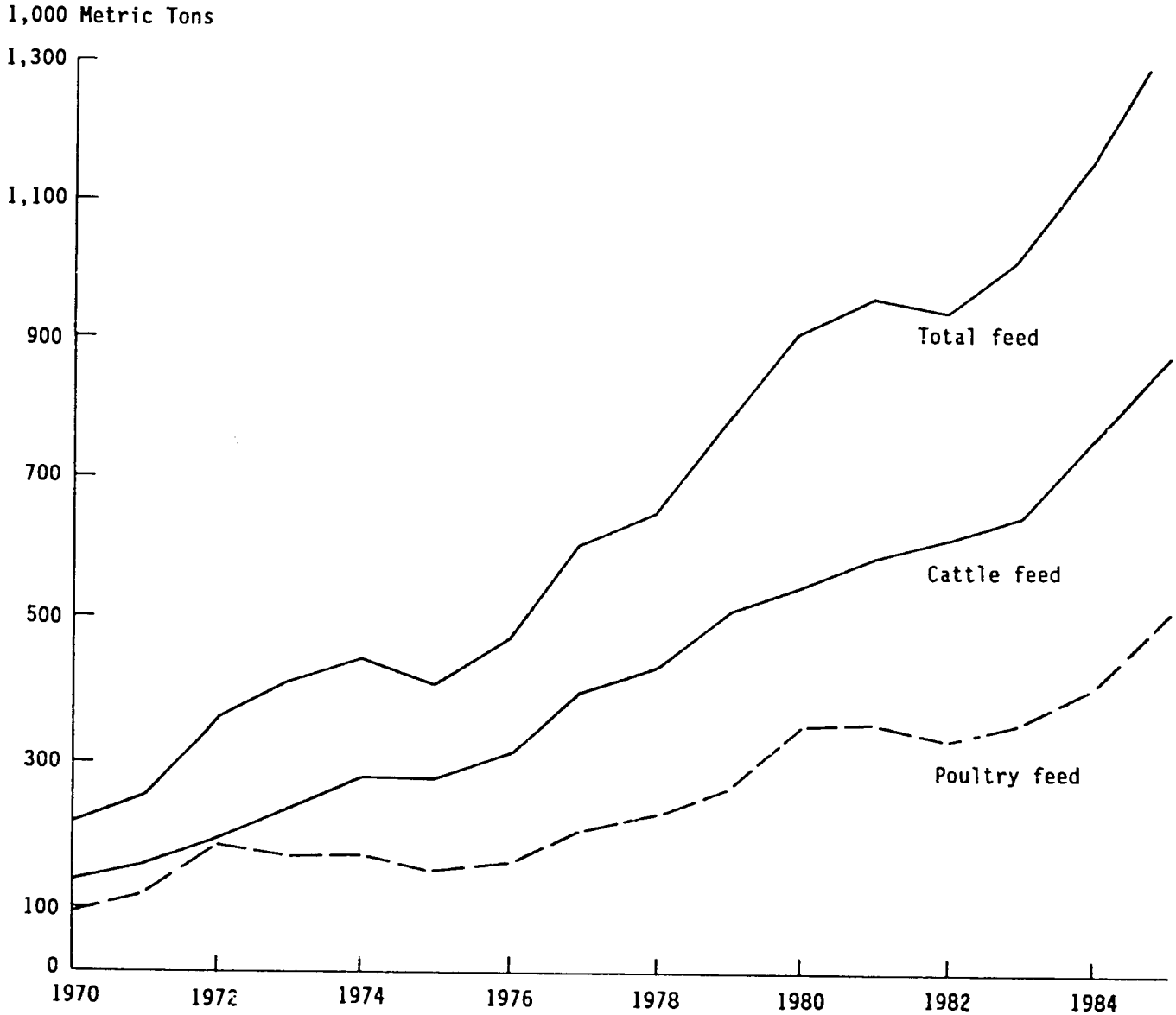
The share of CLFMA in the production of cattle and poultry feed (60 percent of cattle feed and 50 percent of poultry feed) indicates a total production of 1.5 million tons of cattle feed and 1.0 million tons of poultry feed, together accounting for 2.5 million tons of compound feed. If manufacturers who were not members of CLFMA can be assumed to have the same capacity utilization as the members, the installed capacity of cattle feed manufacturers would be 4.1 million tons.

