INTERACTION OF PRICE AND TECHNOLOGY IN THE PRESENCE OF STRUCTURAL SPECIFICITIES
An Analysis of Crop Production in Kerala

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CHAPTER 1

INTRODUCTION AND OUTLINE

The present study attempts to understand the agricultural economy of Kerala in terms of the structural characteristics specific to the state. This approach requires such aspects to be incorporated in the analysis, and also entails a shift from certain accepted modes of thinking and statistical treatment used in the analysis of field crops.

The specificities arise from certain distinctive features on the demand and supply sides[1]. On the demand side, there is substitution between rice and tapioca, and the two crops constitute the food group. The rest of the crops form the non-food group, and there is no substitution among the crops inter-se or with the crops in the food group. The lack of substitutability among crops at the level of consumption rules out synchronous movement of prices and relative price movements have an important bearing on production.

On the production side, area substitution is severely constrained by the specificities of agro-climatic zones - specificities which hold good far more in Kerala than in most other parts of the country. Thus rice lands, confined largely to the valleys and low - lying areas, can be shifted to the cultivation of coconut and arecanut only to a limited extent and that too at a great cost. Such conversion, however, is irreversible. Land under tapioca can be shifted to rubber, but again this change is irreversible. Uplands suitable for coconut or rubber cannot be shifted to paddy. Areas under tea, coffee, or cardamom - mostly at the high elevations - cannot be used for growing any of the other crops.

The distinctive features of the consumption and production levels give rise to certain structures. Rice and tapioca are substitutable on the consumption plane, but not very much so in terms of area. Tapioca and rubber are substitutable on the area plane, but not as far as consumption is concerned. As regards the rest of the crops, there can be no substitution on the consumption plane and very limited substitution in the areas under cultivation. All these result in the following structure. Rice occupies a distinct place in the whole crop spectrum because it constitutes the state's staple food, and the area under the crop has certain distinctive features. On the consumption plane, rice has a close nexus with tapioca, the two forming one group. On the area plane, tapioca is closely related to rubber and can be clubbed together. The rest of the crops stand on their own. Aspects of physical production also distinguish the crops. Rice is a seasonal crop, having three harvests. Tapioca is an annual crop, and most of the non-food crops are perennial tree crops with moderate to long pre-bearing periods or gestation lags and long life spans. These aspects of physical production give rise to particular structures of production for these crops.

The distinctive relationships between money wage rates, prices, technology and profitability of these crops which in turn have a bearing on their area, production and productivity, are an outcome of their structures of production. The agriculture of the state is dominated by cash crops most of which are perennials. In the latter case internal consumption in the state accounts for an insignificant proportion of the production and the bulk of it is exported. The crops which are significant on the consumption side are rice and tapioca and their prices have an important role to play in the determination of money wage rates. Between rice and tapioca rice is the preferred food item and tapioca is substituted for it during periods of relative scarcity and high prices. Such substitution leads to the price of rice having an influence on the price of tapioca. On the production side, as the area under tapioca is substitutable for the cultivation of rubber the price of rubber may also enter into the determination of the price of tapioca. The prices of perennials are determined independent of other food and non - food cash crops.

Other specificities of the economy and their consequent relations are to be considered. Given the higher density of population and the lower proportion of area under food crops the state is deficit in food and has been increasingly dependent on imports over the last century. The major proportion of food grain need is met by imports. This brings into focus the importance of availability of food from outside the state and the channels of imports as determinants of the prices of food crops within the state. The relatively low share of rice in the total area under cultivation, the growing use of high yielding varieties (HYVs), the favourable price of milk and the fairly rapid growth of milk production have combined to create a trend of growing imbalance between demand for and supply of paddy straw leading to steep fall in the price of rice relative to that of straw. The price of straw is therefore likely to have a bearing on the adoption of technology in rice production.

In short, this study is an analysis of crop production through these specificities, structures and relations indicated above. Before setting out the problem in detail, a background to the study is provided in terms of a review of the studies on Kerala. The feature which distinguishes Kerala from the other states of India is the paradox of a high quality of life with a low economic base. The social science research on Kerala also seems to have concentrated on these two features, but with greater emphasis on issues related to the quality of life and lesser emphasis on the productive sectors. We turn to an overview of these studies in the next two sections.

1. Background

Two significant developments seem to have influenced the course of social science research on Kerala roughly over the last three decades. The first was the capture of power, through the ballot box, for the first time ever, by a communist party in Kerala in 1957. The second, was the study carried out by the Centre for Development Studies (CDS) in 1975 on Poverty, Unemployment and Development Policy: A Case Study of Selected Issues with reference to Kerala. Since (development) policy and (political) power are inextricably linked, issues which had assumed importance in the context of the Communist ministry continued to draw major attention in the Kerala study and beyond.

The Communist Party of India coming to power in Kerala attracted attention of researchers world wide. They focused on the specific social circumstances which made possible the development of a working class and communist movement in Kerala. The success of the Communist Party was related by them to certain unique features of Kerala society such as its high literacy (Zagoria, 1973), breakdown of the matrilineal system (Robin Jeffrey, 1978), the skill of the Communists in utilising the caste divisions in Kerala (Fic, 1969) and so on. Simultaneously, two thrust areas of the successive communist ministries, namely agrarian reforms and the working class movements, which were the pillars of the evolution of the communist party in the two distinct regions of Kerala - Malabar, and Travancore-Cochin -emerged as areas of continuing interest among researchers[2]. The working class movements having taken shape in the traditional industries, studies about the movements could not ignore their fortunes.

The impulse behind the CDS study was the explicit recognition "that growth in terms of per capita gross product of developing countries would, in the absence of redistributive measures, prove inadequate to provide opportunities for a better life to the bulk of the population of these countries" (p.ix). Accordingly, "the focus of the study has been mainly on factors that have, or are likely to have, influenced disparities in income and consumption, on the impact that various development policies could have had on these factors and on the inferences that could be drawn from Kerala's experience about strategies of development in which attention is given from the outset to redistributive policies to ensure the minimum essentials of life to the poor" (p.153).

One of the main findings of the study was that "land reform in Kerala, together with the extension of the public distribution system of foodgrains (PDS) to cover the entire population, has helped the rural poor....." (p.150). The "rise in real wage rates of agricultural labourers", which could also be considered a redistributive measure, was also attributed to the "improvement in the position of the rural poor following land reform, the extension of education, growth of trade union organisation and the gaining of a foothold within the existing social and economic power structure made possible as a result" (p.150). Both these observations clearly reflected the issues which had been brought to the fore by the Communist ministry.

The dimensions substantiated by the CDS study were the role of the PDS, health and education in this development. The study hypothesised that the significant downward trend in birth rates, reduction in infant and child mortality, and longer life expectation on relatively low level of per capita income was mainly attributable to the development of health and educational services. The years mid-seventies witnessed the testing of the hypothesis, as it were, that the factors responsible for "the demographic transition " were the development of health and educational services. The impact of education on demographic behaviour pointed out by Nair (Nair, P.R.G.,1974) was examined further by Krishnan [Krishnan,1975; Panikar,Krishnan and Krishnaji,1977]. In later years the two areas, namely *educational development* in Kerala and health status of Kerala, drew major attention of researchers.

The development of the educational system in Kerala during the modern period is examined in a comparative setting by Nair (Nair, P.R.G.1981). *An attempt is made to identify* the factors that led to the development of the education system in the Travancore state from the second half of the nineteenth century. The factors identified are social competition among major communities for economic upliftment, changes in the land tenure system, cropping pattern, emergence of processing and export trade and development of land and water transport. Various dimensions-historical, political, religious and economic - of the process of educational development have also been analysed by Tharakan (Tharakan,M. 1984).

The detailed treatment of educational development in Kerala since 1921 in Nair (1983) has relevance for the light it throws on the forces operating within society which has led to the quantitative expansion, and the qualitative deterioration of education, a phenomenon which has attracted much research attention in recent years. The strategies adopted by government at different stages, the conflicts thrown up, the methods adopted for their resolution, the new orientation that the educational strategy received after the re-organisation of the state and the coming to power of the Communist party are the major issues discussed (Nair, P.R.G.1983). The quantitative expansion of education has created a pool of educated unemployed. With the growing numbers in the pool, a constant pressure to upgrade educational qualifications exists, leading to the massive expansion of higher education(Nair and Thomas,1984;Nair and Ajith,1984). This expansion is most striking in the proliferation of 'parallel colleges' run by private enterprise.

It may be recalled here that one aspect of employment discussed in the CDS study was the large share of the tertiary sector in the total employment in the state.Over the last eighty years,this is the only sector that has steadily improved its share in the total employment; the primary sector has shown a steady decline and the secondary sector has shown no significant increases,only a change in the composition, with the non - household industry gaining at the expense of the household industry. Within the tertiary sector, over half the employment is accounted for by the personal, social and community services. This is the sub-sector that has been accommodating a large part of the growing educated manpower. Could it then be that the pressure on the growing number of educated unemployed to upgrade their educational qualifications is a manifestation of their attempt to seek entry into the growing personal, social and community services?

The remarkable advances made by Kerala in basic indicators of health status highlighted by the CDS study has led to investigation of two sets of issues. One set of studies has sought to link the mortality decline with socio-economic indicators such as women's education,spread of health care and immunisation services etc. (Krishnan,1985; Caldwell,1986; Raman Kutty,1987). The second set of studies have taken up an altogether different dimension of health status in Kerala. The low mortality levels exist alongside high morbidity levels, and part of the problem of high morbidity is seen as one of perception(Kumar and Vaidyanathan,1988). At another level attempts have been made to relate high morbidity to socio-economic factors, public policy and the situation existing in the other sectors. In one word, high morbidity is seen as a reflection of economic backwardness (Panikar and Soman,1984; Soman et al,1990; Kannan et al,1991).

Thus, the issues selected by the CDS study were Public Distribution System (PDS), nutrition, education, health and demographic transition, besides the already dominant themes of agrarian reforms and working class movements. These issues and their various linkages, dominated academic enquiry during the decade, 1975-85.

The Gulf boom of the seventies and the migration of labour from Kerala to the Middle-East initiated studies on migration and remittances during the decade. In fact, studies on migration had begun before the Gulf boom. These studies however, focused on internal migration, especially from south Kerala(Travancore) to north Kerala (Malabar) from the later half of the twenties (Tharakan,1976; Joseph,1986). The migration of educated and professionally qualified manpower from the fifties to the western countries and Africa had also attracted the attention of researchers (Andrews,1983). However, the spectacular migration of the seventies has attracted the maximum scholarly attention. The migrants' socio-economic and educational background, employment status on return, economic conditions as a result of migration, and the quantum and distribution of remittances were the issues taken up for analyses. (Alwin Prakash,1978; Raju Kurien,1978; Mathew and Nair, P.R.G.1978; Radhakrishnan and Ibrahim,1981; Nair, P.R.G.1981; Gulati and Mody,1983; and Nair, P.R.G,1986).

2. The Productive Sectors

The counter-point to the achievements in health, education and the demographic transition was the low economic base,as posited by the CDS study and subsequently elaborated as a paradox of (economic) backwardness and development (See subtitle Panikar and Soman, 1984). The economic base itself was barely touched upon by the analyses. The first attempt to take up the question of backwardness was in the context of the industry of the state by the High Level Committee on Industry, Trade and Power in 1984 (Government of Kerala, 1984). A series of studies followed on the industrial structure, inter-industry linkages and growth potential (Subramaniam and Mohanan Pillai, 1985 and 1989; Albin,Alice, 1988); performance of state sector enterprises (Mohanan

Pillai, 1990; Ramachandran,V. 1987); and growth and performance of private corporate sector (Nirmala Padmanabhan, 1989). Together with the studies on traditional industries (Thomas Isaac, 1984; Kannan,K.P. 1983) a somewhat comprehensive account of the industrial sector of the economy of the state was gained.

The studies on modern industry seek to 'explain' the slow industrial growth either in terms of the high wage cost or the 'industrial structure' and are thus essentially 'inward looking'. These explanations ignore the larger question of the role of factors external to the industry, the relation between trade and industry, and between agriculture and industry. Trade is an important and dominant sector of the economy; its share in the state domestic product (SDP) (around 16 per cent in the early eighties) is close to the share of manufacturing (around 18 per cent). Trade dominates production both in agriculture and traditional industries because of their export orientation. If profits are considered an important source of investment, industrial growth cannot be understood without a systematic analysis of trade, its structure, linkages and profitability.

Recent work has shifted the focus in a small way to issues relating to trade.Thomas Isaac et al(1992a,1992b) have compiled data on inter-regional trade flows and attempted to analyse the inter-relationship between trade flows and the regional production structure,movement of terms of trade and the transfer of surplus through trade. The question of surplus is especially important given the history of the region. The entire import-export trade of Malabar at one time was controlled by foreign mercantile houses. By whom have the foreign mercantile houses been replaced, and where and how are the profits used; these are obvious questions that arise.

Compared to the numerous studies on the Public Distribution System, health, education, working class movements, agrarian reforms per se and in relation to the demographic transition, or even industrial structure and the potentialities and performance of this sector, studies on agriculture, the dominant sector of the economy in terms of its share in SDP are relatively few. Livestock and fisheries have been extensively researched. Besides analysing the inter-relationship between the bovine economy on the one hand and human population, techno-economic, ecological and institutional factors on the other, the role of draught power in Kerala's agriculture, the factors making for the increased productivity of dairy stock, and the generation and adoption of technology have been analysed in great depth (Nair, 1977, 1979, 1981, 1982,; Nair, Thara, 1988; George & Nair, 1984). The studies on fisheries have dealt with the emerging structure of production, economics of artisanal and mechanised units; on technological changes and its impact on fishery resources and fish workers; and on internal marketing of fish. Other studies have also gone into the structure, composition, and backward linkages, as also the trends and performance of the marine products export industry (Kurien and William, 1982; Kurien and Mathew, 1982; Kurien 1978, 1984 and 1985; John, 1976; Mathew, 1986; and Shajahan, 1987).

Studies on crop production however are relatively few and limited in scope, and have mostly concentrated on rice and coconut, the two dominant crops. Important cash crops have been neglected. Little attention has been devoted to coffee, arecanut, ginger, turmeric, cocoa and other such minor crops grown in the state. The few studies on rubber, tea, and pepper have confined themselves largely to the marketing and price formation aspects (Sunil Mani, 1983; George, Tharian, 1982 & 1984; George et al, 1987). Cardamom has received somewhat better treatment in that the studies on it have examined the demographic and socio-economic factors (including encroachment of forest land) behind the spread of cardamom cultivation. Trends in production, prices and the interaction between the two, and the constraints in increasing productivity and production (Nair, K.N. et al, 1989) have also been analysed and a fairly rigorous analysis of the historical evolution of the marketing system of this crop and the price realisation across size class of producers under the present system completed (Joseph, K.J. 1985).

Among the cash crops, only coconut has been studied in depth. Price movements of the crop, effect of imports of copra and coconut oil on domestic price and trends and seasonal fluctuation of price have been thoroughly analysed (Mathew, Jacob, 1978; Narayana et al, 1991). Marketing of the crop, the trading margins and the inter-linkages between the credit and product market have also been given some attention (Kurup, 1976; Hamed Kutty, 1986). An analysis of trends in area cultivated, production and productivity of the crop is common to many studies (Kuttappan, 1981; Narayana et al,ibid.). Interestingly, coconut is the only tree crop, studies on which have attempted to incorporate the specificity of the crop namely, gestation lag, yield profile over age of the tree and life span of the tree. Discussion of the development strategies for aging assets with specific reference to coconut palms in Kerala (Mukherjee,1981) and an attempt at developing a model of underplanting to explain the growth of production of coconuts in Kerala (Narayana,1990) are such examples.

Rice has also attracted much scholarly attention. The area shift from rice to coconut for the period 1960-1978 has been charted(Unni,Jeemol, 1981). Detailed investigation of labour use in rice cultivation has been undertaken, both at the aggregate level and at the level of different size class of producers (Vaidyanathan et al, 1989). Labour use in the cultivation of rice relative to that of tapioca has also been taken up (Ninan, 1986). Trends in area, production, productivity and the factors explaining growth has been the subject of detailed studies (George and Mukherjee, 1986; Sivanandan, 1986; Kannan and Pushpangadan, 1990). The problem of area shift from (Unni, Jeemol,1981) has been further analysed, particularly the rapid shift of area away from rice in the late seventies (Panikar,1981). The decline in price of rice and the relative increase in wage and other input costs are seen as responsible for this shift.

As is evident,these studies on crop production have a narrow focus; they are either concerned with individual crops or particular aspects of the crops. With few exceptions, merely the trends in area, production, productivity, exports, prices and so on have been analysed. One of the few attempts which goes beyond individual crop studies, is the analysis of the growth rates of three crop combinations-all crops, food crops and non-food crops- both separately and in comparison with the all-India pattern in respect of all crops (Sivanandan, 1986). The divergence is then explained by a decomposition of the effects into their area and yield components. Differential growth performance is sought to be explained in terms of six critical factors, land capability, irrigation, fertiliser, HYV, credit and price. A further elaboration of this finding (Kannan and Pushpangadan,1988, 1990) points out that taking the crop sector as a whole there has been a stagnation in the sector since the mid-seventies. Both these efforts have remained largely empirical - statistical. Sivanandan's explanation was confined to six critical factors while Kannan and Pushpangadan identified the sources of stagnation to be the critical inputs of water and land development. Ending up with a discussion of the different models of agricultural development and their applicability to the Kerala situation Kannan and Pushpangadan's conclusion that "Kerala's agriculture seems to have reached a threshold warranting an induced innovation strategy so as to break out of its technological stagnation" seems questionable as it is arrived at neither by any systematic analysis of the factors involved nor by establishing any linkages between them.

3. The Problem

In brief, the object of this study is an integrated view of crop production in Kerala keeping in mind its specificities, structures and relations. It is an outcome of the recognition that although there are numerous studies on crop production, these studies have a narrow focus, being either related to individual crops or on particular aspects of the crops, and with few exceptions, have analysed the trends in area, production, yield, exports, prices and so on. Attempts to go further have led to explanations either in terms of universal categories such as price, wage, and technology, or in terms of critical inputs such as land, water, fertilisers, high-yielding varieties, and credit. The specificity of the crop or the specificity of the structure of crop production and the relations arising out of it have hardly ever been incorporated into the analysis.

To take an example, profitability is one of the major elements to explain the performance of crops. But given the cropping pattern of Kerala and varying intensity of labour use across crops, is it correct to assume that all prices affect the profitability of crops similarly? If food prices entered money wage-determination while non-food prices did not, analyses of crop performances, ought to take this into account.

However, studies on crop production do not incorporate aspects specific to the agriculture of Kerala. This is in stark contrast to the studies on other aspects of the economy which have often analysed issues in terms of certain structures and their linkages.

The question of structure warrants some clarification. While studies on livestock have dealt at length on the impact of ecology and crop pattern on draught power requirement or availability of crop residues,very little attention has been paid to the impact of developments within the livestock economy, for example its rapid growth, on crop production. Similarly, since PDS is dependent on supply from outside the state, its positive impact on consumption levels and welfare gains of various classes have been studied. But, how has this very system affected the foodgrain economy of the state is yet to be taken up. If the cash crops are all export crops (exported from Kerala), what governs the long term price movement of these crops and what is the internal response merits attention. Thus, certain processes in the economy can only be understood in the light of the structures underlying them. This is one of the major gaps in the existing studies on crop production and the present study attempts a beginning in the direction of overcoming such lacunae.

As indicated at the very outset the specificities of the agricultural economy of the state gives rise to certain structures and relations which in turn set out the structure of the study. As rice is the dominant item of consumption and is a major crop produced in the state it has a primacy of its own and its three relations raise three different issues for investigation. Wages, the supply through PDS dependent on imports and the livestock economy are the three relations and together these constitute one type of structure. Rice is related to tapioca on the consumption plane and that leads to the question of tapioca. On the plane of land substitution, tapioca is related to rubber and leads to the relationship of rubber and other perennials with their own specificities. Thus, there are three distinct structures to the study (1) Rice per se (2) tapioca in relation to rice on the one side and to rubber on the other, and(3) perennial crops per se. What is common to all the three structures is technology and through which the relationship with formal R & D is established at the end in this study. This is the overall structure of the study.

The thread of analysis here follows an elaboration of the structural specificities. One structural specificity which greatly simplifies the whole analysis, needs to be indicated at the very outset. This relates to the agrarian structure and relations. It may be questioned as to whether an analysis of the agricultural economy can be carried out without referring to the agrarian structure and relations. However, the fact that agrarian reform in Kerala over the two decades has made for an institutional structure which is largely based on peasant proprietorship would remove any doubt. On this issue, the comments of Raj and Tharakan may be recalled.

> "...... the southern part of the State (which formed part of Travancore) had been freed more than a century ago from the oppressive system of tenancy dominated by 'jenmies' which persisted in the north (particularly in Malabar) till very recently. This had helped to promote a highly commercialised

pattern of agricultural development based on peasant proprietorship and on an upper stratum of entrepreneurs with strong capitalist orientation. The land reform implemented over the last two decades after the formation of Kerala was not designed to change this pattern; their main thrust was in effect to extend to the northern districts what had already been accomplished earlier in the south" (Ghose, A.K.(ed.), 1983, p.71).

This makes it amply evident that the agrarian structure is differentiated in the state. Peasant proprietorship is the dominant form in paddy, tapioca, coconut and such other crops; but in the plantation crops the capitalist form is dominant. While it is important to take note of this aspect, it does not directly enter into the present analysis of crop production.

Structural Specificities

An elaboration of the structural specificities may now be undertaken. The agriculture of the state is characterised by a highly diversified crop mix, consisting of numerous cash crops and a few food crops. There is practically no crop substitution on the demand plane and hence no sympathetic movement of prices may be expected. Consequently, relative price movements will have an important influence on crop shift. On the cost side, the labour intensities of these crops are very different and hence movements of money wage rates will affect the profitability of crops differently. But money wage rates cannot be taken independently of prices. Prices enter into the determination of money wage rates. However, given the specificity of the consumption basket and the dominant role of rice in it, not all prices will enter into the determination of it. While the price of rice will have a deciding influence, prices of many other crops, which are export crops or industrial raw materials, and do not enter the consumption basket directly or significantly, will not have any influence. The specific wage-price relationship implies that the price of rice enters the cost of every other crop whereas the other prices do not show the same characteristic. It may be noted here that this distinction is comparable to the one made by Sraffa between basics and non-basics.

It is imperative then to estimate the strength of the wage-price relationship before proceeding further. A distinction may be made between estimating the strength of a relationship and offering an explanation for it. This study confines itself to the estimation of the strength of the relationship. Using this relationship the profitability of crops is worked out to arrive at conditions for the shift away from rice, given the movement of price and yield. The effect of price and yield changes are then taken up step by step.

Turning to the question of the price of rice, it may be noted that Kerala's public distribution system (PDS) is marked by 100 per cent coverage and rice is the main item supplied through the ration shops. This rice has come to account for nearly 50 per cent of the total supply of rice in the state. In recent years, it has come to depend entirely on supplies from outside the state, the procurement within the state being negligible. The larger supply through the PDS, especially to all income classes, means that the demand in the open market is depressed to that extent, which in turn depresses the farm prices within the state. That in itself need not have affected the rice crop in the state if yield improvements had been large enough to compensate for the losses on account of depressed prices.

The recent yield improvements elsewhere in India have been dependent on shift of area from unirrigated to irrigated and on the adoption of HYVs. As far as rice in Kerala is concerned, in parts of the state owing to the agro-climatic conditions and the location of the paddy fields, the yield potential of the HYVs has been affected. Consequently, the yield differentials between HYVs and the traditional varieties (including the nationally improved varieties) have been low in many parts of Kerala.

Livestock development is crucially linked to the availability of crop residue. But in Kerala a spectacular growth of livestock - mainly for milk production and not for draught power - has taken place despite a poor crop base. Such growth has depended largely on purchased feed and fodder. This has drawn the only fodder available in Kerala, namely paddy straw, into the market nexus. Thus, on the one side the increasing supply of rice through the PDS has dampened its price in the open market and on the other side, the spectacular growth of livestock has boosted the demand for the by-product, namely paddy straw. The relatively low and declining share of rice in the total area under cultivation and the rising demand for straw consequent to the rapid growth of milk production have contributed to create a situation of growing imbalance between demand for and supply of paddy straw. This has caused a rise in its price. Such movements of price will obviously have an adverse impact on the price ratio of paddy relative to straw. Given the adverse straw to grain ratio of the HYVs relative to the traditional varieties, it would have an impact on the adoption of HYV rice in Kerala.

Tapioca, a tuber grown in Kerala is used as food. Although rice is the preferred food, tapioca has always been used as a substitute in periods of low availability. Thus, the demand for tapioca is related to the availability of rice. But, on the supply side the area under tapioca is also suitable for the cultivation of rubber. The price movements of rubber relative to tapioca will thus make for an area shift away from tapioca. But since tapioca is an annual crop and rubber is a perennial, the shift to rubber is irreversible. Clearly, the fortunes of tapioca are tied to rice on the one side and rubber on the other: which of the two has come to exert a stronger influence on the production and price of tapioca is of considerable interest.

Having so far elaborated on the food crops, attention may now be turned to the cash crops in the economy. Many of the cash crops grown in Kerala are perennials characterised by long gestation lags or pre-bearing periods. Two issues are particularly of interest with regard to these crops; first,the 'violent' fluctuations in the prices and second, the supply response to price changes. Owing to the long-gestation lag, the area response would get translated into an output response with a time lag. And if the yield response is the one associated with the introduction of improved varieties - other types of yield response, related to fertiliser, irrigation, etc. are not very important -then this would also get related to the area response in a broader sense, inclusive of replanting.

The starting point for the analysis of both the price question and the area question is the demand. As most of these crops are export dependent, issues such as changes in the overall demand, movements of Kerala's share in this overall demand etc.need necessarily to be taken up in the analysis of the demand scenario facing the agriculture of the state. This is beyond the scope of the present study. Hence, to begin with, certain demand scenarios may be drawn out and then attention turned to the area question, incorporating into the analysis the two structural specificities, namely long gestation lag and life span of the tree. The resultant model generates patterns of growth in area, yield and production. Together with the demand scenario the pattern of production growth can then be used to raise the issue of the 'violent' fluctuations in the prices.

While working out the profitability conditions of crops, the movements of prices and yields have been held constant. Having unfolded the problem of prices starting with rice, turning to tapioca and ending with the perennials, the movements of yield have to be examined. In this connection, it must be noted that Kerala is a state with numerous public-funded research stations and laboratories. These research stations, it is often claimed, have come out with yield improving varieties but their adoption has been poor largely because of lack of enterprise on the part of the cultivators. Nevertheless, it is seen that adoption rates themselves vary very widely across crops under widely divergent agro-climatic zones. This raises an important question. If lack of enterprise is the reason for the non-adoption of varieties developed by the research stations, how come high rates of adoption are seen in the case of some of the crops? A specific characteristic of the Kerala society, namely its high levels of literacy and readership, may provide some insight into this matter.

At issue is the question of the larger worth of education in the sense of "it enhancing a person's ability to identify alternatives and to assess and compare, and adopt when judged desirable" and how it leads to selective adoption of technologies in particular situations. Such selective adoption of technologies by a fairly literate society can then be taken as a good assessment of the desirability of the technologies evolved by the research stations. Going by this criterion, can it be said that the technologies developed are desirable? The yield performance of crops brings up this crucial question.

Before concluding this statement of the problem, a word of clarification on the method of statistical analysis followed in this study is essential. The shift away from certain accepted modes of thinking for the analysis of field crops means that the statistical treatment carried out have also been somewhat unconventional.The cornerstone of the approach followed in this study is exploratory data-analysis for characterising the patterns or relationships revealed by it, which is followed by analytical reasoning.

Following the principle of going from specificities to structures to relations, the statistical treatment in this study is also inherently partial. No explicit econometric modelling, or estimation of an economy wide or sector wide model is attempted. The only exception is tapioca, which is the only crop for which relations get completely specified. For the other crops, a certain specificity, or structures and relations arising out of it, is sought to be drawn out or explicated. Both rice and the plantation crops are open-ended. For rice, the supply is conditioned by the flow through the PDS, the quantity and the price of which are set from outside. For the plantation crops the demand is set from outside. Given these conditions from outside, the internal response is modelled.

Beginning with a specificity, a structure is set out. Certain relations or inter-connections are arrived at. This is translated into data analysis as follows. Either the movement of a variable is characterised, or a relationship or pattern is discovered between a set of variables using techniques of exploratory data analysis. This is followed by confirmation, that is, the estimation of parameters or strength of relationships as the case may be. Then, the estimated relationship is either explained or used to explain some other observed phenomenon. The explanation itself is on the basis of analytical reasoning, wherein simulation exercises are carried out wherever they help clarify certain issues. The need for simulation in fact arises from the very approach taken. Because the statistical treatment is partial, comparison with other crops or situations calls for simulation.

One limitation still needs to be mentioned. As already indicated the number of cash crops grown in Kerala are many, each with its own specificities. The study does not claim to be comprehensive in its coverage of crops; it is selective and the selection of crops itself is based on two very different considerations. One, the crop is selected for its ability to represent a particular aspect which is dominant in the agriculture of the state. Second, an equally weighty consideration is the availability of data for illustrating the points made. Needless to add these two considerations do not always go together. So, quite often logical deduction has dominated empirical substantiation.

OUTLINE

Following the introduction, Chapter 2 provides an account of the data base of the agricultural economy of Kerala. The reliability and comparability of the estimates of area, yield and production are gone into. The chapter sets out the limits within which the data could be used.

Chapter 3 is an explanation of the area shift away from rice in Kerala in the post-1975 period in terms of relative profitability. The dominant position of rice in the consumption basket of agricultural labour is incorporated in the analysis in terms of a relationship between money wage rate and the open market price of rice. With the internalising of wages, the relative profitability can be expressed as a function of relative prices, yield and labour intensities. Given the long term constancy of labour intensities, movement of relative prices and yield performance explains the movement of relative profitability and crop shift. The questions of the movement of price and yield performance themselves, are left open, to be taken up in Chapters 4 and 5 in that order.

Chapter 4 takes up the question of the distribution of rice through the Public Distribution System (PDS). At the very outset, an analysis of the share of PDS rice in the total availability of rice in the state is provided. Its distribution across expenditure classes is then presented. It is then shown that import dependence of the PDS and distribution of rice to all income classes and especially to the upper income classes, depressed the price of rice in the post-1975 period in the state.

The yield performance of rice is examined in Chapter 5. Since the late sixties the yield performance of rice is inextricably linked to the adoption and performance of high-yielding varieties (HYVs) of rice.

Kerala has reported one of the lowest intensity of adoption and even this rate has shown a decline since the late seventies. Given the agro-ecological specificities of the state and the generally wet growing seasons, the HYVs, which thrive under conditions of proper control of water have not been able to outperform the traditional varieties. The spectacular growth of livestock and milk production has generated demand for paddy straw raising its price. The higher straw content of the traditional varieties together with the relative prices operate upon the low yield differential of HYVs in relation to the traditional varieties. This inter-relationship of factors has come in the way of the adoption of HYVs, in turn resulting in low and declining intensity of adoption.

Chapter 6 discusses the specific case of tapioca, a constituent of the food group. It is argued that the sharp fall in production in the post-1975 period is more due to supply side factors than owing to a fall in demand, in the wake of increased availability of rice. An analysis of area under crops during the period shows an area shift over to rubber in the face of the rising price of rubber relative to tapioca. The sharp fall in production led to a rise in the price of tapioca relative to rice.

Chapter 3 pointed to the rising prices of non-food crops in the post-1975 period. Chapter 6 assumed the sharp increase in the price of rubber. What has however not been explained is the existence of long cycles in the prices of perennial crops. Chapter 7 develops a model of area response to explain the production and price cycles of perennial crops. The model is set out in terms of phases of area expansion, phases of replanting and phases of yield growth wherein the former two respond to price signals and the latter is related to the phases of area expansion.

Chapter 8 is an exercise in empirical estimation of some of the equations of the model developed in Chapter 7. The crops taken are rubber, arecanut and cardamom.

Chapter 9 examines the question of technological change with reference to the perennial crops and critically evaluates the claim made by the research stations. Going by the criterion of selective adoption of technology being linked to levels of literacy, it can be concluded that the major problem with the agricultural economy of the state is the poor performance of the formal R & D system in generating technologies.

Chapter 10 is the conclusion.

An appendix at the end provides a descriptive account of the diversity of physical environment, the diversified cropping pattern and the demand situation facing the agriculture of the state. The appendix is intended to provide the necessary background for the discussion carried on in the study.

Notes

1. A detailed account of these specificities is provided in the appendix.

2. See Thomas Isaac (1986) for a concise account of the role of the movements in the evolution of the Communist Party in the two regions of Kerala. The disproportionately large number of studies on these two issues contained in the survey of studies on agricultural development (Prakash, A., 1987) is a clear indication of the interest of the researchers.

CHAPTER 2

THE DATA BASE OF THE AGRICULTURAL ECONOMY

1. Introduction

In as much as the study makes extensive use of the data on area under various crops grown in Kerala and their yield and production a discussion of the data base becomes an imperative preliminary task. This is all the more necessary as different cropping systems exist in different agro-climatic zones of the State. The cropping systems are characterised by pure cropping and inter/mixed cropping of various types. The crops are also characterised by distinct output patterns, namely point output, output over a harvesting season and output over the year.

This chapter concentrates on the data base of the agricultural economy of Kerala. It is organised into six sections. Following this introduction, section 2 takes up the issue of estimation of area under crops; both plantation and others. Section 3 discusses the estimation of yield, but confines itself to crops other than the plantation crops. Section 4 takes up the estimation of production, largely of the plantation crops. Section 5 is a discussion of the wage and price data. Section 6 points out the limits within which the empirical analysis may be carried out.

2. Estimates of Area under Crops

Two different systems exist for the collection of area statistics in India. In one, called the 'reporting system', the patwari (village level official) is entrusted with the task of collecting information on land use and area under crops in all units (survey number or holding) under his jurisdiction. It is a complete enumeration of all the holdings. In the second system, data is collected by the sample survey method. Kerala, along with Orissa and West Bengal, follows the sample survey method for the collection of data on area under crops.

In the erstwhile Travancore-Cochin state (now part of Kerala) the collection and compilation of data on land utilisation and area under crops was entrusted to the Department of Statistics (present Directorate of Economics and Statistics) in 1954. The sample survey system was introduced first in Travancore-Cochin and later extended to Malabar after the formation of the Kerala state.

Till 1975-76, the annual estimates on land utilisation and area under crops (excluding the plantation crops of tea, coffee, rubber and cardamom) were framed on the basis of the land utilisation surveys (LUS). The surveys were conducted in two rounds during each agricultural year and the sampling design was the following:

> "A stratified two stage sampling design with the taluk as the stratum, census village as the first stage and cluster of plots as the second stage sampling unit was adopted for the survey. The sample size for each stratum was fixed as 15 Census Villages at the first stage and 10 clusters of 5 plots at the second stage irrespective of the variation in size and other characteristics between strata, mainly due to cost considerations" (Nair, Somasekharan, 1983, p.35).

The sample size was slightly over one per cent of the total number of plots in the state. Stratum-wise estimates were obtained by pooling those for 'wet land' plots and 'dry land' plots and which were framed separately by the ratio method of estimation.

The estimates of area under crops obtained from the land utilisation surveys had some limitations. They could only provide estimates of area under major crops at the district level and that of minor crops at the state level with reasonable precision. Considering the heterogenity in the land use and cropping pattern prevalent in the state, a need was felt for moving away from the survey method to the enumeration of all the plots. However, the cost involved in any complete enumeration of the plots inhibited the State Governments, efforts in this regard. Therefore, a variant of the complete enumeration, known as Timely Reporting Scheme (TRS), was introduced during 1975-76. This scheme envisaged complete area enumeration of all the revenue villages in the state over a period of five years. The scheme started with the complete enumeration of 10 per cent of the villages during 1975-76. The percentage was enhanced to 15 in 1976-77 and then to 20 during 1977-78 and the subsequent years. By 1980-81, a complete enumeration of all the villages had been achieved.

Owing to the shift from area estimates based on land utilisation surveys to area estimates based on Timely Reporting Scheme in 1975-76, the area figures reported upto 1974-75 are not comparable with those reported beyond. The differences are sharp as may be evident from the data on area under coconut and rice provided in Table 2.1. The area under coconut which had been showing a steady increase till 1974-75 would show a sharp drop between 1974-75 and 1975-76 if one were to compare the LUS estimates with the TRS estimates. An attempt made by Jeemol Unni (Jeemol Unni, 1981; Table 1.7) to build a series comparable to the LUS series for 1975-76 to 1977-78 (shown within brackets in the Table) showed no such sharp drop in area between 1974-75 and 1975-76. Hence, the sharp drop observed is purely an outcome of the change in the system of data collection.

A similar discrepancy may be observed in the case of area under rice in all the three seasons. In Virippu[1] the area which hovered around 3.94 lakh hectares from 1968-69 to 1974-75 showed a sharp drop between 1974-75 and 1975-76. In Mundakan, it was a sharp increase from an average of 3.82 lakh hectares till 1974-75 to 3.96 lakh hectares in 1975-76 and in Puncha, the increase was from 0.99 lakh hectares to 1.05 lakh hectares. This looks unlikely given the tendencies till 1974-75 and beyond 1975-76. Thus, any analysis of area under crops over a long period can only be in terms of sub-periods.

Table 2.1

Area Under Rice and Coconut in Kerala (lakh hectares)

Year	Coconut	Rice (Virippu)	Rice (Mundakan)	Rice (Puncha)
1968-69	6.86	3.95	3.81	0.98
1969-70	7.08	3.94	3.82	0.98
1970-71	7.19	3.95	3.82	0.98
1971-72	7.20	3.95	3.82	0.97
1972-73	7.45	3.92	3.82	1.00
1973-74	7.45	3.93	3.81	1.01
1974-75	7.48	3.95	3.85	1.01
1975-76	6.93(7.51)	3.75	3.96	1.05
1976-77	6.95(7.53)	3.64	3.82	1.09
1977-78	6.73(7.30)	3.65	3.71	1.04
1978-79	6.61	3.47	3.46	1.07
1979-80	6.63	3.48	3.40	1.05

Source: Directorate of Economics and Statistics, Statistics for Planning (Various Issues)

Notes: 1. Estimates of area upto 1974-75 are based on LUS.
2. Estimates of area beyond 1974-75 are based on TRS.
3. Figure within brackets are from Jeemol Unni, op. cit.

The concept of area used is that of the gross area. This is evident from the instructions to the field staff, which run as follows:-

"it may be noted that the gross area concept will be followed with regard to the recording of area under crops. According to this concept, the area under various crops in one acre of land can be more than one area according to the intensity of crops. The following example will make this clear.

Let the crops grown in a particular survey number having a net area of 50 cents be as follows:

1. Banana - 400 (Nos.) 2. Pineapple - 1000 (Nos.)

3. Tubers - 10 cents 4. Tapioca - 5 cents.

Converting the crops grown in number into area adopting the standard per acre, the area under banana will be 50 cents (800 numbers per acre) and pineapple - 20 cents (5000 numbers per acre). So, the gross cropped area will be 50+20+10+5 = 85 cents". [Quoted in Jeemol Unni, op.cit.]

What is reported is the gross area. The corresponding net area is not reported and there is no way of deriving it either. This is applicable to the area under rice as well. The area under rice for all the three seasons is reported but not the net sown area under rice. The only instance of the application of the net concept is in the reporting of the net area sown in the aggregate.

With regard to the area estimates of crops like coconut, banana, arecanut, pepper and pineapple there is a further problem. For such crops what is estimated is the tree or plant population and estimates of area are arrived at by dividing the estimated population by the norm, that is, the number of trees per hectare, estimated from a sample of pure cropped plots in each district. Such estimates of area are representative of area only in a nominal sense; what is real is the tree or plant population of the crop which need not be the only crop in the area under consideration.

A serious problem arising out of the above method of using the estimated norm to arrive at an estimated area under the crop and of using the gross area concept is that, it effectively inhibits any inferences being drawn regarding the intensity of cropping. If the estimated norm shows an increasing trend for a crop, it could either be because of underplanting or actual increase in intensity. By applying this norm to the total plant population neither is an idea gained about the actual level of underplanting, nor of the intensity of cropping in the inter-mixed cropping systems. Further, such a method throws up estimates of area for individual crops in a basically inter-mixed crop regime without providing any idea about the mix itself. This creates serious problems in drawing inferences regarding crop shift.

The comparability and estimational problems indicated above do not affect the data on area under the plantation crops of tea, coffee, rubber and cardamom. The development of these crops are governed by separate Commodity Boards set up under Acts of Parliament. As per the relevant Acts, various statutory details in prescribed forms have to be submitted by the individual planters. The area planted has to be registered with the respective Commodity Boards in the case of tea and rubber and with the State Governments in the case of coffee and cardamom. Hence, the published data on area under the plantation crops represents the total registered area.

Nevertheless, there are problems with regard to the registered area under crops. The data are reliable only to the extent of the efficiency of the registration process. It is believed that the registration process is more efficient in the case of rubber and tea, compared to that of coffee and cardamom. In the case of coffee, the Coffee Board also publishes the unregistered area for some years. For example, during 1989-90 the registered area was 48070 hectares while the unregistered area was 21845 hectares. In the case of cardamom, the existence of the unregistered area could prove to be a serious problem. This has been explained by the lax administrative procedures involved in the registration, cultivation of the crop in government lease lands, and large-scale encroachment of forest land for the purpose of cultivation.

3. Estimates of Yield

Estimates of yield of paddy are arrived at using crop-cutting experiments, initiated in the erstwhile Travancore-Cochin state in 1950. The crop-cutting experiments are also used to arrive at the estimated area, mean yield and production of "high yielding" and "other" varieties of paddy. Thus, the area under high yielding varieties of paddy are estimates based on sample surveys. While the overall area under paddy and its mean yield are estimated for each taluk, the area and mean yield of high yielding and other varieties are estimated for each district. Crop-cutting experiments to estimate tapioca yields were initiated in 1964-65. Estimates of mean yields for the state as a whole and for each district are based on these experiments.

In the case of crops other than paddy and tapioca only conventional estimates framed on the basis of the enquiry reports of the Taluk Statistical Inspector are available. These estimates were revised on the basis of ad hoc sample surveys conducted for pepper (1954), sugarcane (1956), coconut and arecanut (1964) and cardamom (1967). These surveys, being ad hoc in nature, were not useful to revise the yield rates annually.

Since 1976-77, yield estimation surveys have been integrated with the TRS. With this, regular crop-cutting experiments are conducted not only for paddy and tapioca but also for coconut, arecanut, cashew, pepper and cocoa (from 1982-83 only). Since 1977-78, important minor crops have also been brought under the purview of yield estimation surveys in a phased manner. With the integration of yield estimation with TRS, the selection of plots for crop-cutting experiments for each taluk was confined to revenue villages selected for the TRS for the year. A stratified multistage random sampling design was adopted for the crop cutting experiment. The taluk was taken as the stratum, revenue village as the first stage unit, survey sub-division numbers as the second stage units and a plot as the ultimate sample unit. For paddy, the ultimate unit is a square plot of side 5 metres. The produce from the plot is harvested, threshed, winnowed and the weight recorded. For tapioca, 'wet' and 'dry' plots are selected. A square plot of side 2 metres is fixed and all tapioca plants falling inside the plot are harvested. For coconut, arecanut, cashew, pepper, cocoa and plantain, five bearing trees are selected from each of the selected plot. In respect of mango, jack and drumstick only two trees are selected. It may be noted that in the case of all these crops, except banana, harvesting is carried out at many time points and nuts which have fallen are collected throughout the harvesting season. In such a situation weighing or counting the harvest in the presence of the investigator is probably impossible and the yield recorded by the investigator is that reported by the cultivator.