The ownership pattern of the 69 members of CLFMA indicates that there were 52 private, 11 cooperative, and 6 government feed manufacturing units.

Composition of Feeds

The composition of feeds varies from region to region and from season to season. However, most feed manufacturers are unwilling to disclose their feed ingredients. Data from one feed manufacturer shown in Table 36, indicate that it had two formulations for cattle feed. Depending upon the local availability of different ingredients, concentrate mixtures for different types of animals are evolved. An illus-

Figure 4--Cattle and poultry feed production by the members of Compound Feed Manufacturers Association



trative example of the concentrate mixtures suggested for cows in the north, central, east, west, and south zones of the country (Table 38) indicates that there were substantial variations in the ingredients and their proportion in the mixtures.

Table 38--Illustrative concentrate mixtures for cows

Component	North	Central	East	West	South
			(percent)		
Coconut meal	...	...	...	...	10
Maize	17	12	...	15	...
Maize gluten	10	...	...	...	...
Barley	15	...	...	...	...
Groundnut meal	10	10	15	22	...
Cottonseed meal	10	...	...	...	...
Mustardseed meal	10	...	...	...	...
Molasses	5	...	...	...	...
Wheat bran	20	10	...	10	...
Mineral	3	3	3	3	3
Sorghum	...	10	...	...	...
Guar meal	...	10	...	...	...
Beet pulp	...	10	...	...	...
Seasama meal	...	10	...	...	25
Linseed meal	...	10	...	...	...
Gram husk	...	5	...	...	5
Rice bran	...	10	10	10	10
Arhar chuni	...	...	10	...	...
Horse gram	...	...	7	...	...
Rice grit	...	...	20	...	...
Linseed cake	...	...	20	...	...
Molasses	...	...	5	...	10
Rice polish	...	...	10	10	...
Pearl, millet	...	...	...	10	...
Gram chuni	...	...	...	10	...
Oats	...	...	...	..	5
Brewery grain	...	...	...	.	10
Tamarind seed	...	...	...	...	7
Cassava flour	...	...	...	...	5

Source: S. P. Arora, "Feeding of Dairy Cattle and Buffaloes," Indian Council of Agricultural Research, New Delhi, 1978.

Note: The ellipses indicate a nil or negligible amount.

While there have been a number of studies on least-cost rations for dairy cattle using a linear programming framework, most of them have not included cassava as an ingredient. Even feed composition studies in Kerala, where cassava production is important, included only cassava residues. For example, a study based on the data collected from a cross-section survey of 175 cattle-owning households in Alleppey district treated cassava residues along with plantain leaves and other leafy items.[44] In linear programming exercises with digestible crude protein, total digestible nutrients, calcium, and roughage as minimum restrictions and dry matter, phosphorus, and paddy straw as maximum restrictions, the optimum mix contained mainly local grass, paddy straw, groundnut oilcake, rice bran, and compound cattle feeds. The optimal diet pattern could introduce some savings in the feed cost of milk production from crossbred cows, but it increased the feed cost per liter of milk from nondescript cows. The existing pattern of feeding and the optimal solution are available in Table 39.

To sum up, there is a growing market for both cattle and poultry feed. It is possible to expand the use of cassava in preparing livestock feeds. The major constraints for enlarged use of cassava in livestock feed originate in uneconomic cassava prices for the feed producers and inadequate linkage between farmers and feed producers. The economic price of Rs 360 per ton of cassava suggested by the feed manufacturers offers a viable price for the farmers if the cost of production can be kept around the cost incurred by the Experiment Station in Salem or the cost of production of HYVs achieved by the CTCRI experiments.

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[44]T. P. Gangadharan, "Feed Economy in Milk Production, A Probe under New Dairy Farm Technology in Kerala," Indian Journal of Agricultural Economics 35 (No. 4, 1980): 135-138.