On the basis of the results obtained from the crop-cutting experiments average yield estimates are arrived at. For paddy, average yield estimates are available from the taluk level upwards. For the other crops, district-wise and state-wise estimates are constructed.

A careful examination of the results of these surveys for the year 1977-78 showed that:

> "...the estimates of average yield per unit area show large variation between districts, the coefficient of variation ranging from 14 per cent to 40 per cent for the different crops. This is probably an indication that the district-wise estimates are less reliable than that of the state mainly due to small sample size at the district level...." (Nair, Somasekharan. op.cit., p.38)

It is evident that the state-level estimates of yield are fairly consistent over time but the district-level estimates are not. The 'noise' in the district-level estimates being high, the results arrived at using the data may have certain weaknesses.

Two problems become obvious with the available data on crop yields. Firstly, reliable time series data are not available for many crops over a long period of time. The exceptions are rice and tapioca among the field crops and tea, coffee and rubber among the plantation crops. For tapioca a reliable series on yield can be built up from 1964-65. For the plantation crops series on yield exist from the early fifties, if not earlier.

Secondly, the suitability of crop-cutting experiments for the estimation of yield of perennial crops characterised by harvests over a period of time during a season or over the year is questionable. The seriousness of the problem may be gauged by comparing the official estimates (based on crop-cutting experiments) of yield of coconut with the estimates arrived at by the Coconut Root (Wilt) Survey.The Root (Wilt) Survey was carried out in the southern districts of Kerala to measure the intensity of the disease in both the pre-bearing and bearing palms and to estimate the loss in production and productivity consequent to the development of the disease. The sampling design adopted by the survey [details of which are contained in the Report (Central Plantation Crops Research Institute, 1985)], is not very different from that for crop-cutting experiments. There is, however, an important difference in the procedure for the measurement of the yield at the level of the plot. Under the crop-cutting survey, the investigator is supposed to visit the plot as many times as the crop is harvested in a year and record the harvest. However, in practice, the investigator records the yield reported by the cultivator. The Root (Wilt) Survey followed a very different approach. A tree climber accompanied the investigators to all the plots. He would climb up the tree and count the nuts in two rounds, first in August, 1984 and then in February, 1985. The exact procedure adopted was as follows:

> "The palms selected for yield observation were given bands with paint for future identification. Number of nuts in bunches, which are five months and above in maturity, was counted and recorded by climbing

on to the crown. The youngest bunch so counted was also tagged for future observations" (Central Plantation Crops Research Institute, op.cit., p.8).

The assumption underlying the five month cut-off point is that button-shedding comes to a stop by about five months and the number of nuts in a bunch stabilises. Hence, the same number of nuts are available for harvesting at maturity. 1984-85 was an exceptionally good year after the bad harvest of 1983-84. But the difference between the official estimates and the Root (Wilt) Survey estimates were striking. As is evident from Table 2.2, the Root (Wilt) Survey estimates were 34 to 108 per cent higher than the official estimates. This in itself need not affect a time series if there were reasons to assume that the extent of under- reporting remained the same or moved in a predictable way over the years. But given the variations across districts (Col.4, Table 2.2) such an assumption does not seem to be valid.

Table 2.2

Average Yield of Coconut in Kerala, 1984-85

District	Number of Nuts per Bearing Palm		
	Root (Wilt) Survey	Official estimate	Col.2 / Col.3
(1)	(2)	(3)	(4)
Trivandrum	77	37	2.08
Quilon	54	38	1.42
Pathanamthitta	59	32	1.84
Alleppey	49	36	1.36
Kottayam	35	23	1.52
Idukki	49	24	1.88
Ernakulam	59	44	1.34
Trichur	63	38	1.65

Sources: 1. Central Plantation Crops Research Institute, 1985.

2. Directorate of Economics and Statistics.

For the plantation crops, estimates of yield are arrived at on the basis of production and area data compiled by the respective Commodity Boards. The method of compiling the area data has already been gone into in section 2. Section 4 below takes up the question of production data.

4. Production Estimates

From the discussion of sections 2 and 3 it is clear that two different systems have evolved for the estimation of crop production in Kerala. For all the crops, except the plantation crops, the estimation procedure involves the combining of the estimated area or plant population with the estimated yield. And the production estimates are reliable only to the extent of the reliability of the area and yield estimates.

Some idea of the serious problem with the production estimates of the non-plantation crops because of the non-reliability of the area and yield estimates, may be had by comparing the trade estimates of production of pepper with the official estimates. The former were consistently higher than the latter over a long period of time. In fact, the net exports of pepper from the state were 30818 tonnes and 44387 tonnes in 1975-76 and 1980-81 respectively while the official estimates of production for the corresponding years were 24580 tonnes and 28519 tonnes respectively.

For the plantation crops, the primary source of information on production data is the respective Commodity Boards. For coffee, the Coffee Act stipulates that "every grower in respect of each estate owned by him should submit a monthly return furnishing the crop picked at the estate" (UPASI, 1983, P.75). Further, the coffee growers are under statutory obligation to deliver their entire crop to the Board. On the basis of the information contained in the returns and the delivery of coffee by the growers, the Board estimates the annual production of the crop.

The Cardamom Rules, 1966, stipulate that every registered grower send to the Board a return of the actual crop harvested. Further, the registered dealers and auctioneers are also required to submit returns on the quantity handled by them, that is, auction sales and direct sales outside the auctions. Based on the information provided by the growers, dealers and auctioneers the Board estimates the production of cardamom in the state.

In the case of tea, each factory producing either black or green tea is required to submit a return to the Central Excise Authority and this forms the nucleus of production base. But these are available with a time lag. The tea planting associations also compile production statistics from all the estates whether registered with the Tea Board or not.

For rubber, all the registered growers are statutorily bound to submit yearly returns containing information on area, production and employment. A small percentage of these returns are supposed to be verified by the field officers of the Board. The officials also make some adjustments to cover the unregistered estates while finalising the data.

The production data published by the commodity boards suffer from certain weaknesses owing to the existence of unregistered area, lax verification of the returns by the staff, sales taking place outside the stipulated channels and so on. As regards coffee a study on data base says,

> "Even though all coffee growers are expected to give a statement relating to the area to the State Government and production to the Coffee Board every year, only very few observe this rule. It is expected that the Coffee Inspectors should go round and collect the required statistics and verify the returns received from the cultivators. Due to inadequacy of field staff, wide dispersal of the crop area and large number of cultivators the present system does not seem to be effective. There is significant under-reporting of both area and production" [Joseph, P.T., 1983, p.81].

Under-reporting is a problem with rubber, tea and cardamom as well; but the intensity varies. As both area and production estimates are not accurate the yield estimates also suffer from serious weaknesses.

5. The Data on Wages and Prices

This section turns to a discussion of the wage and price data. The problems with the wage and price data are of a different order when compared with the data on area, yield and production of crops in Kerala.

The only source of time-series data on money wage rates of agricultural labourers is The Agricultural Wages in India. The data are available for all the districts of the state and for various classes of workers over a long period of time. However, there are certain limitations of the data. Wage rates of labourers are collected on a monthly basis from selected centres, the selection of which does not follow any sampling scheme. The centres are changed as and when they lose their rural character. As there can be a significant difference between wage rates in any two centres within a district the reported series is subject to discrete jumps owing to change of centres. The data are collected from two leading agriculturists and two agricultural labourers and kind wages are converted into cash wages. However, no clearly laid down procedures have been evolved for the identification of leading agriculturists or for conversion of kind wages into cash wages. Further, state average money wage rates of male paddy field labour have been used. Owing to the infirmities in the procedures involved and the averaging resorted to - averaging over the months of the year and over the districts - the data used are only indicative of a broad trend.

The price data used in the following chapters are of various types. Retail prices of some of the essential commodities are collected from the district headquarters everyday. These are compiled and weekly, monthly and annual averages are regularly published. The retail price of rice used in the study is the annual average for the state. In estimating the wage - price relation, the price to be considered should have been the one taken from the centres from which wage data had been collected.

Farm prices of some of the agricultural commodities are collected every fortnight from all the taluks in the state. The data are collected from two or three representative cultivators in each selected centre. The farm price of paddy and tapioca used in the study are the annual averages. In many taluks paddy and tapioca are noy very important crops and fortnightly farm price data may simply not be available. Hence, the averages could be figures derived over different centres and over different periods.

In the case of rubber, the wholesale prices put out by the Rubber Board have been used. Data on prices published by the Board are simple averages of prices ruling in three major markets of the state. The data are collected from a sample of dealers. The annual average of a specific grade of rubber is used here. It is possible that the importance of this specific grade has changed over the years and the data used are only indicative of a trend.

The price of paddy straw used in the study is that put out by the Animal Husbandry Department. The department publishes monthly average price of paddy straw for selected market centres in the state. The averages over the market centres within a district have been taken and averaged over 12 months to arrive at annual average price. It is not known whether the published price is the price received by the farmer or the price paid by the cattle - keeper. If it is the latter and the margins have varied over the years then, it is not a very good indicator of the price received by the farmer. Further, the considerable variation in price during various months will definitely have a bearing on the valuation of paddy straw of the different crop seasons.

In interpreting the results of our analysis these limitations of the data are to be kept in mind. The attempt simply is to discover certain broad patterns rather than precise relationships.

6. Conclusion

From the discussion of the last three sections, it may seem that the data base of the agricultural economy of Kerala is weak. Area, yield and production estimates of many crops are either not reliable or not comparable over a long period. Naturally, some doubts may arise as to the nature of analysis that can be carried out with such data.

The shift from LUS to TRS in 1975-76 and the consequent non-comparability of the data on area does not permit any time - series analysis of the area under the crops over long periods, except for some of the plantation crops. Any analysis needs necessarily to take account explicitly of the two sub-periods, the first upto 1974-75 and the second beyond 1975-76. Within the sub-periods, analysis of area under some of the individual crops may raise problems owing to the concept of area used.Firstly, the concept of area used is that of gross area, except for the plantation crops. Secondly, area estimates are arrived at by dividing the plant population by the estimated norm. Hence, analysis of area under individual crops in comparison with the net sown area becomes a serious problem. Accordingly, it may be meaningful to talk about crop shift only when the intensity of cropping is taken into account. Similarly, it may be problematic to talk about area under high yielding varieties of rice in absolute terms as these are arrived at on the basis of crop-cutting surveys, but analysis of the proportion of area under high yielding varieties to the total area under rice may be quite in order. As these are estimates, the district level figures may contain lot more 'noise' and the results may be affected to that extent. Among the plantation crops, figures of area under both coffee and cardamom may not be accurate but no serious problems may arise in using those of the area under tea and rubber. In fact, the data on rubber is supposed to be the most reliable, mainly because only registered growers can avail the planting subsidy.

Turning to the estimates of production, they are fairly reliable for rice and tapioca. For these two crops, the estimates of area are reliable and estimates of yield based on crop-cutting experiments are quite in order. The two estimates together are fruitfully used to generate reliable estimates of production. The same cannot, however, be said regarding the estimates of production of the numerous perennials (other than the plantation crops). As their harvesting is spread over seasons or over the year, the yield estimates based on crop-cutting experiments are not reliable. The existence of trade estimates as seen in the case of pepper, prove the point. It is exactly because of this reason that the estimates of production of the plantation crops are more reliable; they are mostly trade estimates based on the returns from the dealers and auctioneers. Hence, in their case the published estimates of production may be fruitfully analysed.

Yield estimates are probably the weakest. In the case of plantation crops, this happens because of the unreliability of area estimates despite having reliable estimates of production. But among them rubber, probably, has the most reliable estimates. In the case of the other perennials, the inaccuracy of yield estimates is an outcome of the inadequacies of crop - cutting experiments to capture the extent of yield. That leaves rice and tapioca as the main crops which have reliable estimates of yield over a long period.

Compared to the problems of reliability and comparability of the data on area, production and yield of crops grown in Kerala, the problems with respect to the data on prices and wage rates are of a different order. In the case of wage and price data, the problems that come up are those of selection of centres, cultivators, and then of averaging over geographical units and over months of the year.

Owing to the problems of reliability and comparability of data, the results of our analyses are subject to certain limitations. The analyses simply attempts at discovering certain broad patterns rather than exact relations.

The study is based on the data from the following sources:

1. Government of India, Directorate of Economics and Statistics,

   (a) Agricultural Wages in India;

   (b) Agricultural Prices in India;

   (c) Farm Harvest Prices in India;

   (d) Area and Production of Principal Crops in India.

2. Government of India, Department of Statistics,

   (a) Sarvekshana.

3. Government of India, Ministry of Commerce,

   (a) Indian Rubber Statistics;

   (b) Indian Tea Statistics;

   (c) Indian Coffee Statistics;

   (d) Cardamom;

4. Government of Kerala, Directorate of Economics and Statistics,

   (a) Statistics for Planning;

   (b) Report on the Crop Cutting Experiments

5. Government of Kerala, Ministry of Agriculture,

(a) Bulletin of Animal Husbandry Statistics

6. Government of Kerala, State Planning Board, The Economic Review.

Notes

1. The three rice growing seasons of autumn, winter and summer are known as Virippu, Mundakan, and Puncha respectively in Kerala.

CHAPTER 3

LABOUR INTENSITY AND THE PRICE OF RICE IN THE AREA SHIFT OF RICE

1. Introduction

A striking feature of agriculture in Kerala in the post-1975 period is the overall stagnation in output contributed to a large extent by the relative stagnation in output of rice. This stagnation in output was contributed by a sharp decline in area under the crop, which has generally been explained by the declining profitability of the crop.

It has been noted by Panikar (1981), that 1974-75 was a turning point as far as paddy acreage was concerned. Ever since then paddy acreage has shown a declining trend, though before it, this was not the case. This observation has been confirmed by George and Mukherjee (1986) and Kannan and Pushpangadan (1990), henceforth KP. KP indicate that paddy acreage declined at 2.1 per cent annually between 1975-76 and 1985-86. These negative growth rates were also observed separately for the virippu (autumn), mundakan (winter) and punja (summer) crops, the rates being 2.6, 2.1 and 4.5 per cent respectively. A countervailing tendency, however, has been the increase over time in per acre yields, the rates being 1.6 and 1.0 per cent respectively for virippu and mundakan. The yield growth was insignificant for the punja crop.

Existing literature which tries to explain why paddy cultivation has reached such an impasse, has tended to focus on economic factors, mainly the role of prices and wage rates. Panikar underlined the price of rice and the wage rate of agricultural labour, while George and Mukherjee also found that the paddy price, the coconut price and the wage rate were important factors. KP by adding some elements of 'marginal analysis' to the pure empiricism of earlier researchers took up the profitability (defined as the difference between the growth rates in land productivity and product wage) trail and arrived at inconclusive results. KP compared trends in area with the trends in profitability in the two sub-periods, namely the period upto 1974-75 and the period after 1974-75 for ten crops at the state level. Although they claimed that "the area response in general is in conformity with the trend in profitability", their results showed many exceptions - eight out of twenty cases. In order to account for these exceptions, they applied an instability index of earnings. But that too did not give conclusive results. Their results showed that in a situation of declining profitability with low instability (lower than the average for all the crops) whereas paddy showed a sharp fall in area, both coffee and cashew were marked by an increase.

The case of arecanut follows the same inconclusive pattern. In the first period marked by declining profitability together with high instability in earnings (thrice the average) no clear trend in area is observed. However, increasing profitability (one of the highest) with high instability (twice the average) in the second period is accompanied by a decreasing tendency in area.

All these studies emphasise the role of prices and wages in explaining the sharp decline in area under paddy. There can be no dispute that prices play an important role in affecting the profitability of different crops with variations depending on the respective rates of price change. Can the same be said about wages? Can the movement of wage rates vary for different crops? It is generally held that wage rates will largely be uniform for the labour employed in different crops over a small geographical area. Even if they are different, it is argued (Krishnan,1991) that there is a remarkable stability in the differentials not only among the wages for agricultural operations but also between the wages for agricultural and non-agricultural operations. If this is so, then existing studies still need to explain why increasing wage rates should affect the profitability of paddy differently from that of coconut,or some other cash crop. This chapter makes an attempt at such an explanation in general and also with specific reference to the area shift away from rice in Kerala.

The chapter is divided into nine sections. Following the introduction, Section 2 sets out an analytical frame for bringing out the role of different forces that shape crop shift in Kerala. Section 3 provides a brief summary of the intensity of labour use among different crops and for rice over the last few decades. Section 4 estimates an equation for the movement of money wage rates in terms of the movement of price of rice. Section 5 is an analysis of the profitability of crops under different relative price scenarios when the price of rice enters into the money wage. Section 6 takes up the effect of changes in productivity on the profits. Section 7 is an analysis of profitability of a crop when the price of rice enters into its price determination. Section 8 applies the results of sections 5, 6 and 7 to explain the area shift of rice and tapioca. Section 9 is the conclusion.

2. Analytical Frame

In order to bring out the role of prices, yield and wage rates in influencing the profitability of crops in Kerala, it is necessary to set out an analytical frame. The need for such a frame arises because of the highly diversified cropping pattern and the complexity of the issues involved. The diversity of the cropping pattern is evident from the discussion in an appendix.

In shaping the cropping pattern farmers are not guided by relative prices but by relative profitability of crops[1]. In the Kerala context, as the hired labour cost is the major component of the paid out cost (see Table 3.1), the equation for profitability(π) may be written as,

$$\pi = Y P - L W ,$$

where Y is the productivity per unit area, P is the output price, L is the hired labour applied and W is the money wage rate.

Changes in π can come about on account of changes in any of the variables shown on the right hand side of the equation.

Taking prices first,it was indicated in Chapter 1 that agriculture in Kerala was characterised by crops which are not substitutable at the level of consumption. Prices will therefore not move in step and they will have a role in determining the profitability of crops. The same is the story with the productivity of crops. What governs the prices of different crops and what governs changes in the productivity of crops are taken up in subsequent chapters.What is of immediate interest is the cost side of the equation and the cost - price relation.

Turning to the cost side,if labour intensities were the same for all crops no changes in relative costs and hence relative profitability could ensue, however great were the changes in the wage rates. The key to the movement of relative costs of production (and profits) consequent upon a change in the wage rate lies in the inequality of the proportions in which labour are employed in the various crops. The differing proportions or intensities of labour use get translated into differing cost increases (equivalently declines in profit) consequent upon a unit increase in wage. Hence, it is necessary to present the problem of inequality in the labour intensity of crops before entering into the discussion of, changes in the profitability of crops consequent upon changes in the wage rate.

The wage increase itself cannot be treated independently of changes in prices and some prices may affect the wages to a greater extent than other prices. Rice being the 'wage good' par excellence, its price has a lot to do with the movement of the money wage rate, whereas the prices of many other crops - non-wage goods - grown in Kerala may not affect the wages at all. This would mean the price of rice enters the cost of production of all other crops, affecting their profits whereas the prices of other crops affect only their own profits. If this be called a wage-price structure of Kerala's agricultural economy, then this structure needs necessarily to be taken into account in any explanation of the changing profitability of crops in the face of changing prices. This chapter takes up these two components in the order indicated and offers an explanation for the sharp decline in area under paddy in the post-1975 period[2].

3. Labour Intensity

In this section, data are provided on the share of hired labour cost in the total paid out cost, the intensity of labour use in paddy cultivation from 1962-63 to 1984-85, and the variation in the hired labour costs across some of the crops grown in Kerala.

Table 3.1 presents the data on the share (per cent) of hired labour cost in total paid out cost for some of the important crops grown in Kerala. It may be noted that wage is the major component of the total paid out cost for all the crops. As is evident from Table 3.1, it accounted for over 60 per cent of the paid out cost and is the highest for rice.

Table 3.1

Share (%) of Hired Labour Cost in Total Paid Out Cost

Crop	Share (%)
Rice	64.62
Coconut	59.27
Tapioca	62.24
Arecanut	61.53
Pepper	57.17

Note: Average for 1980-81 to 1984-85.
For rice it is a simple average of three seasons.

Source: Government of Kerala, (Department of Economics and Statistics), Report on Cost of Cultivation of Important Crops in Kerala (Various Issues).

Table 3.2

Total Labour Use in Paddy Cultivation

Year	Human Labour Days Applied per hectare of Gross Cropped Area
1962-63	156.33
1963-64	152.40
1976	144.40
1977	149.80
1978	132.90
1980-81	170.10
1981-82	184.01
1982-83	179.60
1983-84	165.95
1984-85	127.90

Source: 1 For 1962-63 and 1963-64, Government of India (Directorate of Economics and Statistics), Studies in the Economics of Farm Management in Kerala (Various Issues).

2 For 1976, 1977 and 1978, Vaidyanathan, A. et.al. (1989) Labour Use in Indian Agriculture: Part II.

3 For the last five years, Government of Kerala (Department of Economics and Statistics) Report on Cost of Cultivation of Important Crops in Kerala (Various Issues).

Table 3.2 provides data on the number of human labour days applied per hectare of gross cropped area under paddy[3]. As is evident the intensity of total labour use has shown no systematic increase or decrease over the two decades. There is no reason to expect any sharp fall or rise in the labour use. Neither has mechanisation taken place to any significant extent nor has the introduction of HYV seeds made any difference to labour use.

A perusal of the Report on Cost of Cultivation of Important Crops for its latest two years, viz., 1983-84 and 1984-85 showed that of the total cost of hired human labour, bullock labour and machine labour, the share of machine labour was 8.62 per cent and 5.41 per cent respectively. This is very low.

As regards the effect of seed variety on labour use, Vaidyanathan et al report that "the shift to HYV varieties in Kerala is associated with lower labour absorption". (Vaidyanathan et al, 1989, p.143). They go on to elaborate,

> "The effect of seed variety on labour use, however varies across the seasons. In the two important cropping seasons, viz., Season 1 (autumn) and Season 2 (winter), the use of local seed variety is associated with higher labour absorption. But in Season 3 (summer), the use of high yielding variety seed leads to higher labour absorption". (op.cit., p.148).

The share of Season 3 in the total cropped area under paddy being around 12 per cent the higher labour use may not have much of an impact on the total labour use. Further, the intensity of HYV use itself has remained low in Kerala (See Chapter 5).

Table 3.3 provides data on the intensity of hired labour use of various crops grown in Kerala. The table provides data on the indices of hired labour cost per hectare of net sown area. Even if the wages vary across crops, the indices are roughly indicative of the intensity of hired labour use. The indices are computed per hectare of net sown area. This is necessitated by the duration of the crops. Most of the crops grown in Kerala are perennials and the intensity of labour use is estimated on an annual basis. The duration of tapioca is about ten months. But for paddy there are three cropping seasons and profitability per unit of land requires the accounting for of labour used in all the three seasons. The labour used in the three seasons are combined in the ratio 1:1:0.27, being proportionate to the distribution of gross cropped area over the three seasons.

The indices presented in Table 3.3 are striking. The intensity of hired labour use per unit of paddy land is more than double that of arecanut or coconut. Given such order of differences in labour cost among crops, this necessarily emerges as the key to the movement of relative costs of production consequent upon a change in the money wage rate.

Table 3.3

Indices of Hired Labour Cost Per Hectare of Net Sown Area (Cost of Paddy = 100)

Year	Hired Labour Cost Paddy (Rs.)	Paddy	Indices of Labour Cost			
			Coconut	Tapioca	Areca-nut	Pepper
1962-63	670	100	24	21	-	-
1980-81	3438	100	40	29	43	22
1981-82	4231	100	34	25	37	21
1982-83	4363	100	36	27	41	19
1983-84	4941	100	28	29	33	15
1984-85	5374	100	28	27	35	19

Source: Same as in Table 3.2.

In sum, wage is the main item of paid out cost for all the crops accounting for over 60 per cent of the total paid out cost. The hired labour cost per unit of land is the highest for rice and for most of the other crops it is well below 40 percent of that for rice. So, money wage rates play a crucial role in the determination of profitability of crops. But money wage rates cannot be taken independent of prices, as the price movements govern the changes in the former.

4. The Wage-Price Relationship

It is sought to examine which prices enter into the determination of agricultural wage rates. Various rounds of the National Sample Survey Organisation's (NSS) consumption expenditure surveys report that between 40 to 56 per cent of the total consumption expenditure in Kerala was spent on cereal and substitutes by the bottom five income classes. Rice is the cereal which accounted for the bulk of this expenditure (Sunny, K.P, 1988). Hence, it has a predominant budget share in the food basket of the lower income classes and it is the preferred food.

Bhattacharya et al (Bhattacharya et al, 1991) observed that there is a close relationship between the movement of money wage rate of agricultural labourers and cereal price:

> "When the relative price of cereals rises,this is most often caused by a rise in the absolute price of cereals (p), since the manufacturing prices seldom fall .... the money wage rate of agricultural labourers is rather sticky or at least does not rise up to the full extent of the price rise, their real wage rate(w) goes down. Similarly, when the relative price of cereals falls, this is very often accompanied by a fall in the absolute price of cereals/food and given the relative stickiness of money wage,the real wage rate is likely to rise. We thus expect an <u>inverse</u> relation between w and p" (p.110).

Rice being the dominant cereal consumed in Kerala, its price is the most relevant one. Baby (Baby, 1986) observed a close relationship between the movement of money wage rate of paddy field labour and the open market price of rice:

> "The movement of retail prices when superimposed on the movement of money wages shows a trend sychronisation in all the districts all through the time. It is seen that, over the period 1960 to 1980, whenever there was an increase in the retail price of rice, this was followed by an increase in the money wage rate, when the retail price of rice declined the money wage rate did not fall but increased at a lower rate or remained stagnant" (p.55).

Following the above two studies, a hypothesis of the relationship between money wage rate and open market price of rice may be posited. The money wage rate increases when the open market price of rice increases and the increase in wage rate is proportional to the increase in price. On the downswing of the price cycle, the money wage rate is sticky. That is, money wage rate does not decline when the open market price of rice declines.

The relation may now be set out in algebraic terms,

$$W_t/W_{t-1} = 1, \text{ if } P_t/P_{t-1} \leq 1;$$

$$= \beta(P_t/P_{t-1}), \text{ if } P_t/P_{t-1} > 1.$$

Where W_t and P_t are the wage rate and retail price of rice in year t respectively; β is a parameter representing the response.

Let us define a dummy variable, D as follows:

$$D = 0 \text{ if } P_t/P_{t-1} \leq 1;$$

$$= 1 \text{ if } P_t/P_{t-1} > 1.$$

Then, the above equation for W may be rewritten as,

$$W_t/W_{t-1} = 1 - D + \beta(P_t/P_{t-1})D$$

That is,

$$W_t/W_{t-1} - 1 + D = \beta(P_t/P_{t-1}) D$$

$$\text{or} \quad V2 = \beta V1,$$

where $V2 = W_t/W_{t-1} - 1 + D$,

and $V1 = (P_t/P_{t-1}) D$.

An attempt at empirical estimation of the above equation was made by taking up the annual average money wage rates of paddy field labour (men) and the annual average retail price of rice (open market), for the period 1960 to 1989. Equations were run with an intercept term and the price relative. The estimated equations are presented below.

(1) $V2 = 0.901\ V1$ $\quad \bar{R}^2 = 0.91$
$\quad\quad (23.54)^*$

(2) $V2 = 0.133 + 0.793\ V1$ $\quad \bar{R}^2 = 0.94$
$\quad\quad (3.43)^* \quad (20.23)^*$

Although the $\bar{R}^2$ values are very high the values of the DW statistic are around 1.25 indicating mild serial correlation. When lagged value of V1 is introduced as an additional explanatory variable serial correlation is removed.

(3) $V2 = 0.828\ V1 + 0.092\ V1\ (-1)$ $\quad \bar{R}^2 = 0.92$
$\quad\quad (18.68)^* \quad (2.035)^*$

(4) $V2 = 0.112 + 0.772\ V1 + 0.048\ V1\ (-1)$ $\quad \bar{R}^2 = 0.94$
$\quad\quad (2.48)^{**} \quad (16.65)^* \quad (1.07)$

Among the equations, (2) and (4) are better than (1) and (3).

The estimated wage equation is then of the form

$$V2 = \alpha + \beta V1,$$

$$\text{or, } W_t/W_{t-1} - 1 + D = \alpha + \beta (P_t/P_{t-1})D$$

To put it differently,

$$W_t/W_{t-1} = 1 + \alpha, \text{ if } P_t/P_{t-1} \leq 1 ;$$

$$= \alpha + \beta (P_t/P_{t-1}), \text{ if } P_t/P_{t-1} > 1.$$

The existence of a statistically significant intercept term in equation (4) indicates that during periods when price of rice was declining or stagnant there was an upward thrust on money wage-rates. That is, the movement of money wage rate was not only related to the movement of the price of rice but also to other factors. What are these factors, and how do they operate to bring about an upward thrust on money wage rates etc. are all important questions.but outside the scope of the present study. For this purpose, all that is required to be noted is that the relationship of money wage rate with the upward movement of the price of rice was rather strong.

When the price of rice fell, the money wage rate increased at a rate α irrespective of the rate at which the price was falling. When the price of rice rose, say at a rate r, the rate at which money wage rate rose was given by the formula $(\alpha+\beta+\beta r-1)$. It may be rewritten as $(\alpha+\beta-1)+\beta r$. If $\beta<1$, then $r\beta<r$. And if $\alpha+\beta<1$, then $\alpha+\beta-1<0$ and the total will be still smaller than $r\beta$. For the estimated values of α and β, a 30 per cent increase in the price of rice resulted in a wage increase of 17 per cent and a 80 per cent increase in price resulted in a wage increase of 57 per cent. Typically, the price increases, when they did occur, were sharp - between 30 to 50 per cent in the early sixties and the early seventies, and between 20 to 30 per cent in the early eighties - and the money wage rate too moved up sharply.

5. Relative Price Movement and Profitability When the Price of Rice Enters the Money Wage Rate:

Let Y be the yield and L the labour applied per unit of land in a year, P the price and W the money wage rate. Then, the equation for profitability of a crop (π) may be represented as,

$$\pi = YP - LW.$$

Let us think of a situation where there are two crops, rice and coconut, indicated by subscripts 1 and 2, the profitability of which are equal. That is,

$$\pi_1 = Y_1 P_1 - L_1 W = \pi_2 = Y_2 P_2 - L_2 W.$$

A uniform wage W is taken for the agricultural economy as a whole. A further simplifying assumption made is that the price at which Y is valued and the price which enters W are the same. Various cases may be taken up to analyse the effect of price changes on the profitability of crops.

Case 1: Both the prices are falling at a rate r.

Taking two periods Ø and 1, we may write,

$$P_1(1) = (1-r)\ P_1(\emptyset);$$

$$P_2(1) = (1-r)\ P_2(\emptyset).$$

and following section 3 on the wage-price relationship, we may write,

$$W(1) = (1+\alpha)\ W(\emptyset).$$

The equation for profitability becomes,

$$\pi_1(\emptyset) = Y_1\ P_1(\emptyset) - L_1\ W(\emptyset);$$

$$\pi_2(\emptyset) = Y_2 P_2(\emptyset) - L_2 W(\emptyset).$$

$$\pi_1(1) = Y_1 P_1(1) - L_1 W(1)$$

$$= Y_1(1-r) P_1(\emptyset) - L_1(1 + \alpha) W(\emptyset)$$

$$= (1-r) \pi_1(\emptyset) - (r + \alpha) L_1 W(\emptyset)$$

Similarly,

$$\pi_2(1) = (1-r) \pi_2(\emptyset) - (r + \alpha) L_2 W(\emptyset).$$

If in period Ø profitability of the two crops are equal, then we may write,

$$\pi_2(1) = \pi_1(1) + (r+\alpha) L_1W(\emptyset) - (r+\alpha) L_2 W(\emptyset)$$

$$= \pi_1(1) + (r+\alpha) (L_1-L_2) W(\emptyset).$$

$$= \pi_1(1) + (r+\alpha) (s-1) L_2 W(\emptyset),$$

where $L_1 = sL_2$ and $s > 1$.

Then $\pi_2(1) > \pi_1(1)$.

It may be concluded that a proportionate fall in prices of crops, leaving relative prices invariant, resulted in a fall in the profits of both the crops. But the decline in the profitability of rice is greater than that of coconut, the difference being proportional to the labour intensities of the two crops. As the labour intensity of rice is much higher than that for coconut (Section 3 above), the fall in the profitability of rice would also be much greater than that for coconut consequent upon a proportionate fall in prices of both the crops.

Case 2: Price of rice is falling at a rate r_1 and price of coconut is rising at a rate r_2.

Now, the equations for profit would be,

$$\pi_1(1) = (1-r_1)\ \pi_1(\emptyset) - (r_1 + \alpha)\ L_1 W(\emptyset).$$

$$\pi_2(1) = (1+r_2)\ \pi 2(\emptyset) - (-r_2 + \alpha)\ L_2 W(\emptyset).$$

And $\pi_2(1) = \pi_1(1) + (r_2+r_1)\ \pi_1(\emptyset) + [r_2+sr_1+(s-1)\alpha]L_2\ W(\emptyset)$

$$> \pi_1(1).$$

The profitability of rice would decline not only because of its declining price but also because of the increasing wage rate. The profitability of coconut would increase because of its price increase, and for $r_2 > \alpha$ the contribution of the second term on the R.H.S. of $\pi_2(1)$ would also be positive. Thus, in a situation marked by the falling price of rice and rising price of coconut, profitability of rice would show a sharp decline and that of coconut a sharp increase.

<u>Case 3:</u> Prices are increasing at rates r_1 and r_2 respectively.

Now the wage equation becomes,

$$W(1) = [\alpha+\beta(1+r_1)]\ W(\emptyset).$$

And equations for profitability become,

$$\pi_1(1) = (1+r_1)\pi_1(\emptyset) + [(1+r_1)\ (1-\beta) - \alpha]\ L_1\ W(\emptyset)$$

$$\pi 2(1) = (1+r_2)\pi_2(\emptyset) + [1+r_2 - \beta r_1-\alpha-\beta]\ L_2\ W(\emptyset)$$

$$= (1+r_2)\pi_2(\emptyset) + [(1+r_1)\ (1-\beta)-\alpha-(r_1-r_2)]\ L_2\ W(\emptyset)$$

The most striking aspect of the profitability equation for coconut, $\pi_2(1)$, is that the price of rice enters it in the form of r_1. Borrowing Sraffian terminology, rice may be called a basic good in that it enters the profitability of every other crop. The same cannot be said of any other crop. Thus, the price of rice not only determines its own profitability but also that of every other crop. This is of crucial importance in the elaboration given below.

The profitability equation for rice, $\pi_1(1)$, clearly brings out that for an increase of r_1 in the price of rice, the profitability increases by more than r_1, the second term on the R.H.S. being positive for all positive values of r_1, given $\alpha+\beta<1$. The increase in the wage rate being smaller than the increase in the prices, the difference between the two multiplied by the initial wage cost accrue as profit. Thus, given the wage-price relationship, that is, given the values of α and β, an increase in the price of rice causes more than a proportionate increase in profits. For the same increase in the price of coconut, the increase in the profit will be smaller because the second term on the R.H.S. of $\pi_2(1)$ has a smaller term in L_2 compared to L_1 in the case of rice. The higher labour intensity which made for a sharp fall in profitability in Case 1 now makes for a more than proportionate increase in profits.

In order to examine the impact of a change in the price of rice on the profit of coconut we need only compare the R.H.S of $\pi_1(1)$ and $\pi_2(1)$. The additional term in the equation of $\pi_2(1)$ is $-(r_1 - r_2)\ L_2\ W(\emptyset)$. This is negative for $r_1 > r_2$. This would indicate that an increase of relative price in favour of rice would push down the profitability of coconut through the unit wage cost.

Combining the two,

$$\pi_1(1) - \pi_2(1)$$

$$= (r_1 - r_2)\ Y_2 P_2(\emptyset) + [(1+r_1)\ (1-\beta) - \alpha]\ (s-1)\ L_2\ W(\emptyset).$$

Suppose, that $r_1 = r_2$. Then the first term on the R.H.S. will vanish. The second term stands for the gain on account of wage payment. As $\alpha+\beta<1$, there is a net gain on account of wage payment because wage increase is smaller than price increase by the amount shown within the parenthesis. The total gain is larger for rice because $s > 1$. If the price increase is also higher for rice, then there is a gain on account of the value of the produce (first term on the R.H.S).

On the whole, Case 3 clearly brings out that the profitability of rice is maintained only when relative price moves in favour of it. In such a situation not only the price effect on profitability is positive but also the wage effect. When relative price moves adversely for rice, not only the price effect but also the wage effect operating through the higher labour intensity, is adverse.

6. Yield Increase and Profitability

So far in the discussion the effect of changes in prices and consequent changes in wages, on profits have been considered, all along holding yield fixed. This condition may be relaxed at this point, in order to examine the movement of profits consequent upon changes in yield and to see how they compare with the movement of profits consequent upon changes in prices.

Case 1: Both the prices are declining at a rate r and yields are increasing at a rate δ.

Following case 1 of the previous section,

$\pi 1(1) = (1-r)\ (1+\delta)\pi_1(\emptyset) + [\delta(1-r) - r - \alpha]\ L_1W(\emptyset).$

$\pi_2(1) = (1-r)\ (1+\delta)\pi_2(\emptyset) + [\delta(1-r) - r - \alpha]L_2W(\emptyset).$

It may be seen that for $\delta = r/1-r$,

$\pi_1(1) = \pi_1(\emptyset) - \alpha\ L_1W(\emptyset)$

$\pi_2(1) = \pi_2(\emptyset) - \alpha\ L_2W(\emptyset)$

As $L_1 > L_2$, $\pi_1(1) < \pi_2(1)$; and $\pi_1(1) < \pi_1(\emptyset)$, $\pi_2(1) < \pi_2(\emptyset)$.

For $\delta = (\alpha+r)/1-r$,

$\pi_1(1) = \pi_2(1) = (1+\alpha)\ \pi_1(\emptyset)$ if the profits of both the crops are equal in the initial period. For $\delta > (\alpha+r)/1-r$, $\pi_1(1) > \pi_2(1) > (1+\alpha)\ \pi_1\ (\emptyset)$.

Thus, in a situation of declining prices and yield increases at rates lower than r/1-r, profits of both the crops decline. The decline in the case of rice is larger than that of coconut. For yield increase at rate $(\alpha+r)/1-r$, profitability of both the crops will be equal and will be higher than the initial value by a factor $(1+\alpha)$. The profitability of rice will be higher than that of coconut for productivity increases larger than $(\alpha+r)/1-r$. This would mean that for a 10 per cent fall in price of rice a yield increase of at least 23 per cent is required to maintain the profit, given the value of α and . On the whole, in a situation of declining price of rice, a small increase in the yield of rice will not be able to maintain its profitability.

<u>Case 2:</u> Prices and yields are increasing.

When prices and yields are increasing the complete equations for profits are,

$$\pi_1(1) = (1+\delta_1)\ (1+r_1)\ \pi_1(\emptyset) + [(1+r_1)(1+\delta_1-\beta)-\alpha]L_1 W(\emptyset)$$

$$\pi_2(1) = (1+\delta_2)\ (1+r_2)\ \pi_2(\emptyset) + [(1+r_2)(1+\delta_2)-\alpha-\beta(1+r_1)]L_2 W(\emptyset).$$

Let us consider three different combinations of r and δ.

(1) $r_1 = r_2$
$\delta_1 = \delta_2 = \emptyset$

$$\pi_1(1) = (1+r_1)\ \pi_1(\emptyset) + [(1+r_1)(1-\beta)-\alpha]L_1 W(\emptyset).$$

$$\pi_2(1) = (1+r_2)\ \pi_2(\emptyset) + [(1+r_2)-\alpha-\beta(1+r_1)]L_2 W(\emptyset).$$

It may be seen that $\pi_1(1) > \pi_2(1) > \pi_2(\emptyset)$. For comparable increases in prices, profits of rice increase faster than that of coconut.

(2) $r_1 = r_2 = \emptyset$
$\delta 1 = \delta 2 = \delta$

$$\pi_1(1) = (1+\delta)\pi_1(\emptyset) + (\delta-\alpha)L_1 W(\emptyset).$$

$$\pi_2(1) = (1+\delta)\pi_2(\emptyset) + (\delta-\alpha)L_2 W(\emptyset).$$

It is evident that for $\delta > \alpha$, $\pi_1(1) > \pi_2(1) > \pi_2(\emptyset)$ and for $\delta < \alpha$, $\pi_1(1) > \pi_2(1)$. For comparable increases in yield, profits of rice increase faster than that of coconut only when $\delta > \alpha$.

(3) $r_1 = \delta_2 = \emptyset$
$r_2 = \delta_1$

$$\pi_1(1) = (1+\delta)\pi_1(\emptyset) + (\delta-\alpha)L_1 W(\emptyset).$$

$$\pi_2(1) = (1+\delta)\pi_2(\emptyset) + (\delta-\alpha)L_2 W(\emptyset).$$

The equations are exactly the same as in (2) above.

A comparison of (2) and (3) shows that the profitability of coconut, $\pi_2(1)$, remains unaltered in the two situations: $r_2 = \emptyset$, $\delta_2 = \delta$, or $\delta_2 = \emptyset$, $r_2 = \delta$. That is, comparable increase in price or yield has the same effect on the profit of coconut. This cannot, however, be said of rice. A comparison of (1) and (2) shows that the difference, D, between $\pi_1(1)$ of equation (1) and $\pi_1(1)$ of equation (2) is $D = 1-\beta-r_1\beta+r_1-\delta_1$. If we set $r_1 = \delta_1$, then $D = 1-\beta-r_1\beta$. It may be noted that D is a function of r_1 and for small values of r_1, that is $r_1 < 0.25$, D is positive and for larger values of r_1, D is negative. This would mean that in the case of rice, between comparable small increases of price and yield, price boosts up profits more, while for larger increases, yield has this boosting effect. An important asymmetry between the two crops is observed. Comparable increases in price or yield have the same effect on any crop other than rice. In the case of rice a large increase in the price would not increase the profits to the extent that a comparable increase in the yield would. Thus, in the case of rice, to obtain really large gains in profit, increase in yield is the key, rather than that of price.

On the whole, in the case of rice whether to maintain profits in a situation of declining price, or to obtain significant increases in profit, the key is large yield gains. This is not the case with the other crops; yield increases and price increases stand on par for increasing the profit.

7. Relative Price Movement and Profitability When the Price of Rice Enters the Price of Tapioca

In this section we turn to a special case where the price of rice not only enters the cost through the money wage rate but also the price of the produce. The equation for the price of tapioca as estimated in Chapter 6 has the following form,

$$P_3 = a+bP_4+cP_1,$$

where P_3, P_4 and P_1 are the prices of tapioca, rubber and rice respectively. Taking such an equation for the price granted, the profitability equations for tapioca and rubber under different price situations may be worked out.

<u>Case 1</u>: Price of rice is increasing at a rate r_1 and price of rubber is changing at a rate r_4.