Table 39--Existing and optimal feeding practices for crossbred and nondescript cows in Kerala, by season

Component	Brown Swiss Crossbred				Nondescript			
	Rainy		Summer		Rainy		Summer	
	Existing	Optimal	Existing	Optimal	Existing	Optimal	Existing	Optimal
	(kilograms)							
Local grasses	3.08	12.45	2.58	9.72	3.88	6.50	2.30	3.91
Hybrid napier grasses	1.01	...	0.84	...	0.12	...	0.25	2.59
Guinea grass	0.14	...	0.04	...	0.06	...	0.05	...
Others[a]	0.05	...	0.03	...	0.05	...	0.09	...
Paddy straw	4.14	4.00	4.86	4.00	1.82	3.00	2.18	3.00
Groundnut oilcake	0.16	0.65	0.62	0.59	0.25	0.40	0.31	0.38
Coconut oilcake	0.16	...	0.11	...	0.06	...	0.04	...
Gingelly oilcake	0.14	...	0.15	...	0.05	...	0.03	...
Tamarind seed	0.35	...	0.32	...	0.24	...	0.19	...
Cotton seed	0.04	...	0.04	...	...	...	...	...
Gram	0.03	...	0.02	...	...	...	...	...
Rice bran	0.32	0.30	0.27	0.28	0.22	...	0.23	...
Compound cattle feeds	0.76	0.50	0.72	0.50	0.16	0.10	0.19	0.10
Others[b]	0.06	...	0.07	...	0.03	...	0.05	...
Feed cost per kilogram of milk	0.70	0.61	0.90	0.68	0.97	1.04	1.10	1.21
Percent change in feed cost in optimal plan	...	-12.9	...	-24.4	...	+7.2	...	+10

Source: T. P. Gangadharan, "Feed Economy in Milk Production, A Probe under New Dairy Farm Technology in Kerala," Indian Journal of Agricultural Economics 35 (No. 4, 1980): 38.

[a] Includes plant residues, such as cassava residues and plantain leaves.
[b] Includes crop residues, such as jaggery and rice residue.

7. SUPPLY AND DEMAND PROJECTIONS FOR CASSAVA

SUPPLY PROJECTIONS

The supply projections are obtained from independent estimates of area and yield based on current technology and price relations.

Projected Area

Trend growth rates of area showed a wide range, varying according to the number of years included in the estimation process. It may be recalled that the growth rates of area for all India and for Kerala and Tamil Nadu remained positive for the period 1960/61 and 1983/84. However, during the period 1970/71 and 1983/84, there was a negative rate of growth in area for Kerala and all India, but a positive rate of growth for Tamil Nadu. In view of the differences in trends, it can be assumed that the estimates based on the recent past (shorter period) represent a lower bound and those based on the longer period an upper bound. The projected area for 1990 indicates a lower bound of 288,100 hectares and an upper bound of 354,000 hectares. The lower and upper bounds of area for 2000 are 257,600 and 406,400 hectares (Table 40).

Table 40--Projections of cassava area based on trend estimates

State	Average of 1981/82 to 1983/84	1990		2000	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound
		(1,000 hectares)			
Kerala	242.1	201.4	260.6	160.0	274.2
Tamil Nadu	49.4	55.2	61.7	63.4	81.3
Other regions[a]	25.1	31.5	31.7	34.2	50.9
All-India	316.6	288.1	354.0	257.6	406.4

Source: Calculations made by the author.

[a] This was obtained as a residual.

The National Commission on Agriculture estimates that by 2000 the area under cassava can be raised to 1 million hectares. The Commission's estimate was based on the following logic:

> In the major producing state, viz. Kerala, there already appears to be a saturation in the matter of tapioca area. The neighbouring state of Tamil Nadu, however, affords an opportunity for area expansion.... Karnataka has also got suitable soil and climatic conditions for growing tapioca on the western side. Andhra Pradesh and Assam region provide suitable conditions for growing tapioca and can undertake substantial increase in area. Maharashtra and Orissa also offer some scope.[45]

Keeping these possibilities in view, and assuming a base level of 350,000 hectares (being the average area of 1969/70 to 1971/72) the Commission envisaged that the area under cassava in 2000 would be 1 million hectares spread over the different states as follows:

State	Area (1,000 hectares)
Kerala	325
Tamil Nadu	200
Karnataka	125
Maharashtra	50
Andhra Pradesh	125
Orissa	75
Assam Region	100
Total	1,000

As the average area during the period 1981/82-1983/84 was only 316,600 hectares and as the growth rates declined during the 1970s, it is unlikely that the NCA projections will materialize. Considering the possible changes in area in different regions, and assuming that the area in Kerala will stabilize around the levels projected here for 1990, it is estimated that the area under cassava in 2000 will be very near to the 1969/70-1971/72 average. The position in Kerala, Tamil Nadu, and other regions might follow the pattern shown in Table 41.

Projected Yield

As in the case of area, there were major changes in the growth rate of yield between the two periods considered. The growth rate of yield in Tamil Nadu was fairly high for both periods. However, from

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[45]India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture, p. 289.

Table 41--Projected area under cassava, 1990 and 2000

State	1969/70 to 1971/72 Average	1981/82 to 1983/84 Average	Projections 1990	Projections 2000
	(1,000 hectares)			
Kerala	267.5	242.1	231.0	231.0
Tamil Nadu	42.0	49.4	58.5	72.3
Other areas[a]	40.5	25.1	40.0	55.0
All-India	350.0	316.6	329.5	358.3

Source: Calculations made by the author.

Note: These projections assume that area in Kerala will stabilize at the level of 1990 and that the proportion of cassava area in other regions will increase.

[a] This was obtained as a residual.

1970/71 to 1983/84 Kerala had a negative growth rate of yield (-1.01 percent) against a moderate growth rate of 2.88 percent during 1960/61 to 1983/84. When these trend growth rates are used, the projected all-India yields for 1990 ranged between 17,741 and 22,131 kilograms per hectare. The projected yields for 2000 indicate a range between 18,578 and 30,549 kilograms per hectare. The range for individual states was large (Table 42). The National Commission on Agriculture envisaged that by 2000 the all-India yields would be 40 tons per hectare. The yields projected on the basis of past trends for Tamil Nadu and the NCA estimate appear to be beyond reach on the basis of currently available varieties and the rate of adoption of new varieties. Therefore, to obtain the projected yields in Table 43, some adjustments were made in the trend estimates based on the progress of adoption of improved varieties and the use of irrigation and fertilizers.

Projected Supply

The projections for area and yield indicate that production of cassava in 1990 will be 6.6 million tons and by 2000 it will go up to 8.8 million tons (Table 44). The current share of different states in all-India cassava production (average of 1981/82 to 1983/84) is 69 percent in Kerala, 26 percent in Tamil Nadu, and 5 percent in other

Table 42--Projected cassava yields based on trend estimates, 1990 and 2000

State	1990		2000	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
	(kilograms/hectare)			
Kerala	14,256	19,412	14,256	25,234
Tamil Nadu	50,466	56,363	100,693	129,121
All-India	17,741	22,131	18,578	30,549

Source: Calculations made by the author.

Note: In Tamil Nadu the lower bound corresponds to the growth rate for 1960/61 to 1983/84. The estimates reflect the high growth rate in that period. But it is highly improbable that the trend estimates for Tamil Nadu will materialize.

Table 43--Projected cassava yields based on adjusted estimates, 1990 and 2000

State	1969/70 to 1971/72 Average	1981/82 to 1983/84 Average	Projections	
			1990	2000
	(1,000 kilograms/hectare)			
Kerala	16.4	15.3	17.0	19.7
Tamil Nadu	11.6	29.0	34.4	43.6
Other regions	5.2	10.3	15.5	19.5
All-India	15.5	17.1	19.9	24.5

Source: Calculations made by the author.

Note: These projections were made with adjustments in the trend estimates to allow for progress in the adoption of improved varieties and greater use of irrigation and fertilizers.