The complete equations for profit are,

$$\pi_3(\emptyset) = Y_3P_3(\emptyset) - L_3W(\emptyset).$$

$$\pi_4(\emptyset) = Y_4P_4(\emptyset) - L_4W(\emptyset)$$

Ignoring the intercept term in the price equation for tapioca,

$$\pi_3(\emptyset) = Y_3[bP_4(\emptyset) + cP_1(\emptyset)] - L_3W(\emptyset).$$

$$\pi_3(1) = Y_3[bP_4(1) + cP_1(1)] - L_3\left[\alpha+\beta(1+r_1)^{H}\right]W(\emptyset).$$

$$= Y_3[b(1+r_4)P_4(\emptyset)+c(1+r_1)P_1(\emptyset)] - L_3[\alpha+\beta(1+r_1)W(\emptyset)$$

$$= (1+r_4)\pi_3(\emptyset)+(r_1-r_4)cY_3P_1(\emptyset)+[1+r_4-\alpha-\beta(1+r_1)]L_3W(\emptyset).$$

Following the equations of profitability of coconut in section 5,

$$\pi_4(1) = (1+r_4)\pi_4(\emptyset) + [1+r_4-\alpha-\beta(1+r_1)L_4W(\emptyset).$$

The difference between $\pi_3(1)$ and $\pi_4(1)$ is on account of two different influences, namely price and wage. The difference between the price increases of rice and rubber operates through the coefficient of rice price, that is c, in the price equation of tapioca. The difference arising on account of the labour intensities is similar to that between rice and coconut. The price influence is an addition compared to the situations elaborated in section 5 between rice and coconut.

Comparing $\pi_3(1)$ and $\pi_4(1)$, it may be seen that one major difference is on account of the labour intensities. It is known that labour intensity for rubber is greater than that for tapioca, that is $L_4 > L_3$. Whether it boosts up or pushes down relative profitability depends on the sign of $[1+r_4-\alpha-\beta(1+r_1)]$. For sharp increases in the price of rubber relative to rice, that is for $r_4 >> r_1$, its sign will be positive. And the gain on account of the rubber price increase netted for the wage increase will be larger for rubber than tapioca. Further, for $r_4 >> r_1$, $(r_1-r_4)cY_3P_1(\emptyset) < \emptyset$ which will push down the profit of tapioca. Thus, for $r_4 >> r_1$ profitability of rubber will increase relative to tapioca.

For sharp increases in the price of rice relative to rubber, that is, $r_1 >> r_4$, $[1+r_4-\alpha-\beta(1+r_1)]$ will be negative. Then, the increase in the profitability of rubber will be smaller than that for tapioca owing to a larger increase in the wage cost for rubber as compared to tapioca. Further, $(r_1-r_4)cY_3P_1(\emptyset)$ will now be positive adding to the profit of tapioca. Thus, for $r_1 >> r_4$ profitability of tapioca will increase relative to rubber.

Case 2: Price of rice is falling and price of rubber is increasing.

Now the equations for profit get reduced to,

$$\pi_3(1) = (1+r_4)\pi_3(\emptyset) + (r_1-r_4)cY_3P_1(\emptyset) + (r_4-\alpha)L_3 \; W(\emptyset).$$

$$\pi_4(1) = (1+r_4)\pi_4(\emptyset) + (r_4-\alpha)L_4 \; W(\emptyset).$$

As the price of rice is falling, $r_1<0$, and for any small increase in the price of rubber $(r_1 - r_4)cY_3P_1(0)$ is negative. And if the increase in the price of rubber, (r_4) is greater than α then, $(r_4-\alpha)$ is positive. L_4 being larger than L_3, the increase on the saving after netting the wage increase from the price will be larger for rubber compared to tapioca. This together with the negative term in $(r_1-r_4)cY_3P_1(0)$ will result in the profitability of rubber increasing relative to that of tapioca. This result is similar to the one obtained when $r_4 >> r_1$.

Overall, the profitability of tapioca will increase relative to rubber only when $r_1 >> r_4$. That is, when the price of rice increases rather sharply the profitability of tapioca will increase.

8. Profitability and Area Shift

One advantage of setting up the wage-price relationship, as attempted in the previous section, is that profitability simply became a function of yield, labour intensity and price. Yield of rice grew at a very low rate (about one per cent per year) over the last thirty years[4], and productivity of coconut did not show any increase[5]. Labour intensity of rice had not shown any significant change and hired labour cost had remained much above that for coconut as shown in section 3 above. That leaves the relative price movement as the sole determinant of relative profitability of crops.

As regards the relative price movement, we quote from an earlier study of ours,

"...........the period between 1964 and 1987 can be divided into two distinct sub-periods in terms of the movement of prices relative to the CPI (consumer price index number). The index of price of rice which was above the CPI line till 1975-76 went below it the next year and remained well below it during the rest of the period. The movement of prices of all the tree crops showed a marked contrast in that they remained below the CPI line till the mid or late seventies, moved up and remained above it since then....." (Narayana,D., 1990, p.25)

The farm price of paddy which steadily increased through the sixties and the early seventies reported a peak price of Rs.2.38 in 1974-75. There was a steady fall till 1978-79 and the 1978-79 price level was half of the 1974-75 level and two-thirds of the 1973-74 level. The 1973-74 price level was crossed only by 1982-83 and the 1974-75 level was crossed by 1985-86. During this period of declining price of paddy the money wage rates were increasing. The money wage rate of male agricultural labour was about 30 per cent higher in 1978-79 compared to 1973-74. By 1982-83 when the price was at the 1973-74 level, the money wage rate had almost doubled.

The increase in the price of rice relative to that of coconut till the mid-seventies is a situation approximating case 3 of section 5. With $r_1 > r_2$ the increasing price of rice acting through the wage increase would have pushed the profits of other crops down. It would have increased the profit of rice not only on account of the price increase [first term on the R.H.S. of the equation $\pi_1(1)$] but also on account of the net gain after paying out the increased wages [second term on the R.H.S of the equation $\pi_1(1)$].

The fall in the price of rice and the increase in the price of coconut between 1975 and 1980 is a situation approximating case 2 of section 5. This would suggest a decline in the profitability of rice and an increase in that of coconut. There was, however, a reversal from 1980 in that the price of rice began rising . But the upswing in the price of rice was slow; it was so slow that only after 1985 the price level crossed the peak of the early seventies. The upswing of the eighties approximates the situation of case 3 of section 5. The low values of r_1 would not have raised the profit of rice to any significant extent. Although the profit would have started rising it would not have been enough to compensate the steep fall that had taken place between 1975 and 1980. During this entire period wages were increasing and the price of coconut was also increasing. There was no significant increase in the yield of rice; in fact the intensity of adoption of HYVs was coming down.

Overall, the post-1975 period was the obverse of the pre-1975 period as far as rice was concerned. During the sixties and the early seventies, price was favourable and area under HYVs was increasing, and the profitability of rice was improving. In the post-1975 period, area under HYVs was coming down and price was falling relative to all other crops. The profitability of rice would have come down sharply, leading to the massive shift in area under the crop.The data provided in Table 6.2 (Chapter 6) clearly points to such a phenomenon.

The story of tapioca follows that of rice. The rising price of zice relative to rubber throughout the sixties and the mid-seventies (approximates case 1 of section 7) boosted the profitability of tapioca and attracted shift in area. The sharp fall in the price of rice during the mid-seventies and the sharp increase in the price of rubber (approximates case 2 of section 7) by turning the profitability in favour of rubber made for the area shift away from tapioca.

9. Conclusion

The central finding of this chapter is that the effect of changes in price and yield on profits was not the same for rice and other cash crops. Changes in price or yield have the same effect on the profits of all crops other than rice. In the case of rice, yield increase results in a larger increase of profit than a similar increase in price. This has far-reaching implications. Rice being a staple food in the state, large price increases, to maintain the profitability of the crop would be politically suicidal. This need not be the case with the other crops. Thus, conditions permitting, there would be pressure to import rice and hold the price line. This is exactly what has happened in the post-1975 period. As we shall argue in Chapter 4, the large-scale import of rice on the state account(PDS) and the private trade account depressed the price of rice during the period. The consequent fall in the profit could have been reversed only by raising the yield. This is where the High Yielding Varieties, which, elsewhere in India brought about a "green revolution", could have played a major role. But in

Kerala this did not happen. After an initial increase in the intensity of adoption of HYVs, there was a disenchantment. Why did this happen is taken up for discussion in Chapter 5.

The fortunes of tapioca followed that of rice. The increasing price of rice relative to that of rubber through the sixties to the mid-seventies boosted the profitability of tapioca relative to that of rubber. The area under the crop showed a phenomenal increase during this period. In the post-1975 period, with the falling price of rice relative to that of rubber there was no way the profitability of tapioca could have been boosted up. Further, the yield of rubber was increasing whereas it was not all spectacular for tapioca (see chapter 9). The falling profitability of tapioca made for the area shift away from tapioca to rubber. The extent of this shift and its implications for the movement of price are taken up in Chapter 6.

Notes

1. There is a problem comparing the relative profitability of seasonal and annual crops with that of perennial crops in the context of crop shifts. As far as the perennials are concerned the shift is irreversible and there is a moderate pre-bearing period. Then, the question is how is profit computed and at what level of profitability does the shift occur?

2. In the formulation of the problem in terms of these two components our indebtedness to Piero Sraffa need hardly be mentioned. The formulation as presented here is based on two key passages from Production of Commodities by Means of Commodities.

3. In computing human labour days male and female labour hours have been treated on par, and not reckoned in "efficiency units".

4. This is an issue which is taken up for detailed analysis in Chapter 5.

5. Interpretation of the observed productivity changes of tree crops has its own problems which we turn to in one of the later chapters.

CHAPTER 4

PUBLIC DISTRIBUTION OF RICE IN KERALA AN ANALYSIS OF THE EFFECTS OF UNIVERSAL COVERAGE AND IMPORT DEPENDENCE ON DOMESTIC PRICES

1. Introduction

Large-scale public food distribution programmes in a number of developing countries are intended to ensure minimum levels of food supply at reasonable prices to low income people. Evidence that agricultural growth alone may not lead to adequate 'trickle down' mechanisms being established, in order to reach the gains of growth to the poor and that they may inturn be constrained by lack of effective demand, has drawn increasing attention to the food distribution programs in South Asia. Of interest in this context are a whole range of questions. Which groups are reached. To what extent does food distributed through the system represent a net addition to consumption. What is the impact of these programs on food prices and production, transfers of income, and what is the sustainability of such programs in the context of the resource crunch faced by many of the governments.

The public food distribution program in Kerala, which has a long history, now covers nearly all the population in both urban and rural areas. The state is reputed for having one of the best Public Distribution Systems (PDS) in the country (George, 1979 and 1985; United Nations, 1975). A recent round of National Sample Survey Organisation reports that nearly 95 per cent of persons purchase rice from the PDS in the rural areas of Kerala compared to the all- India percentage of 57.With practically the entire population purchasing edible oil, sugar and kerosene through PDS, the use of PDS in Kerala in respect of all essential commodities is also one of the highest among the states of India(NSSO, 1990). The operation of the PDS thus supports the consumption of various essential commodities by different segments of the population both through providing the essential commodities at subsidised prices and exerting indirect control over the market prices of these commodities.

It is widely believed that the PDS has been able to increase the purchasing power of various segments of population, especially the poor (George, 1979 and 1985; United Nations, 1975). Less well understood, however, is the equity aspect of the system. That is, out of each rupee spent on the PDS, what percentage goes to meet the food requirements of low income people is not known. Nevertheless, it is on this factor that the cost-effectiveness of such programmes rests. This aspect becomes highly relevant when the quantity distributed tends to grow over the years, with the concomitant burden on government expenditure, as the experience of Egypt and Sri Lanka in particular has shown (World Bank, 1990; Tyagi, 1990).

The existing studies on public distribution discuss these issues on a general plane without explicitly incorporating the perspectives of a state like Kerala characterised by a cash crop dominated agriculture and a chronic food deficit. The difference is that in a highly food deficit state like Kerala where PDS is entirely supported by massive imports (from the other states or abroad) the price depressing effects of such imports become all the more dominating compared to the effective demand effect. These, then, have serious implications for production and productivity within the state. Significant price changes of a few food crops can alter relative prices within agriculture, and with or without yield changes can alter relative profitability, setting off massive changes in cropping pattern. The aim of this chapter is to clarify some dimensions of these inter-relationships.

The chapter is organised into six sections in all. Section 2 sets out the broad dimensions of PDS activity in Kerala. Section 3 discusses the beneficiaries of PDS and the effect of PDS on consumption levels. Section 4 goes into the aspects of costs, prices and income transfers associated with the PDS. The implications of the PDS for the open market prices within the state are taken up in Section 5.

2. Some Dimensions of Coverage, Public Distribution, and Procurement in Kerala

Kerala has a long tradition of providing public services in the areas of health, education, and subsidised food distribution to most of its population. Nearly 100 per cent of the population is covered by subsidised food distribution, the exception being a small percentage of rice producers who are not entitled to draw rice from the PDS[1]. The commodities supplied through the PDS include rice, wheat, edible oil, sugar, kerosene...etc and the allotments are on a weekly basis for the distribution of rice and wheat and on a monthly basis for sugar, kerosene and edible oil. The allotments of foodgrains and sugar are made on a per capita basis and for other commodities on a per card(that is, per household) basis[2]. The number of ration cards, which entitle a household to subsidised supplies of essential commodities, has grown over the years and stood at 49.08 lakhs in 1989 [Table 4.1].

The distribution of foodgrains by the state of Kerala through PDS has shown a phenomenal increase over the last two decades. Off-take of rice and wheat through the PDS which was 12.07 lakh tonnes during 1965 steadily declined over the next five years to reach a level of 8.90 lakh tonnes during 1970-71 (George, 1979:28). From then on, it showed a steady increase reaching 17.60 lakh tonnes in 1986 before declining to 14.82 lakh tonnes in 1989 (Table 4.2). Along with such an increase in off-take may also be observed the increasing

Table 4.1

Number of Ration Cards Issued in Kerala

Year	Number (lakhs)
1975	36.16
1976	38.73
1977	40.30
1978	40.37
1979	40.47
1980	40.60
1981	41.02
1982	41.09
1983	42.00
1984	42.98
1986	44.47
1987	47.31
1988	48.07
1989	49.08

Source: Government of Kerala, Economic Review (Various Issues).

preference for rice. The share of wheat in the total off-take which was over 10 per cent during 1965-76, except for 1969-72, declined steadily till 1982 before showing an upward trend in the next five years. The bulk of this preferred staple, namely rice, came from outside the state. The share of imports of rice both on state and private trade account which was below 30 per cent of total availability of foodgrains(including tapioca in rice equivalents) in the early seventies rose steadily after 1975 reaching a level over 40 per cent by the late eighties. Compared to an earlier period the role of imports on state account has become dominant in the post-1975 period.

Tapioca (cassava) had played an important role in the overall food basket of the state, especially in that of the poorer segments of the population. The massive imports of rice into the state has led to a gradual decline of this crop. The share of tapioca -- in rice equivalent terms -- in total foodgrain consumption which was over 40 per cent in the early seventies has shown a steady decline since 1975 reaching close to the 25 per cent mark by the late eighties.

To complete the picture of increasing dependence of the public distribution system on imports of rice it is necessary to indicate the tatus of procurement of rice within the state. Paddy procurement which was over a lakh tonnes in the late sixties and early seventies accounting for about six to seven per cent of the local production has declined steadily since then and has become negligible by the late seventies (Table 4.3). Hence, procurement as a factor in the PDS of the state has simply dropped off. The dependence on imports is complete.

Table 4.2

Availability of Foodgrains in Kerala (Lakh tonnes)

Year	Rice: Internal Production	Rice: Import on State Account	Rice: Import on Private Trade Account	Wheat: Import on State Account	Tapioca: Availability for consumption	Total Availability
1969	11.26(31)	7.61(21)	2.00(6)	1.51(4)	13.91(38)	36.29
1970	11.19(28)	7.34(19)	4.00(10)	1.13(3)	15.91(40)	39.57
1971	11.80(29)	7.74(19)	4.50(11)	0.85(2)	15.74(39)	40.63
1972	12.38(27)	8.06(18)	5.00(11)	1.28(3)	18.51(41)	45.23
1973	12.65(31)	6.97(17)	0	2.47(6)	19.23(46)	41.32
1974	10.68(26)	7.44(18)	1.50(4)	2.40(6)	19.12(42)	41.14
1975	12.00(27)	5.12(11)	3.50(8)	5.18(12)	19.00(42)	44.80
1976	11.96(25)	9.02(20)	4.50(10)	2.55(6)	18.21(39)	46.24
1977	11.29(25)	15.03(32)	2.00(4)	0.92(2)	17.32(37)	46.56
1978	11.66(22)	16.20(31)	7.00(13)	0.73(1)	17.28(33)	52.87
1979	11.45(31)	5.32(14)	6.00(16)	0.83(2)	13.66(37)	37.26
1980	11.58(27)	7.72(19)	7.00(17)	1.09(3)	14.27(34)	41.66
1981	11.71(27)	8.83(20)	5.00(12)	0.94(2)	17.20(39)	43.68
1982	12.05(29)	11.70(28)	4.00(10)	1.13(3)	12.65(30)	41.53
1983	11.75(26)	12.97(29)	5.00(11)	2.48(5)	13.00(29)	45.20
1984	11.87(26)	13.36(29)	5.00(11)	2.05(4)	13.96(30)	46.24
1985	11.30(24)	14.60(32)	5.00(11)	2.08(5)	12.60(28)	45.58
1986	10.56(24)	16.03(36)	5.00(11)	1.57(4)	11.17(25)	44.33
1987	10.21	16.60	..	..	8.78	35.59*
1988	9.30	15.50	..	2.35	10.85	38.00*
1989	9.02	12.70	..	2.12	9.55	33.39*

Sources: 1. Government of Kerala, Economic Review (Various Issues)

2. For estimates of import of rice on private trade account see Thomas Isaac, T.M. and Reddy, Ram Manohar. 1992.

Notes: 1 . .. indicates figures not available.

2 Figures in parenthesis are percentages of the total.

3 Tapioca is in rice equivalents after setting apart 25 per cent of production for industrial and other uses. One tonne of rice = 2.2 tonnes of raw tapioca.

4. The Economic Review provides data on a calendar year basis as well and we have used the same here.

5. * Excluding imports on private trade account.

Table 4.3:

Procurement of Paddy from Local Production, 1966-67 to 1983-84.

Year	Total Paddy Procurement (000 tonnes)	Procurement as a Percentage of Local Production
1966-67	93.1	5.7
1967-68	118.6	7.0
1968-69	138.0	7.3
1969-70	130.9	7.4
1970-71	114.5	5.9
1971-72	105.0	5.2
1972-73	78.1	3.8
1973-74	80.9	4.3
1974-75	60.3	3.0
1975-76	60.0	3.0
1976-77	35.0	2.1
1977-78	21.0	1.6
1978-79	2.5	0.1
1979-80	0.7	Neg.
1980-81	0.4	Neg.
1981-82	0.3	Neg.
1982-83	0.07	Neg.

Source: Department of Civil Supplies, A Handbook of Statistics (Various Issues).

3. Beneficiaries of PDS and the Effect on Consumption Levels

Studies carried out in the seventies pointed to both low income and high income groups benefiting from the PDS in Kerala. As regards rice, a 1974 study showed that ration rice not only contributed more calories per person at the upper end of the population but its share in their total number of calories was also higher. (Table 4.4) (Kumar, 1979). As her sample households represented the bottom 50 to 60 per cent of the population, the upper end referred to the middle deciles of the population. Further, her analysis of consumption across sub-regions showed that, "subregions 2 and 3 have a higher incidence of the lowest income households and also tend to have lower overall consumption of rationed rice" (Kumar, op.cit., p.2[3]). She was also able to show that ration purchases were subject to wide seasonal fluctuations corresponding largely to the swings of the rural, agriculture based economy" and "the smaller food budgets in March-April and July-September reflect lower agricultural employment and incomes at that time" (Kumar, op.cit., p.23). Thus, Kumar's study showed that PDS was more beneficial to the population at the upper end of the income scale.

Table 4.4

Overall Dietary Measures by Income Groups

Calories by source (Daily Adult Equivalent)	Monthly Per Capita Total Income (Rs.) Less than 15	15-24	25-34	35-49	50-74	75 or above
Total Calories	1086	1893	2102	2211	2290	1898
Ration Rice Calories	263	376	414	439	569	584
(% to total)	(24)	(20)	(20)	(20)	(25)	(31)
Open Market Rice Calories	133	240	336	338	270	386
Tapioca Calories	1013	898	819	817	729	213
Number of Households	8	7	14	6	6	2

Source: Kumar, 1979: Table 7.
Note :1. Obviously, the figure 1086 for the total calories for the lowest income class is a mistake.

The study carried out by George (George, 1979) reported the per household purchases of rice from ration shops for a week in 1977 to be marginally higher for the lower income groups compared to the higher income groups (Table 4.5). Given our understanding of the variation in household size across income classes as per the NSS data - larger size at the lower end and smaller at the upper end - it is possible that per capita purchases from the ration shops are lower for the lower income classes. But they are unlikely to be as low for the lower income classes as reported by Kumar.

The results of the NSS, 42nd Round data on purchases of rice from the ration shops show the validity of George's findings in 1977 for 1986-87 (Table 4.6). The per capita ration purchases show a slight bulge at the middle and a dip at both the ends. It may be seen that the purchases by the top two decile groups are not only lower than the overall average but also lower than the quantity purchased by the bottom decile groups (decile groups throughout this chapter refers to the distribution of persons). In fact, the lowest purchases from the PDS are by the top decile group.

Table 4.5.