Table 44--Projected production of cassava, 1990 and 2000

State	1969/70 to 1971/72 Average	1981/82 to 1983/84 Average	Projections 1990	Projections 2000
		(1,000 metric tons)		
Kerala	4,883	3,712	3,927	4,551
Tamil Nadu	488	1,431	2,012	3,152
Other regions	54	258	618	1,075
All India	5,425	5,401	6,557	8,778

Source: Calculations made by the author.

states. Kerala's share in all-India production is projected to decline to 60 percent in 1990 and to 52 percent in 2000. At the same time, the share of Tamil Nadu is projected to increase to 30 percent in 1990 and to 36 percent by 2000. The states other than Kerala and Tamil Nadu are projected to account for 10 percent of production in 1990 and for 12 percent of production in 2000.

DEMAND PROJECTIONS

Cassava is used for human consumption mainly in Kerala and the Kanyakumari district of Tamil Nadu. In 1981, 70 percent of the gross cassava production in Kerala and 25 percent of the production in Tamil Nadu was utilized for human consumption. Thus, the quantity of cassava used for food was almost 3 million tons.

NCA estimates the average annual net consumption of cassava for the period 1969/70-1971/72 to be 2.1 million tons. It also estimates that about 15 percent of average production was wasted in the process of harvesting and marketing, and therefore the gross quantity of cassava used for food was 2.5 million tons. Thus the annual growth rate in aggregate consumption of cassava between 1970/71 and 1981 was about 1.5 percent.

Changes in the demand for cassava for human consumption occur through changes in population, income, relative prices, and tastes and preferences. The estimates of income elasticity for cassava in the NSS data indicate positive values for lower-income groups and negative values for higher-income groups. Furthermore, the aggregate income

elasticity was positive for rural areas and negative for urban areas. Some of the cross-section surveys also indicate a negative relationship between cassava consumption and income. Although low-income groups will increase cassava consumption, improved incomes for middle-income families and changes in income distribution will reduce overall cassava consumption. In view of these estimates, the income elasticity of cassava is close to zero, and therefore the effect of income changes on consumption is excluded from the projection framework.

In recent years rice availability in the major cassava-consuming areas has been satisfactory. With an improvement in the availability of rice and other cereals in Kerala, the demand for cassava has been depressed. With improved rice and wheat availability, the market prices of cereals have been kept within certain limits, and it is unlikely that relative prices will move in favor of cassava. Therefore, no increase in the demand for cassava for human consumption on account of favorable relative prices for cassava is envisaged. It is also assumed that there will be no major change in the tastes and preferences of consumers in the important consuming centers over the period of the projections. Thus population change will be the major factor influencing cassava consumption.

The annual growth rate of population in Kerala during the decade 1971 to 1981 was slightly less than 2 percent. Considering that the annual growth rate of consumption of cassava between 1970/71 and 1981 was less than 1 percent, and that population increase would be the major factor contributing to the increase in cassava consumption, it is estimated that the demand for cassava for human consumption would increase at an annual rate of 1.5 percent, so that the quantity demanded in 1990 and 2000 would be between 3.3 and 3.9 million tons.

The major nonfood uses of cassava include preparation of starch and its use in animal feed. It was estimated that the current use of cassava for starch preparation was about 1.3 million tons. With an allowance of 20 percent for wastage, this accounts for 1.6 million tons of cassava. In view of the availability of maize and the starch manufacturer's preference for maize starch, it is visualized that the demand for cassava from starch manufacturers may not show a substantial increase. Therefore it is assumed that the utilization of cassava for starch preparation in the near future will increase only marginally.

As pointed out earlier, there is ample scope for using cassava in cattle feed manufacturing. It is estimated that the shortfall in concentrate feeds of plant origin in 2000 will be at least 5.8 million tons. Since about 25 percent of this deficit could be made up from cassava, there is a demand for about 1.4 million tons of dried cassava for this purpose. Assuming the ratio between raw cassava and dried cassava to be 2.75 : 1, the demand for raw cassava in 2000 for animal feeds will be about 3.9 million tons.

In addition to the industrial demand for domestic markets, it is possible to export cassava pellets if the raw material cost can be brought down. During 1985, the export price of cassava pellets from Thailand was about U.S. $85 per ton and if the cost of cassava can be brought down to about Rs 350 per ton it may be possible to compete effectively with export markets. With favorable prices and some export efforts, it is possible to achieve an export target of about 500,000 tons of cassava by 2000.

The total expected demand for cassava in 2000 is estimated to be 10.1 million tons. The potential uses are summarized in Table 45.

Table 45--Projected use of cassava

Use	1981/82 to 1983/84 Average	Projections	
		1990	2000
	(1,000 metric tons)		
Human consumption	2,956	3,330	3,865
Starch[a]	1,625	1,750	1,875
Cattle feed	820	1,850	3,850
Exports	...	100	500
Total	5,401	7,030	10,090

Source: Calculations made by the author.

[a] This includes 20 percent waste.

DEMAND-SUPPLY GAP

The demand and supply projections indicate that by 2000, the potential demand for cassava will exceed the potential supply by 1.3 million tons. The alternatives available for bridging the gap are based on strategies depending on area expansion and yield increases. Since the scope for increasing the area under cassava in Kerala and Tamil Nadu above the projected levels is limited, filling the entire gap by area expansion will require an additional area of about 60,000 hectares from the other states. On the other hand if yield increases are considered, yields will have to rise to 28 tons per hectare, or an increase of 15 percent over projected yields, to fill the gap. In view of the limitations to increases in area, it may be necessary to concentrate on strategies to raise yields.

The key factor in realizing projected demand is the expansion of the domestic market through cassava use in cattle feed. Development of export markets is also a possibility. Both will involve favorable cassava prices, stable supply, and linkage of producers and processors through appropriate marketing arrangements. Technology has a vital role to play in expanding yield and reducing unit costs to levels at which cassava can compete effectively with other alternatives as an ingredient in cattle feed production and on international markets. Using cassava to its full demand potential and bridging the supply-demand gap will depend upon development and adoption of improved technology at the farm level, evolution of suitable processing technology, and integration of producers and processors with cattle feed manufacturers.

8. SUMMARY AND CONCLUSIONS

India accounts for about 2.6 percent of the world's area and 5 percent of the world production of cassava. Though cassava area in India reached a peak level of 3.9 million hectares in 1975/76, it declined to 3.0 million hectares by 1983/84. The peak production of 6.6 million tons was achieved in 1975/76, but by 1983/84, production declined to 5.8 million tons.

Cassava production in India is concentrated in the two southern states of Kerala and Tamil Nadu. In the chronic rice-deficit state of Kerala, cassava was popularized as a cereal substitute toward the end of the last century, and it continues to play that role even today. In Tamil Nadu, the Kanyakumari district (which is geographically contiguous to Kerala) produces cassava mainly for supplementing the rice diet. However, introduction of cassava in the Salem district of Tamil Nadu, which did not develop until after the Second World War, was influenced by the industrial use of cassava for the manufacture of starch. In 1960/61 Kerala accounted for about 88 percent of the cassava area in India, and Tamil Nadu accounted for another 9 percent. By 1983/84, Kerala's share of area had declined to about 76 percent and Tamil Nadu had increased its share to about 16 percent. More than half the area in Kerala came from the three southern districts of Trivandrum, Quilon, and Kottayam; Salem district alone accounted for more than half the area in Tamil Nadu.

During the 1960s, area under cassava in India increased at an annual rate of about 4 percent, with a growth rate of 3 percent in Kerala and about 9 percent in Tamil Nadu. However, from 1970/71 to 1983/84, Kerala had a negative growth rate in area (-2.3 percent), while Tamil Nadu had a positive growth rate (1.3 percent).

The all-India average yield of cassava during 1983/84 was about 19 tons per hectare (16.7 tons per hectare in Kerala and 31.2 tons per hectare in Tamil Nadu). Between 1960/61 to 1983/84, yields of cassava increased at an annual rate of 2.9 percent in Kerala and 7.2 percent in Tamil Nadu, resulting in an all-India growth rate of about 3.4 percent. While Kerala had a higher growth rate of yield during the 1960s than Tamil Nadu, the 1970s and early 1980s witnessed a negative growth rate of yield in Kerala and a growth rate above 8.6 percent in Tamil Nadu.