<u>Household Consumption of Rice, Wheat and Tapioca by Income Group and Source, 1977</u>

Annual Income Group	Percentage of House Holds	Weekly Household Consumption (in Kgs): Rice Ration	Own Production	Open market purchase	Ration Wheat	Tapioca in Rice Equivalents	Total (Rs) Consumption
Upto 600	20	5.65	..	2.75	0.10	6.45	14.95
601- 1200	23	6.39	..	3.04	1.09	5.14	15.66
1201-2400	30	7.70	1.77	4.00	3.87	7.03	24.37
2401-3600	10	6.67	1.11	6.11	1.44	5.75	21.08
3601-4800	10	4.90	2.00	5.10	0.50	3.05	15.55
More than 4800	7	5.14	5.71	2.57	0.71	1.50	15.63
Total	100	6.35	1.24	3.73	1.89	6.00	19.21

Source: George, 1979, Tables 13 and 14.

A few interesting findings of the NSS 42nd Round with regard to the utilisation of PDS and the open market for purchases of rice are observed(Table 4.7). Although, for the lowest decile group the percentage of persons wholly dependent on PDS is the highest (17.91) it is fairly high for the highest decile group as well (11.58). It is lower for the decile groups 2 to 6 in comparison with the decile groups 7 to 10. The dependence on sources other than the PDS shows a steady increase from the first decile group. The dependence on PDS and other sources does not show any such systematic variation as in the other two cases. On the whole, across all the decile groups nearly four-fifths purchase rice both from the PDS and the open market. Total dependence on the open market is lowest for the bottom decile groups and highest for the top decile groups. Total dependence on PDS is seen across most decile groups but it was fairly high for the top decile group as well.

Table 4.6.
Per Capita Monthly Consumption of Rice by Decile Group and by Source, Kerala (Rural), 1986-87

Decile Group	Average Quantity of consumption (Kg)	Average Quantity of purchase from PDS (Kg)	
	(1)	(2)	(2)/(1)
1	6.938	4.503	65
2	8.273	4.849	59
3	8.660)	4.631	53
4	9.293)		53
5	9.759)	5.046	53
6	9.700)		
7	9.700	4.290	44
8	10.330	4.569	44
9	11.269	3.809	34
10	11.720	2.731	23
Overall	9.540	4.4105	46

Sources: Government of India, Department of Statistics, National Sample Survey Organisation, Sarvekshana, Vol.XIII, No.4, Issue No.43, April - June, 1990. Sarvekshana, Vol.XII, No.4, Issue No.39, April-June,1989.

Note: For the four decile groups at the top the percentages of total rice purchases to total rice consumption are taken from George to arrive at quantity of purchase from PDS to total purchase which excludes the consumption from own production. These are 90,90,83 and 60 respectively for decile groups 7,8,9,10. This procedure had to be adopted because NSS gives only percentage of purchase from PDS to total purchase, which excludes the consumption from own production.

Table 4.7.
Distribution of Persons by Source of Purchase of Rice, Kerala(Rural), 1986-87

Decile Group	Distribution of Persons by Source of Purchase (Percentages)		
	PDS only	Other than PDS only	PDS + others
1	17.91	4.11	77.98
2	11.75	4.18	84.07
3,4	6.52	8.12	85.36
5,6	6.49	6.84	86.67
7,8	11.08	12.81	76.11
9	9.54	14.02	76.43
10	11.58	22.84	65.58
Total	9.96	8.75	81.28

Source: Government of India, Department of Statistics, National Sample Survey Organisation, Sarvekshana Vol.13, No.4, Issue No.43, April-June, 1990.

Although the three surveys were conducted at three different time points in not strictly comparable locations with varying sample sizes certain results consistent with other macro data are found to be common to all[4]. Firstly, the increasing dependence on ration rice shown by the aggregate data (Table 4.2) is confirmed by the surveys (Table 4.8). It was roughly 18 per cent in 1974 and 32 per cent in 1977 and was around 40 per cent in 1986-87. Secondly, although the share of ration rice in total rice consumed is higher for the lower income classes and lower for the higher income classes,the absolute quantity of purchase is higher for the middle deciles.Hence, going by the absolute quantity of purchases from ration shops it cannot be said that PDS is more beneficial to lower income classes. Finally, as the dependence on tapioca is higher for the lower income classes (Kumar, 1974; Operations Research Group, 1973 quoted in George, 1988; George, 1988) the bulk of which did not originate in their own production, the market dependence (defined as open market purchases of rice, wheat and tapioca as a percentage of total consumption) of lower income classes is significantly higher than that for the upper income classes.

Table 4.8.
<u>Share of Ration Rice in Total Consumption, in Rice Consumption and Market Dependence by Decile Groups</u>

Decile Group	Share of Ration Rice in total Consumption (%) of Rice, Wheat and Tapioca		Share of Ration Rice in total Rice Consumption (%)		Market Dependence
	Kumar (74)	George (77)	George (77)	NSS, 42	George (77)
1,2	14	38	67	62	56
3,4	30	41	68	52	44
5,6,7	31	32	57	52	38
8	n.a	32	41	44	47
9	n.a	32	41	34	39
10	n.a.	32	38	23	16
Total	..	33	56	51	42
Macro Data	18	32	53	51	..

Sources: Tables 4.2,4.4,4.5 and 4.6 above.

Thus, the distribution of rice through the PDS shows the following pattern. In terms of quantity alloted or price charged the system does not discriminate against any particular income class. In terms of purchases however higher purchases by the lower income classes are not observed. If at all, in per capita terms the purchases are marginally higher for the middle deciles. Naturally the question that arises is, how beneficial is the PDS to the poorer segments of the population.

There are two different answers to the question. In terms of open market dependence the poorer segments are at a disadvantage, as their dependence is higher than that of the upper income classes. The upper income classes can draw upon their own production of both rice and tapioca. So, in fact the PDS has brought down the market dependence of the higher income classes more than that of the lower income classes. In terms of additions to consumption, George(George, 1979 and George, 1985) estimated the levels that might prevail in the absence of PDS and compared the same with the actual consumption levels under PDS by adopting the following procedure. He took the expenditure pattern on rice in each income group corresponding to Table 4.5, and determined the quantities corresponding to two levels: the existing open market price level in Kerala and the hypothetical national free market price level. The hypothetical level was obtained by adding transportation cost to the open market price in Andhra Pradesh.In terms of additions to consumption, his estimates pointed to a difference of between 14.3 to 18.1 per cent to consumption at the lower end of the income scale, whereas at the upper end the difference was insignificant. (Table 4.9). That is, in the absence of PDS, consumption of rice by the lower income classes would have been lower by 14.3 to 18.1 per cent. To that extent they are benefited.

Table 4.9:

Estimated Consumption Levels of Rice in the Absence of Rationing, 1974-75

Income Group	Actual Weekly Consumption (Kg)	Estimated Weekly Consumption (Kg)	Percentage from Actual	Decline Consumption (Rs.)
Upto 600	8.40	6.91	17.7	
601 - 1200	9.43	7.72	18.1	
1201- 2400	13.47	11.54	14.3	
2401- 3600	13.89	13.26	4.3	
3601- 4800	12.00	11.74	2.2	
More than 4800	13.42	12.09	1.9	

Source: George, 1979: p.37.

4. Costs, Prices and Income Transfers

The discussion in sections 2 and 3 were entirely on the physical plane, that is, on the plane of quantities of procurement, distribution, actual consumption, and decline in consumption in the absence of PDS. And although in the absence of PDS the consumption of the lower income classes would have suffered, the phenomenon of the PDS providing slightly higher quantities to the people at the middle deciles can be observed. Behind these observed quantities lie costs, prices and transfers of income. The government incurs a cost on procurement/imports and distribution which is a benefit to the consumers. As this cost is met by the general tax revenue and as the benefits accruing to different segments of the population vary some transfer of income is involved. These are the issues taken up in this section.

In India the State governments recover the operating costs of rationing from the consumers, but the Central Government incurs costs which it does not entirely recover. This happens because the issue price of ration foodgrains is often lower than the total cost of procurement/import, storage and handling. This difference between the cost and the issue price is met in the form of consumer subsidies by the Government of India. Although as a percentage of the total revenue expenditure of the government the subsidy on foodgrains has hovered around 5 per cent, in absolute terms it has increased steadily from Rs.117 crores in 1972-73 to Rs.2476 crores in 1989-90. Table 4.10 provides the figures for the eighties. Food subsidy has been one of the major subsidies and has accounted for between 20 to 30 per cent of the official Central subsidies during the eighties.

The direct cost borne by the Central Government in the form of food subsidy may be taken as a transfer of income from the Centre to the population in the States over the head of the State governments. The quantum of such transfers to the States are roughly proportional to the off-take of foodgrains by them[5]. The share of Kerala in the total foodgrain distribution has been around 10 per cent and hence it can be taken that every year roughly 10 per cent of the subsidy on foodgrains passes into the hands of the consumers in Kerala.

Table 4.10

Central Government Subsidy on Foodgrains (Rs. Crores)

Year	Food Subsidy	Total Subsidies
1980-81	660	..
1981-82	761	..
1982-83	711	2262
1983-84	835	2902
1984-85	1101	4208
1985-86	1650	4929
1986-87	2000	5576
1987-88	2000	5980
1988-89	2200	7732
1989-90	2476	10677
1990-91	2200	10624

Source: Food Corporation of India, Annual Report (New Delhi: FCI, Various Issues). For 1989-90 and 1990-91 data is from the budget estimates.

How is this total subsidy distributed over income classes needs to be examined. The PDS is characterised by a uniform price charged to all segments of the population and certain quantitative restrictions. The quantitative restrictions operate through weekly or monthly allotments on a per capita/per household basis. The system does not discriminate between the rich and the poor either in the prices charged or in the quantities alloted. This means for every rupee spent on commodities supplied through the PDS the amount accruing as subsidy shall be uniform for all income classes. Whatever differences that may arise in this subsidy process operates through the quantities bought by different income classes. In other words, if the rich buy more from the PDS they are subsidised to a greater extent than the poor.

Table 4.11.

Share in Central Subsidy on Foodgrains by Decile Groups, Kerala 1986-87

Decile Groups	Percentage share in subsidy	Cumulative share
1	10.21	10.21
2	10.99	21.20
3	10.50	31.70
4	10.50	42.20
5	11.44	53.64
6	11.44	65.08
7	9.73	74.81
8	10.36	85.17
9	8.64	93.81
10	6.19	100.00

Source: Table 4.6 above.

Since the per capita purchases from the PDS across decile groups is already known, their share in the total subsidy (Table 4.11) would be proportional to the purchases. As is evident, there is not much variation in the share of the different decile groups. The bottom 10 per cent of the population gets a share of 10.21 per cent, to the top 10 percent getting 6.19 per cent. The bottom 40 per cent gets a share of 42.20 per cent of the subsidy to 34.92 per cent of the top 40 per cent. Thus, both rich and poor are subsidised and the extent of subsidy is only marginally lower for the rich. This is where the question of cost-effectiveness of PDS comes to the fore. For every rupee spent on PDS only 65 paise goes to 60 per cent of the population from the bottom up, the rest goes into the hands of those whose consumption levels would not have been affected in the absence of PDS. In other words, by restricting the rationing to the 60 per cent from the bottom the government could have brought down the cost by about 35 per cent. Or with the same cost 50 per cent more could have been distributed to the bottom 60 per cent of the population.

5. Impact of PDS and Import on Private Account on Price

The large-scale import of rice on state account (for distribution through PDS) and private trade account had a depressing effect on prices and production within the state of Kerala. This effect is seen not only in rice but also in its substitute, viz., tapioca, leading to a steep fall in its production (Table 4.2). This question will be taken up in Chapter 6. Here the discussion is confined to rice.

The discussion of Section 2 has brought out the increase in the imports of rice into the state over the last two decades. Imports (on state and private trade accounts) which only kept pace with internal production till the mid- seventies doubled in the next ten years. How did such massive imports affect the open market prices?

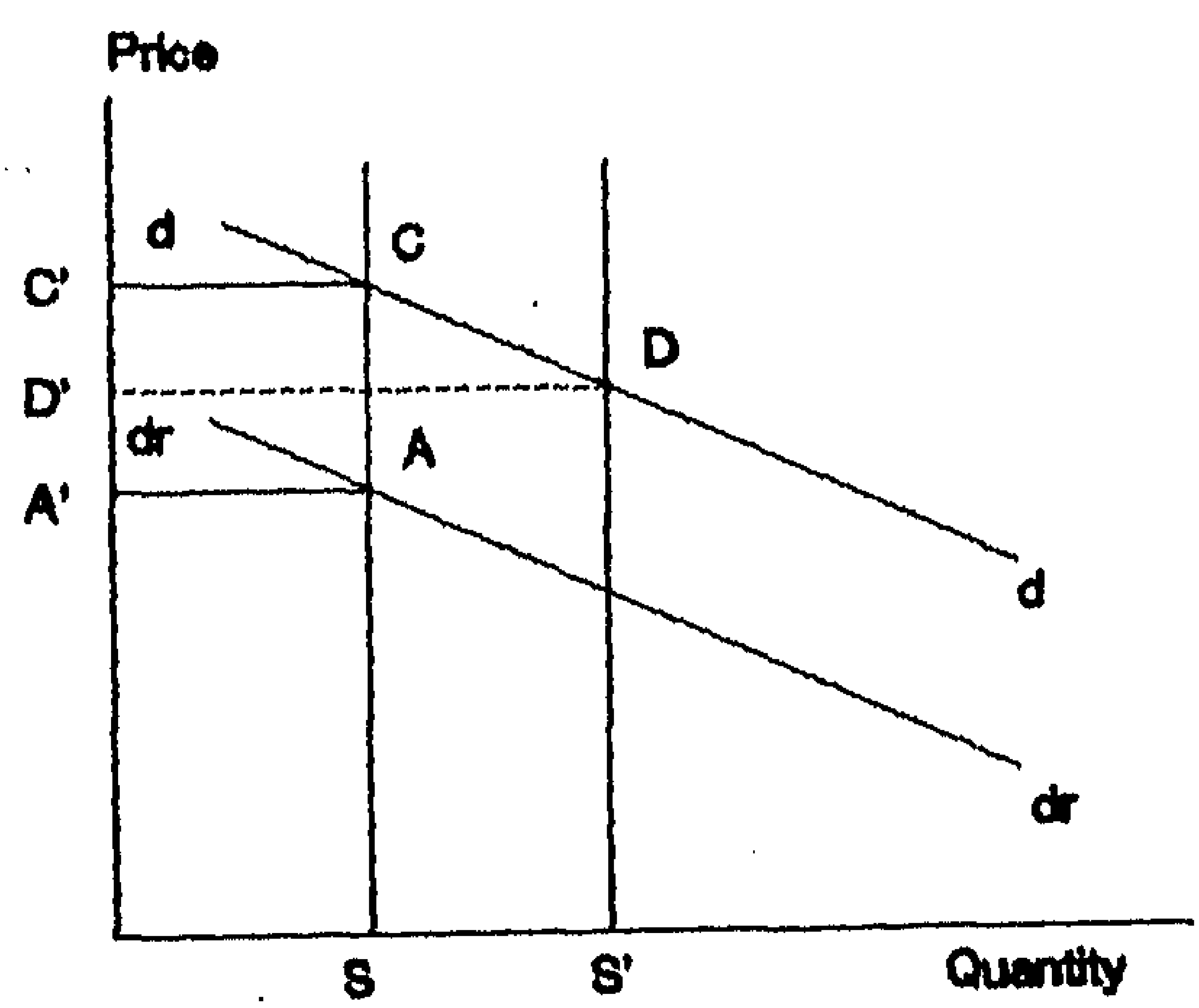
An answer to this question is attempted with the help of the following highly simplified diagram.

Let dr-dr be the open market demand for rice when PDS supply is available to all.

Let d-d be the open market demand for rice when PDS supply is provided only to the bottom 60 per cent of the population.

As consumption of rice is not affected to any significant extent by such a restricted supply (Table 4.9) the difference between d-d and dr-dr may be taken at around 5 lakh tonnes (35 per cent of 15 lakh tonnes). Let S be the internal supply and S' be the total supply when 5 lakh tonnes of rice is imported on private trade account annually. Note that the distance between S and S' is the same as the distance between d-d and dr-dr.

FIGURE



As may be seen from the figure, supplying the top 40 per cent of the population with PDS rice brings down the open market price from C' to A'. Instead, if an equal quantity were imported on private trade account the price would have fallen from C' to D'. It may be seen that the fall in price on account of the ration supply was greater than the fall in price if an equal quantity was imported on private trade account[6].

The extent of the fall in price may be gauged by the figures provided below (Table 4.12). The farm price of paddy (unhusked rice) in Kerala which was 70 to 90 per cent higher than in Tamilnadu, Andhra Pradesh and Karnataka from the mid-sixties to the mid-seventies showed a significant change in the period after the mid-seventies. The relative price came down by about one-fourth over a fifteen year period after the mid-seventies.As is evident from Table 4.12, by 1982 the difference had come down to 32 to 42 per cent. In other words, the farm price of paddy in Kerala which was over 70 per cent higher than the all-India average till the mid-seventies, had come down since then and was only about 30 to 50 per cent higher .

An attempt was made to empirically estimate the relationship between the movement of relative prices, internal production, import of rice on state account and import of rice on private trade account. Considering the fact that there were movement restrictions on private trade in the mid-sixties and that practically no private imports of rice were reported during 1965-67 the period taken for the purpose of estimation is 1968-87 (20 observations). Internal production, imports on state account, and imports on private trade account are all taken in per capita terms denoted respectively by IPR, IMPSA and IMPPA. The equations are set out on the following lines.

Table 4.12.

Relative Farm Price of Rice in Kerala (Percentage)

Farm Price of Rice in Kerala Relative to Farm Prices in Years	Karnataka	Tamilnadu	Andhra Pradesh	All India wholesale price (Index)
Absolute level in 1969-70	169.56	174.48	194.81	100
1966-67 to 1970-71	157.25	163.78	197.97	108.8
1971-72 to 1975-76	162.47	190.64	188.09	111.6
1976-77 to 1980-81	132.41	137.91	142.39	78.4
1981-82 to 1985-86	133.12	144.31	155.69	79.6
1986-87 to 1988-89	..	..	..	76.3

Source: Government of India, Directorate of Economics and Statistics, Farm Prices of Principal Crops in India (Various Issues)

As the long term production within the state itself is a function of price, IPR is a function of the farm price ruling within the state, and may be expressed as,

$IPR_t = a_0 + a_1 FP_{t-1}$,where FP_{t-1} is the farm price in the year t-1. Import on private trade account is a function of the difference between the price ruling outside the state and that ruling within. Hence it may be expressed as,

$IMPPA = b_0 + b_1 (P_t/AP_t)$, where P_t is the wholesale price of rice in Kerala and AP_t the all-India wholesale price of rice.The two equations together represent the open market supply of rice in Kerala.

On the demand side, the import on state account,IMPSA is dependent on the allotment of rice from the central pool, which is not influenced by price to any great extent. Given IMPSA, the open market demand for rice is a function of IMPSA, price of rice relative to the general price level and the real per capita disposable income. In the Kerala context, the per capita state domestic product is not a good indicator of the disposable income because of the large and growing remittances in recent years. This is suggested by the per capita consumption expenditure moving above the per capita state domestic product. Since estimates of disposable income are not available it was not included in the equation. Instead, time was included as a variable. The equation for open market demand, D may then be written as,

$D = c_0 + c_1 IMPSA + c_2 P_t + c_3 P_T + c_4 Time$, where P_T is the tapioca price.

In equilibrium,D = S.

That is,

$$a_0 + a_1 FP_{t-1} + b_0 + b_1 (P_t/AP_t) = c_0 + c_1 IMPSA + c_2 P_t + c_3 P_T + c_4 Time.$$

Rearranging the terms of the equation,

$(P_t/AP_t) = A_0 + A_1 P_t + A_2 FP_{t-1} + A_3 \text{ IMPSA} + A_4 P_T + A_5 \text{ Time}.$

In estimating the equation 1973 had to be excluded because in 1973 the government took over the wholesale trade of foodgrains and there was no import of rice into the state on private trade account(See Table 4.2).The equation was estimated using OLS estimation procedure. P_t,AP_t,P_T and FP_{t-1} were taken in Rs. per kg.;IMPSA was taken as annual per capita offtake in kgs.;(P_t/AP_t) was taken in the index number form to correspond with Table 4.12.

The estimated coefficients with 19 observations are,

$$(P_t/AP_t) = \underset{(8.73*)}{72.38} + \underset{(0.05)}{0.009} \text{ IMPSA} + \underset{(6.03*)}{33.36} P_t + \underset{(0.35)}{1.10} FP_{t-1}$$

$$\underset{(-1.46)}{-25.41} P_T - \underset{(-5.06*)}{3.20} \text{ Time}$$

[0.95, 0.94, 53.00].