About two-thirds of the all-India production of 5.8 million tons of cassava in 1983/84 came from Kerala, and Tamil Nadu's share was about a quarter. During the 1960s, the annual growth rate of production of cassava exceeded 12 percent (about 13.6 percent in Kerala and

11.6 percent in Tamil Nadu). However, in the 1970s and early 1980s, Kerala had a negative growth rate of production (-3.3 percent) and Tamil Nadu's annual growth rate was about 10 percent. Between 1960/61 and 1983/84, production of cassava in India increased at an annual rate of 4.7 percent (3.6 percent in Kerala and 10.1 percent in Tamil Nadu).

Though cassava is not a major competitor of rice in terms of area allocation, the competition on the demand side is reflected in the allocation of other resources for cassava production. The major difference in the use pattern of cassava in Kerala and Tamil Nadu (as a cereal substitute or as an industrial raw material) has introduced major variations in their input use patterns and organization of production and marketing in these two states.

About 70 percent of the cassava produced in Kerala was used for human consumption in 1981. In Tamil Nadu, human consumption accounted for only about 25 percent of cassava production and it was mainly from the Kanyakumari district. Nonavailability of rice was the major factor responsible for increased cassava consumption. Data available from consumer surveys indicate that the income elasticity for cassava is high among the poorest households and declines with increased income, achieving negative values for high-income groups.

Though estimates of starch production vary, it is estimated that about 30 percent of the cassava production in India is used for the manufacture of starch. With another 55 percent of the production of cassava going for human consumption, only about 15 percent of the production remains for other purposes, such as directly feeding cattle.

Cassava prices showed large annual fluctuations. Retail prices of cassava were about 35 percent higher than the wholesale prices. With improved rice availability, the ratio of retail rice and cassava prices has fallen during recent years.

There has been an improvement in the production of livestock products, and this has generated improved demand for livestock feed. The supply of available raw materials for cattle feed is likely to fall short of anticipated demand. Utilization of cassava in manufacturing cattle feed can be an effective means to bridge the gap in feed availability.

Though research and extension on cassava is carried out only on a limited scale, it has been possible to evolve some high-yielding varieties. The cost of production of these HYVs is such that they can effectively compete with other raw materials used in the manufacture of starch and cattle feed, and at low competitive rates these varieties offer enough incentive for farmers to adopt improved cultivation practices to get higher yields.

Supply projections indicate that by 2000, cassava production in India may be about 8.8 million tons. Kerala's share will come down to

52 percent of the all-India production and Tamil Nadu's share will rise to 36 percent. The potential demand for cassava in 2000 will be around 10.1 million tons, consisting of about 3.9 million tons each for human consumption and cattle feed, 1.9 million tons for starch, and the rest for export. The major source of market expansion is likely to come from the use of cassava in cattle feed. Thus, by 2000, the likely demand will exceed the supply by about 1.3 million tons.

Increased dependence on technology will be the only answer to bridge the gap between potential demand and supply as the scope for increasing area under cassava beyond the projection of 3.6 million hectares is difficult to achieve. Realization of the potential demand is conditioned by the adoption of cassava as an ingredient in the manufacture of cattle feed, for which technical feasibility exists. However the economic feasibility of utilization of cassava in livestock feed will be conditioned by a reduced unit cost of production of cassava. Thus increased reliance on yield increasing technology is an important consideration in achieving the full potential use of cassava and in bridging the demand supply gap. It is also important to make reasonable estimates of the income from cultivation of cassava to the farmers so that enough incentives are available for adoption of new technology at the farm level.

Assured supply of good quality cassava on a continuing basis at competitive prices is important to induce feed manufacturers to switch over to cassava. Therefore, in addition to the existence of improved technology, it is important to evolve suitable processing facilities and to integrate cultivators and feed manufacturers through appropriate organizational mechanisms. Such integration has already proved to be effective in starch production in Tamil Nadu. Most cassava producers are small farmers and many of them may also have some cattle. Farmers' organizations are gradually undertaking the organization of milk collection and the supply of cattle feed. In this chain it may be also possible to introduce cassava, at least in the major cassava-producing regions, so that effective links can be established between the supply of cassava for cattle feed production, the distribution of cattle feed, and the organization of milk collection.

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