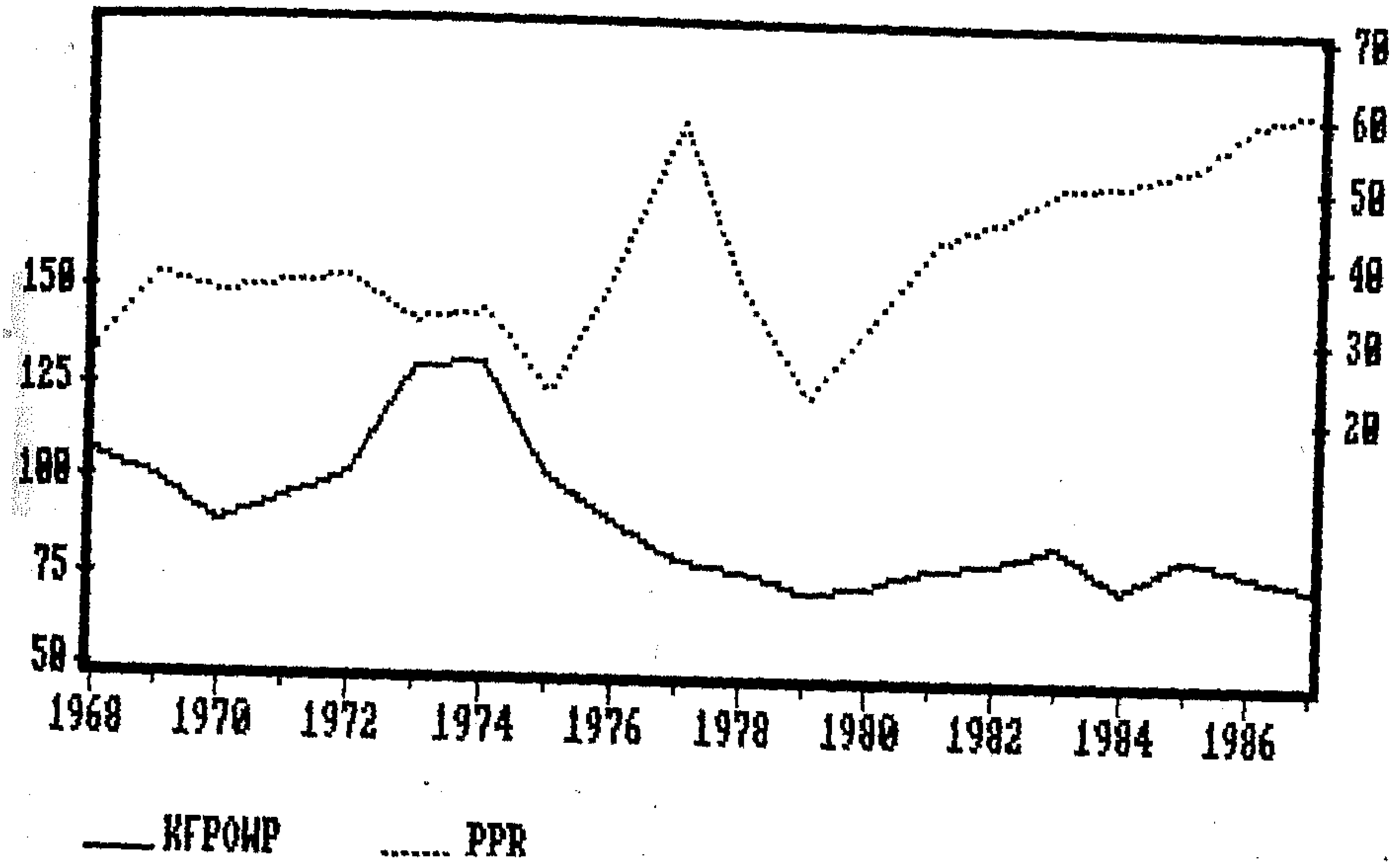
[The convention followed in presenting the regression results throughout this study is as under. Figures within (.) brackets are t values. *, **, and *** indicate significance at one, five, and ten per cent respectively. Figures within [. .] are R^2, adj.R^2, F, and DW values respectively. Wherever DW is not relevant, the value is not shown].

The problem with the above equation is that both IMPSA and P_T are time correlated. The equation is rerun dropping time and FP_{t-1}. The estimated coefficients are,

$$(P_t/AP_t) = \underset{(6.30*)}{80.59} - \underset{(-0.42)}{0.13} \text{ IMPSA} + \underset{(3.16*)}{29.38} P_t - \underset{(-3.31*)}{80.19} P_T$$

[0.83, 0.80, 25.60, 0.59].

Relative Price Vs. Per Capita PDS off-take



KFPOWP:Kerala Farm Price over All-India Wholesale Price (Index),1969-70=100

PPR : Annual Per Capita PDS off-take (Kgs)

It is seen from the graph of IMPSA on (P_t/AP_t) that the relationship is not linear. In order to relate the sharp increase of IMPSA in the mid-seventies to the fall of (P_t/AP_t) as argued earlier in the section, IMPSA was transformed into $IMPSA_1$ = IMPSA upto 1975 and Ø beyond, and $IMPSA_2$ = Ø upto 1975 and IMPSA beyond. When the equation is rerun with $IMPSA_1$, and $IMPSA_2$ the coefficients are:

$$(P_t/AP_t) = \underset{(11.47*)}{89.20} + \underset{(0.13)}{0.04}\ IMPSA_1 - \underset{(-1.63)}{0.41}\ IMPSA_2 + \underset{(1.89***)}{12.92}\ P_t$$

$$\underset{(-1.20)}{-25.80}\ P_T$$

[Ø.87, Ø.84, 26.Ø4, 1.97].

The equation is run dropping P_T also. The coefficients are,

$$(P_t/AP_t) = \underset{(11.70*)}{90.80} + \underset{(0.88)}{0.04}\ IMPSA_1 - \underset{(-2.19***)}{0.52}\ IMPSA_2 + \underset{(1.48)}{6.73}\ P_t$$

[Ø.86, Ø.84, 33.34, 2.Ø5]

The progression of the coefficients of $IMPSA_2$ clearly justify the steps followed. IMPSA has the expected negative sign from step 2 onwards. The coefficient steadily improved as the other correlated variables are dropped. DW also comes to have a value around 2. The equation clearly points to the role of IMPSA after 1975. Before that period, its lower share in the total availability did not influence open market prices to any significant extent. But after 1975, its role in depressing the open market price is unmistakable.

The depressed price of paddy has played a significant role in the decline in production (Ø.9 per cent per annum) in Kerala since 1975-76[7].

A sharp reduction in area under paddy (2.1 per cent per annum) and low increases in yield (1.2 per cent per annum) are held responsible for this decline[8]. But one of the major causative factors (other than the technological one) was the depressed price. The connection of the depressed price of rice with the reduction in area under this crop has already been discussed in Chaper 3; its effect on the adoption of HYVs is taken up in the next Chapter. The main finding here is in agreement with Elminiawy's observation regarding the Egyptian rice economy, that "the distribution of subsidised rice adversely affects rice production by depressing the free market price" (Elminiawy, 1989:67).

The chronic deficiency of rice in the state has obliged the state government set apart a lion's share of its resources for improved rice production. In this connection the findings of an earlier study are pertinent,

> "Agricultural development plans of the state had attached a high priority for improved rice production. During the Fifth Plan period, when there was explicit financial allocation according to individual crops, of the total state sector outlay of Rs.2885.7 lakhs for all crops, 1576.50 lakhs was alloted for rice. Ambitious production targets were specified for rice in each plan, but in every case the achievements lagged behind the targets.....in fact between the fifth and sixth plan periods there had been absolutely no increase in actual production" (George and Mukherjee, 1986:68)

This has come about because on the one hand the Central Government has been spending vast amounts to distribute rice through the PDS; on the other hand the state government has been spending vast amounts to boost rice production which has not materialised as expected. The key economic link between the two is the depressed price.

6. Conclusions

The dependence of Kerala on PDS for its requirements of cereals and cereal substitutes has increased from about 25 per cent in the early seventies to over 35 per cent in the late eighties. Although PDS has universal coverage in Kerala and the share of ration rice in total rice consumption is fairly high for the lower income classes, it has in no way reduced their market dependence as tapioca, a cereal substitute consumed by them, is outside the domain of the PDS. Hence, one of the main objectives of the PDS, namely protection of the poor against the vagaries of the market is met only to a limited extent; the PDS has helped all the classes and not necessarily the poor.

The impact of the massive State intervention through the PDS has depressed the price of rice and has seriously affected the agricultural employment and income within the Kerala. The declining production and prices have called for further governmental measures in the form of production support. In brief, given the structure of procurement and public distribution, the more that is spent on PDS the more would be the need for expenditure on alternate support measures. So, if the strategy to be pursued is to put more in the hands of the poor "through employment and faster growth in poorer and agriculturally stagnant areas" a major restructuring of the PDS is required.

NOTES

1. Such households are entitled to draw commodities other than rice like sugar, kerosene, palm oil....etc.

2. The per capita allotments do take into account the adults and children through a system of units. Adults are considered as two units whereas children are taken as one unit.

3. "Sub-regions 1 to 3 means moving progressively inland, with rapidly declining area under rice cultivation, fewer employment opportunities and poorer all round infrastructure (Kumar, op.cit).

4. Kumar's survey was confined to three sub-regions in Trivandrum district and George's sample size was only 100 whereas NSS covered the whole state.

5. This proportion is modified by the variation in the amount of subsidy for different foodgrains. Since Kerala mostly gets rice for which the amount of subsidy has been the highest in recent years the above proportion may be an underestimate.

6. It may be argued that there are two assumptions underlying the above formulation which are not realistic. Firstly, it may be argued that the demand schedule in the presence of PDS and in its absence may be different. Secondly, private imports may not be a vertical line, that is, it may be price sensitive. Interestingly, even when these assumptions are relaxed the same conclusion holds.

7. In explanations of different hues (George and Mukherjee, 1986 and Kannan and Pushpangadan, 1990) price had an important role to play.

8. The growth rates are from Kannan and Pushpangadan, 1990.

CHAPTER 5

PRICE AND TECHNOLOGY IN THE ADOPTION OF HIGH YIELDING VARIETIES OF RICE

1. Introduction

Many South and South-East Asian countries which were heavily dependent on imports of foodgrains in the sixties and earlier, overcame their dependence by the mid- or late-seventies. One of the causes for such a transformation was the spread of High Yielding Varieties (HYV) of cereals:

> "Perhaps the most significant development in agriculture in South and South-east Asia during the past decade has been the shift from traditional agriculture to modern agriculture using science-based technologies. This shift was made possible mainly by the adoption of new, fertilizer-responsive varieties of rice and wheat ...." (De Dutta, 1981, p.548).

India which was so heavily dependent on imports also came out of such dependence by the mid-seventies, mainly because of the spectacular spread of HYVs.

As regards rice,

> "The most rapid adoption of modern rices has taken place in India, Indonesia, and the Philippines. There has been adoption of the new varieties, but at a slower rate in Burma, Thailand, and Pakistan" (Ibid. p.550).

"The rate of adoption of the new cereal varieties has varied greatly between countries and between areas within countries" (Ibid. p.548). India is no exception to this pattern. There are regions within India where the spread of HYV rice has been slow. The eastern region comprising of Assam, Bihar, Orissa and West Bengal and the Southern State of Kerala fall into this group. The eastern region after a slow start and spread has begun responding to Special Rice Production Programmes of the government by bringing a larger proportion of area under HYV rice since the mid-eighties. Consequently, the all-India percentage of area under HYV rice which had only shown a moderate increase from 44 to 55 per cent between 1978 and 1984 had begun showing a sharper increase since then, reaching a level of 69 per cent by 1990-91 (Government of India,1991).

But the Kerala experience has been different. The area under HYV as a proportion of total area under rice has not only failed to show any increase but has begun showing a decline in the eighties. An analysis of the factors making for such a situation is attempted in this chapter.

The main argument of the chapter runs as follows. The main rice growing seasons in Kerala, viz., virippu and mundakan, are wet and proper water control is fairly difficult. In such an environment the physical yield levels of HYVs are not significantly higher than that of the traditional varieties (TVs)[1]. The massive import of rice and its distribution through the PDS in the post-1975 period depressed the price of rice even as the spectacular growth of livestock in the state and the consequent rise in the demand for paddy straw have led to a steep rise in price of straw relative to that of rice. Under these conditions, the profitability between TVs and HYVs becomes very sensitive to price movements of paddy and straw. It is the interaction of these factors which has made for the low and falling levels of the intensity of adoption of HYVs in the state.

The data on intensity of adoption and yield for the different varieties across the districts are taken from the Report on Crop Cutting Experiments. In as much as the reported data are estimates based on sample surveys they need to be analysed with an awareness of their limitations. Similarly, the data on straw prices taken from the Bulletin of Animal Husbandry Statistics are also averages of various centres and taken over several months of the year. The period of analysis is 1973-74 to 1987-88.

The chapter is organised in seven sections including the introduction and conclusion. Section 2 attempts a characterisation of the paths of adoption of HYVs in the districts of the state for the three growing seasons. Section 3 briefly discusses the agro-climatic specificities of the state and the relative performance of HYVs and TVs. Section 4 develops a model to explain the intensity of adoption in terms of yield differential between HYV and TV(traditional variety), price of paddy relative to that of chemical fertilisers and the price of paddy relative to that of straw. Section 5 brings to the fore the movement of the yield differential over the period across the districts. Section 6 discusses the movement of the price ratio between straw and paddy. Section 7 takes up the influence of the movement of relative price and the yield differential between HYV and TV, on the intensity of adoption.

2. Characterisation of the Time Path of Intensity of Adoption of HYVs

Our first problem is to characterise the time path of the intensity of adoption[2] of HYV at the aggregate, that is, the state, and at the disaggregated, that is, the district levels for all the three rice growing seasons, namely _viriρpu_ (autumn), _mundakan_ (winter) and _punja_ (summer).

In the characterisation of the adoption pattern of new agricultural technologies the S-shaped diffusion path or the logistic curve has come to occupy a central place ever since the pioneering work of Griliches (1957). One of the chief merits of the logistic growth curve is the ease in interpreting the parameters. The logistic growth curve used by Griliches was,

$$P_t = K/[1+\exp -\beta(\delta + t)]$$

Where P_t is the per cent acreage planted to hybrid corn at time t, K is the long run equilibrium value, β is a measure of the rate of acceptance of the new technology and δ the level of adoption at the initial period. Initially, explanation of the estimated parameters itself was clearly distinguished from characterisation of the diffusion path. The work on diffusion developed later saw various modifications of the logistic curve in the charecterisation of the diffusion path. Subsequently there was the confounding of characterisation with explanation. Some idea of the development of the literature over the last three decades may be had from the survey paper of Feder et al (1985).

In the characterisation of the diffusion path followed by Griliches (1957) and modified by Jarvis (1981) diffusion is a non-decreasing function. The possibility of a technology which had been adopted at one point of time being rejected sometime later was not considered. Such a rejection after initial acceptance has been observed by researchers [Leuthold (1967), Diamante and Alix (1974)] and has been called the 'disenchantment discontinuance' by Rogers (1983). This phenomenon was also observed by Bera and Kelley (1990) for Bangladesh. They argued that "Any function which attempts to describe the aggregate adoption curve will have to account for the significant drop in adoption" (Bera and Kelley, 1990:270).

A simple graphical representation of the data on the intensity of adoption of HYV rice in Kerala suggests that it was a case of 'disenchantment continuance', to follow the terminology of Rogers. The intensity is seen to have initially increased to reach a plateau and then decreased. As we shall see not all the districts and all the seasons showed this characteristic. Obviously, the conventional logistic function approach would not fit such a case. What was needed was some function which increased upto a point reaching a ceiling and then decreased. Adopting the dummy variable approach, various functional forms satisfying these conditions were fitted to the data and going by the maximum adjusted R^2 we selected

$$P_t = K+b_1D_1(1/\sqrt{t}) + b_2 D_2 (t-T)$$

where t is time 1,2 ......N

D_1 = 1, if t < T

= Ø o.w.

D_2 = 1, if t >= T

= Ø o.w

and T itself was arrived at by running the regression for various values of 1<T<N and selecting the one with the maximum adjusted R^2.

It may be seen that the functional form is flexible enough to accommodate four distinct patterns. In terms of coefficients it may be grouped as follows:

(i) b_1 <Ø, b_2 <Ø. This is the case where the initial level is $K+b_1$; then the function increases upto t = T, reaching the ceiling K and then decreases reaching a terminal level at time t = N.

(ii) b_1 < Ø, b_2 >Ø. Here beginning at $K+b_1$ the function increases over the period.

(iii) b_1>Ø ,b_2<Ø. In this case it is a decline all the way through, the initial level being $K+b_1$.

(iv) b_1>Ø,b_2>Ø. Beginning at $K+b_1$ the function decreases to reach a lower ceiling, K , at t = T; from then on it increases reaching a terminal level at t = N.

As is evident, there is ease in the interpretation of the coefficients. Wherever it is meaningful to talk of a ceiling (upper or lower) K stands for it; b_1 is the total increase or decrease over the period 1 to T and b_2 is the annual increase or decrease over the period T to N. Thus,(K,b_1, b_2, T) summarise the data indicating the initial level, ceiling, turning point and the terminal level. Provided below (Table 5.1) is the summary for the three seasons together. The regression results are provided in an appendix.

As is evident from Table 5.1, over the period 1973-74 to 1987-88 three distinct patterns may be observed going by the characterisation of the intensity of adoption. Out of the thirty district-seasons, in over half-to be exact, sixteen - the intensity moved within a narrow range,neither increasing nor decreasing. The districts included Trivandrum in the south to Kozhikode in the north and the seasons were mainly <u>mundakan</u> and <u>punja</u>. The levels were distinctly higher in <u>punja</u> and lower in <u>mundakan</u>. The rest of the district-seasons fell into two groups. Of the twelve district-seasons falling in the group, eight showed increase in the intensity till some point of time- the turning point - to be followed by a sharp fall. This group included all the three seasons, but the districts included were the major rice-growing districts of Palghat,Ernakulam and Kottayam. Steady fall in the intensity was noted in four district-seasons. Again, the districts included important rice-growing ones like Trichur and Malappuram, as well as the southern Trivandrum. The group included all the three seasons. Only two districts, Cannanore and Quilon showed a steady increase in the intensity of adoption, both being in viripu. Overall, in the main rice growing districts the intensity of adoption did not show any sharp increase during the three seasons;either it moved within a narrow range or showed a fall-either steady or preceded by an increase.

Table 5.1

Movement of the Intensity of Adoption,1973-74 to 1987-88

Movement of the Intensity of Adoption		Seasons/Districts								
Over a narrow range	Low	MAL	MKZ	VKZ	VTV	MEK	MQL	MTC	MTV	MCN
	High	PKZ	PTC	PML	PAL	PKT	PQL	PCN		
Steadily increasing		VCN		VQL						
Steady fall/ Increase followed by fall		VPL	VAL	VEK	VKT	MKT	MPL	PEK		
		VTC	VML	MML	PTV	PCN				

Source:Appendix.

The levels varied very widely across the seasons and districts (Appendix). Among the seasons,the levels were distinctly higher during punja followed by virippu; the levels were the lowest during mundakan. However,this ordering did not continue throughout the period. Towards the end of the period no such ordering was reported for any of the districts,except Kozhikode. This is largely because of the fall in the intensity of adoption,either steady or of the inverted U shape.Across the districts, the levels were distinctly higher in the main rice-growing districts of the state, viz., in Alleppey, Kottayam, Ernakulam, and Palghat, for all the three seasons initially. Again, this ordering was not to be found by the end of the period.

An explanation for this generally low and declining tendency of the intensity levels now becomes necessary.

3. Agro-Climatic Conditions and Yield Potential of HYVs

Kerala is a narrow strip of land bounded on one side by the Arabian Sea and on the other by the Western Ghats. It receives rainfall from two monsoons and rice is grown in three seasons. Broadly, the sowing and harvesting periods of the three seasons are as follows:

Season	Sowing Period	Harvesting Period
Virippu	April-May	September-October
Mundakan	September-October	December-January
Punja	December-January	April-May.

The quantum and distribution of rainfall over the months of the year across the districts of the state vary widely:

> "As one moves from south to north the quantum of annual rainfall increases. Though the tendency is not regular but discernible. So also the annual precipitation is concentrated around fewer months towards the northern parts of the state while it is spread over larger months in the Southern parts. For instance, only during four months of the year Cannanore district receives rainfall more than the monthly average while in the Trivandrum district the rainfall is above the monthly average for seven months" (Government of Kerala, 1974 : pp.23-4)

The topography of the state is undulating and rice is grown mostly in the valleys under widely varying conditions. The state is also characterised by warm day and night temperatures. "The mean minimum (temperature) moves within a small range of 19-26^{0}c while the mean maximum varies between 27-37^{0}c" (Government of Kerala, op.cit. p.24). Across the districts this range becomes narrower. Tropical location coupled with high rainfall conditions generate high humidity conditions throughout the year, the annual average being around 70 per cent. On the whole, these are the conditions making for low yields of rice in tropical Asia:

> "In tropical Asia, rice yields have been low for many centuries..... Reasons for those low yields are warm day and night temperatures, high humidity, low light intensity, and the poor rice varieties" (De Dutta, op.cit., p.549).

How have the HYVs performed relative to the TVs under these conditions in Kerala?

It may be noted that attempts were made since the 1940s to raise the yield of rice in the state through varietal improvement programmes. The result of these programmes was the introduction of what were later called nationally improved varieties (NIVs). The NIVs, which are included in the group which has been called TV here, were useful in raising the yield levels in Kerala. The yield levels went up rather sharply in the 1950s and the 1960s. As may be seen (Table 5.2) Kerala's growth performance during this phase was comparable to that of the other major rice growing states in India.

During the late 1960s, HYVs were introduced in the state. Their performance in experimental trials was not spectacular. The highest yields obtained in the National Demonstration Plots[3] were one of the lowest for Kerala [Table 5.3]. The results were similar in a trial conducted by the Fertiliser Association of India (Fertilizer Association of India, 1973). The HYVs were not able to outperform the TVs (largely NIVs). Obviously, the yield potential of the HYVs under the environmental specificities of Kerala was low.

Table 5.2

Yield of Rice Across Some of the States of India

State	Yield for the triennium ending (tonnes/ha.)		
	1954-55	1961-62	1972-73
Andhra Pradesh	1.156	1.276	1.450
Karnataka	1.067	1.361	1.762
Kerala	1.009	1.350	1.535
Punjab	1.474	1.056	1.948
Tamil Nadu	1.173	1.451	1.969
West Bengal	1.029	1.064	1.189
All India	0.877	0.995	2.222
Yield for Kerala as a percentage of All India Yield	115	136	138

Source: Ranade, C.G. (1986), Table 4.

Table 5.3
Crop Yields of Rice in National Demonstration,1974-75
(tonnes/ha.)

States	Kharif	Rabi	Summer
Andhra Pradesh	9.37	5.38	4.75
Punjab	5.76	NA	NA
Orissa	4.82	4.90	4.58
Tamil Nadu	5.79	5.50	NA
Karnataka	NA	3.88	5.29
Bihar	5.38	NA	2.90
West Bengal	2.72	NA	NA
Kerala	3.18	3.30	3.40

Source: Swaminathan, M.S, (1989), Tables 13.2 and 13.3
Note: Crop yields are for HYVs.

The performance of HYVs do not compare favourably with that of the NIVs even in the best of the paddy growing areas in Kerala. In a study conducted in 1975-76 in selected areas of Palghat and Kuttanad, the two leading rice growing areas of the state, it was found that the HYVs were not generally able to outyield the NIVs. As against the average yield per hectare of dry paddy (in tonnes) of 2.49(mundakan), 2.70(mundakan), and 3.37(punja) by NIVs in three villages, the yield of HYVs were 2.20, 3.18 and 3.12 respectively (Panikar, 1983: Table IV.6).

Given the agro-climatic specificities of the state and the fact that yield potential of the HYVs is not significantly higher compared to the TVs(including the NIVs),the yield differential (the ratio of HYV yield to TV yield) has an important role to play in shaping the movement of the intensity of adoption. But how do the relative price factors interact with yield differential in affecting the intensity of adoption analyse this question. This is the agenda for the next section.

4. The Model

It is well-known that HYVs of rice respond well to fairly high doses of fertiliser application and compared to the TVs their superiority lies in this aspect. The model attempts to make use of this typical yield response of HYVs to fertilisers.

Assuming profit maximising behaviour on the part of farmers, the level of application of fertiliser and the corresponding yield level is set by equating marginal value product with marginal cost. To begin with the TVs, farmers have been using them for a long time and are highly knowledgeable about them. They apply fertilisers upto the level at which profit is maximised.

Suppose a farmer is on such a yield function for a TV at the point of maximisation of profit. At some point of time he comes to know of HYVs and experiments with one such HYV applying the recommended level of fertiliser.If the farmer makes a larger profit with the HYV,it will be adopted over a wider area.On the other hand,if there is no difference in profit the experiment will end in the farmer rejecting the same.It may be noted here that not a single TV function or HYV function exists for all the farmers within a region or across regions.

Before proceeding any further, it is necessary to provide empirical support to the assumptions made, especially with regard to the quantity of fertiliser applied. To quote from a survey report for the year 1972-73:

> " The rates of application of Nitrogen to the plots grown with high yielding varieties were between 70 and 80 Kg./hectare for all the districts during the three seasons,except for Trichur and Malappuram for the autumn season. But the rates of application of this fertiliser to the fields growing local varieties were nearly half of that of the high yielding varieties. Between 40 to 20 kgs.of nitrogen was the usual dose given to the local varieties during the three seasons." Government of Kerala, 1976:12)

The report provides information on the application of phosphates and potassium as well, which showed a similar pattern. Another study for the year 1976-77,for the two main rice growing regions of the state showed that the level of fertiliser applied to the HYVs compared well with the dosage recommended by the Directorate of Extension Education,Kerala Agricultural University:

> "The application of nitrogen in the Palghat holdings,76- 78 Kg./ha., may therefore be considered to fall a little short of the recommended dosage for the medium duration varieties, whereas in the case of Kuttanad holdings the actual input,87-118 is higher" (Panikar,1981:35).

Thus, the level of fertiliser input is significantly different for HYVs when compared with the TVs and they are fairly close to the recommended dosage.

Turning now to the profit equations, following the characterisation of Herdt and Capule (1983), it is enough to take the input of fertiliser as the only cost. They argued that,

> "......other inputs like labour need not be explicitly mentioned because they can be subsumed within the model by assuming they are used in fixed proportion to land" (Herdt and Capule, 1983:27).

For the present purpose the assumption of fixed proportionality of labour is valid because the empirical evidence of it has already been provided earlier in Section 2, Chapter 3. There it was shown that the number of man-days applied did not show any difference between HYVs and TVs. Then, the only variable input is fertiliser.

The profit equation for HYV rice may now be written as,

$\pi_Y = YP-XC$, where Y is the productivity, P its price X, the fertiliser input and C its price.

A similar equation for TV is,

$$\pi_y = yP-xC.$$

The difference, $D=\pi_Y - \pi_y = yP(Y/y - 1)+C(x-X)$.

As indicated, the fertiliser input is more for HYV. Of course, it would be sensitive to relative prices which shall be taken up later. Hence, $X>x$ and the second term on the R.H.S. of the equation becomes negative. Then, the minimal condition for a positive D is that

$$Y/y > 1.$$

The necessary condition for D to be positive is that $Y/y > 1+\alpha$,where α is a small positive number the value of which will depend on C and P. And D would increase with an increase in Y/y and would fall with a fall in Y/y. Then, the decision to adopt HYV is positive if $Y/y > 1+\alpha$, and negative otherwise. The adoption rate or the area under HYV as a proportion of total area itself may then be taken as a function of Y/y. It is an increasing function in that as Y/y increases adoption rate increases and as Y/y decreases adoption rate decreases.

It follows that a downward shift of Y(the HYV yield) owing to severe pest and disease attack or any other reason, may depress the adoption rate. A similar process may take place if HYV fetches a lower price in relation to TV.

It may be noted t at the level of fertiliser use at which profit is maximised is a function of C/P - the ratio of input price to paddy price - through the relationship $d\pi/dx = 0$. Any increase in C/P brings down the quantity of fertiliser applied and brings down the yield. Depending upon the relative yield response functions, this would push down D and will make adopters become non-adopters, bringing down the intensity of adoption.Thus, the intensity of adoption is inversely related to C/P.

So far, we have only considered the output of paddy. In the Kerala context, paddy straw should also be considered for the following reasons. As one study points out,

"......The Kerala case is particularly interesting because of the fact that the state has been able to transform one-half of the cattle population into cross-breds within a period of about 25 years: a remarkable achievement in the field of cattle breeding compared to other regions of India and also that of other developing countries" (George and Nair, 1990, p.11).

The degree of commercialisation of milk production in Kerala is also far higher.But these developments have taken place in a situation characterised by extreme scarcity of feed and fodder. Although crop residues like tapioca leaves, vegetable wastes etc. are available, their use is low.The most important item of dry fodder in the state is paddy straw. Its purchase among cattle holding households was found to be widespread:

"In the case of paddy straw, in five villages more than 75 per cent of the households reported its purchase.In another 12 villages it varied from 51 to 75 " (George and Nair,op.cit., p.87).

Thus, paddy straw has emerged as an important dry fodder in the state.

The noteworthy points in this context are that (1) owing to the relatively low proportion of area under rice in the state the production of paddy straw per animal is low in Kerala as compared to the other states, and (2) as not all cattle keepers are paddy producers in the state, the dependence on purchased straw is fairly high.The spectacular growth in milk production has generated an increasing demand for paddy straw in recent years, leading to a sharp rise in its price.

Paddy straw, being an important dry fodder bought and sold in the market, has its own economic value and could influence various decisions of the farmers. This assumes importance in the context of adoption of HYVs because the ratio between paddy and straw is roughly 1:1 in the case of HYVs and 1:2 in the case of many TVs (all in physical units)[4]. Further, the ratio between the price of paddy and straw which was 6:1 in the early seventies has moved to 2.5:1 by the late eighties(based on the price information contained in the <u>Bulletin of Animal Husbandry Statistics</u>). Then, instead of taking value productivity as Y.P we need to take $Y.P + S.P_s$ where S is the output of straw and P_s its price.

Let us define, $Y^* = Y.P + S.P_s$

$y^* = y.P + s.P_s$. keeping to the convention of upper case and lower case letters.

$$\frac{Y^*}{y^*} = \frac{Y\ P + S\ P_s}{y\ P + s\ P_s} = \frac{Y}{y}\left[\frac{1+(S/Y)(P_s/P)}{1+(s/y)(P_s/P)}\right]$$

Since, $\frac{S}{Y} << \frac{s}{y}$, $\frac{Y^*}{y^*} < \frac{Y}{y}$

this may lead to the rejection of HYVs on account of the output of straw relative to the output of paddy,even when Y/y itself is greater than 1.

Another factor is the movement of the price of straw relative to that of paddy. It may be seen that

$$d(Y^*/y^*)/d(P_s/P) = Yy[S/Y-s/y]/[1+(s/y)(P_s/P]^2 < 0, \text{ for } S/Y << s/y.$$

This would imply that movement of price in favour of straw would adversely affect the adoption of HYV. Thus, the adoption rate is inversely related to the ratio of price of straw to the price of paddy.

Now, we may summarise the above relationships as,

adoption rate = $f(Y/y, c/P, P_s/P)$

where Y/y, the yield differential has two components: a purely technological component and an economic one in the level of input used which is a function of c/P. Thus c/P affects the adoption rate only through its effect on Y/y. If that effect is eliminated then adoption rate is simply a function of Y/y and P_s/P, in fact, directly related to Y/y and inversely related to P_s/P.

As already indicated, it is possible that changes in the price of paddy relative to fertiliser price may influence the application of fertiliser.Such changes in the fertiliser applied may change the yield differential. In order to test for such a response the yield differential was regressed on the ratio of paddy price to fertiliser price with a time residual (and without it). The fits were found to be poor and the coefficients were insignificant for all the districts and for all the seasons; the exceptions were Malappuram(viripu), Alleppey(mundakan) and Ernakulam(punja), but the signs were negative. Such a result could have come about either because farmers do not respond to relative price movements and change the level of fertiliser use or because the HYV yield relative to the TV yield is not sufficiently responsive to the changing levels of fertiliser use.Hence, the question of fertiliser response to relative price movement needs to be examined.

The response of fertiliser to relative price movement cannot be examined at the district level because of lack of data. At the aggregate, that is, state level, when fertiliser consumption per hectare of paddy land was regressed on the ratio of paddy price(farm harvest) to fertiliser(nitrogenous) price the following result was obtained:

$$\begin{array}{lcl} \text{LNFCON} & = & 3.60 + 0.08\ t + 0.29\ \text{LNPAPOVN} \\ & & \qquad\quad (13.07^{*}) \quad (2.07^{***}) \\ & & [0.94,\ 0.92,\ 88.70\ ] \end{array}$$

Period of analysis:1971-72 to 1987-88.
LNFCON : Log of fertiliser consumption per hectare of paddy land.The variable used is total consumption of nitrogenous fertiliser divided by gross cropped area of paddy.
LNPAPOVN: Log of paddy price over fertiliser price.
t is the time trend.

As is evident there is a very strong time trend. But the fertiliser use is responsive to relative price movements and the elasticity is 0.29.Thus, it may be inferred that the farmers do respond to price movements but the HYV yield function itself is such that the changing levels of fertiliser use do not get translated into changing yield differentials. Empirical evidence of the poor yield response of HYVs have been provided above.

With this, the ratio of paddy price to fertiliser price as a determinant of the intensity of adoption drops out and the analysis need only be confined to the yield differential and the ratio of straw price to paddy price.

5. The Level and Movement of Yield Differential.

An analysis of the yield differential, that is, the ratio of the yield of the HYV to that of the TV, across the districts of the state for the three seasons showed no clear trend, except in a few cases. When a semi-log fit with time as the independent variable was tried, it was found that only five district-season combinations showed any clear trend (Table 5.4).

Only VQL showed a strong rising trend. In MQL and PCN also there is a rising trend but the rate is much slower; and in MQL the initial level itself was very low. Both PKT and PPL showed strong falling trend.

It is possible that the yield differential had not been increasing or decreasing over the entire period. Graphical representation of the data showed systematic rise followed by systematic fall in a few districts. In order to test the strength of such movements a dummy variable regression of the following type was tried,

$$\log (Y/y) = a+b_1 c_1 + b_2 c_2$$

where c_1 = time upto the year T
= Ø beyond T

c_2 = Ø upto the year T
= time beyond T.

Here time is taken to be Ø at T and +ve numbers beyond T and -ve numbers before.

Table 5.4

Regression Results of Yield Differential on Time,1973-74 to 1987-88

District/ Season	a	b	R^2	R^{-2}	F
VQL	0.344 (10.28)*	+0.226 (2.924)*	0.40	0.35	8.55**
MQL	-0.034	+0.0195 (2.975)**	0.41	0.36	8.85**
PKT	0.155	-0.031 (-3.095)*	0.42	0.38	9.58*
PPL	0.433 (9.46)*	-0.042 (-4.025)*	0.55	0.52	16.20*
PCN	0.132 (3.83)*	0.0181 (2.32)**	0.29	0.23	5.40**

Source:Government of Kerala, Report on Crop Cutting Experiments(various issues)

The Table calls for careful interpretation. In the Table, the value of 'a' corresponds to the level in the year T. A positive value of b_1 indicates that the level was lower initially and was increasing; a negative b_1 indicates that the initial level was higher and was falling. A negative b_2 indicates steady fall beyond T and a positive b_2 indicates a steady rise beyond T. T itself was chosen after careful scrutiny of the graphs.

As is evident from the table (Table 5.5) in both MQL and PCN the yield differential showed a steady increase after remaining stagnant at a low level for a few years intially. In VQL, the yield differential increased in the initial years and then remained at 1.55 (corresponding to a=0.438). In PKT, the yield differential fell for a few years initially and then remained at 1.12. In the rest of the district-season combinations an increase was followed by a sharp fall. In Palghat this occurred in all the three seasons.

Table 5.5

Regression Results of Yield Differential on Time with Dummy

$$\log(Y/y) = a + b_1 c_1 + b_2 c_2$$

District/Season	a	b_1	b_2	T	R^2	$\bar{R}^2$	F
VQL	0.438	0.049	-.0003	1978	0.56	0.49	7.62*
	(8.14)*	(3.43)*	(-.239)				
MQL	-0.068	0.0007	0.028	1982	0.45	0.36	4.97**
	(-1.55)	(.496)	(2.64)**				
PKT	0.110	-0.048	-0.02	1982	0.46	0.37	5.07**
	(1.60)	(-2.20)**	(-1.198)				
PPL	0.501	-0.019	-0.057	1981	0.58	0.51	8.35*
	(5.60)*	(-.693)	(-2.834)*				
PCN	0.068	-0.001	0.033	1978	0.38	0.28	3.74***
	(1.14)	(-.247)	(2.44)**				
VPL	0.724	0.086	-0.116	1978	0.62	0.56	9.93*
	(7.11)*	(3.18)*	(-4.33)*				
MPL	0.208	0.049	-0.019	1980	0.50	0.41	5.93**
	(4.48)*	(3.43)*	(-1.83)*				
MAL	0.597	0.063	-0.034	1980	0.38	0.28	3.65***
	(7.73)*	(2.66)**	(-1.95)***				

Source: Same as Table 5.4.

If we leave out the above district-season combinations, then the rest of the districts showed the following pattern in terms of mean levels and coefficient of variations (%) of the yield differentials. Generally, the mean levels of the ratio of HYV yield over TV yield are below 1.35. The levels are seen to be higher for <u>Punja</u> and between <u>Mundakan</u> and <u>Virippu</u> there was not much of a difference. The most striking aspect is the association between mean levels and the coefficient of variation. The strength of this relationship measured in terms of the product moment correlation coefficient was 0.70. That is, the district-season combinations showing higher mean levels of yield differentials also report higher instability.

Overall, few districts could maintain a high level of yield differential. The few districts which had fairly high or increasing levels of yield differential had begun showing a falling tendency from the late seventies or the early eighties. For the vast majority, the yield differential was below 1.35 and even when it was higher it was associated with a higher variation or instability. Thus, the yield levels of HYVs were not very much higher than those of the TVs and there was considerable variation in the differentials.

6. The Movement of the Price of Straw in Relation to the Price of Paddy

As is evident from the discussion in Section 4 above, the movement of the ratio of the price of straw to that of paddy is important for an understanding of the movement of the intensity of adoption of HYVs. A graphical representation of the ratio of the annual average price of paddy straw and the farm price of paddy for the districts of the state showed that there had been a steady increase in the ratio for some districts but an increase followed by stagnancy for other districts. It is therefore necessary to analyse this movement of the ratio.

Going by the equation for profitability differential, D, in section 4, the ratio of the price of straw to the price of paddy in itself is not highly relevant for our purpose. What is more relevant is [P+(S/Y)Ps]/[P+(s/y)Ps]. In order to compute such a ratio it is necessary to know S/Y and s/y. No time series data are available on such ratios. Instead, it is known that S/Y was approximately one and s/y two. For instance, one of the hybrid varieties, viz., 'Jaya", reported the ratio S/Y to be 1.12, 1.16, 1.07, 1.15 and 1.12 for various trials. The ratio s/y was found to be in the range 1.87 and 2.23 (Koruth et al., 1990: pp.30-32). For simplicity S/Y and s/y were taken to be one and two respectively. Using these ratios, the series P^1 =[P+(S/Y)Ps]/[P+(s/y)Ps] were computed for the districts of the state. As the data on straw price were not available for ML and CN, the series could not be computed.

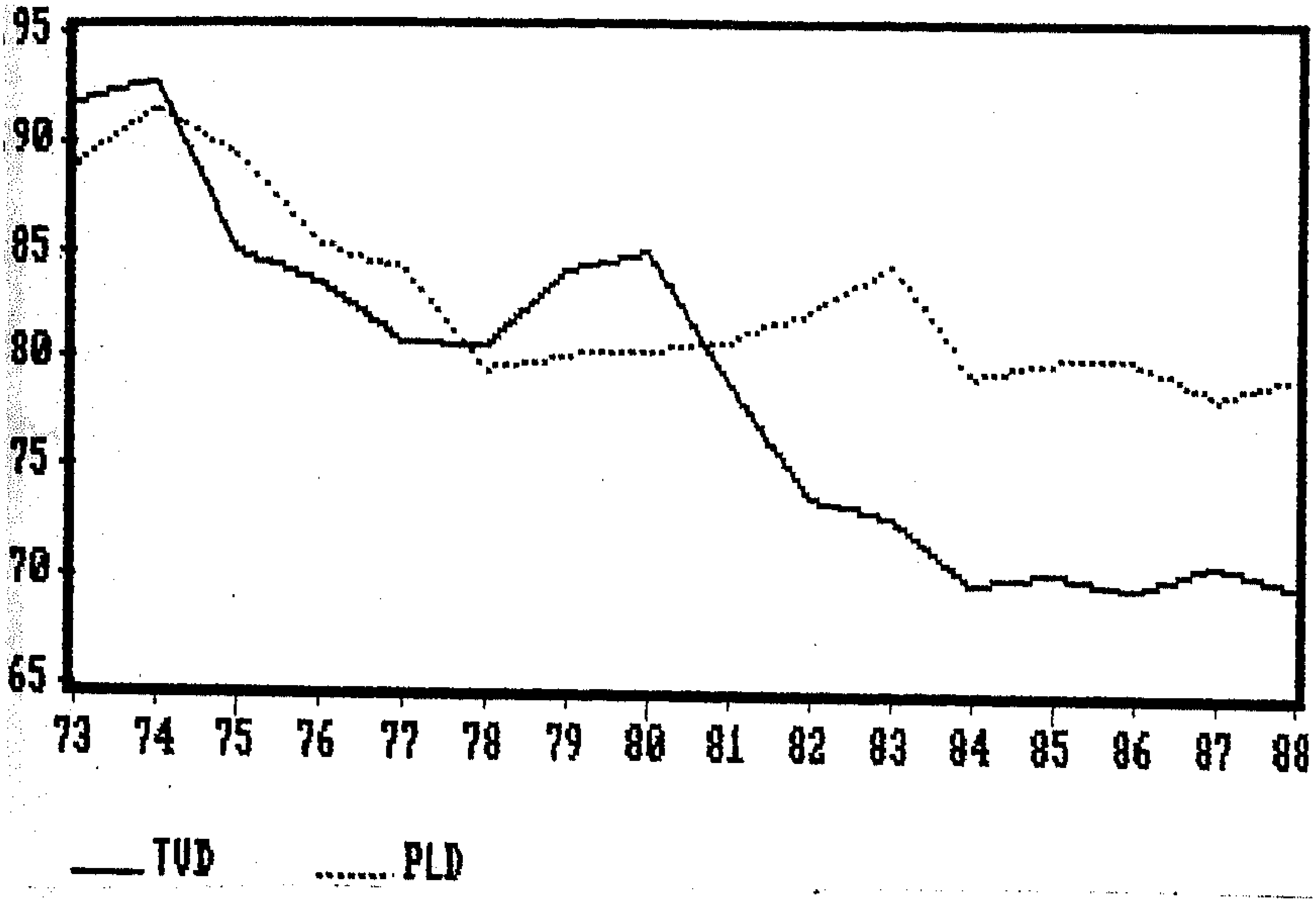
The P^1 series which reported values between 0.90 for Trivandrum and 0.85 for Kozhikode in 1973 fell rather sharply during the next few years. In most of the districts it stabilised at lower levels by the early eighties; but in Trivandrum and Kozhikode the fall continued throughout the period (See the graph). Equations were run to arrive at the magnitudes of the fall using t and t^1.

t is taken as time 0,1,2 ..... and t^1 = t-T, for t<T

=0, for t>=T

When the equation is run with t as the independent variable, the intercept term is the initial level and the coefficient of t is the annual increase or decrease depending upon its sign. When the equation

Price Differential ($P_{*}^{'}$) of Rice and Straw



TVD: Price Differential between rice and paddy straw (Trivandrum)

PLD: Price Differential between rice and paddy straw (Palghat) is run with t^1, the constant term is the level reached at time T which is the level beyond T as well. As in the case of the regressions of yield differential on time, T was chosen after a careful scrutiny of the graphs.

The results are provided in Table 5.6. As is evident from the Table, in Trivandrum, P1 fell from 0.90 to 0.68 over 1973 to 1988 and in Kozhikode, the fall was from 0.85 to 0.76. In the other districts the value of P^1 fell sharply till 1980(T=7) and remained between 0.75 and 0.80 beyond 1980.

Table 5.6
Regression of P^1 on t or t^1, 1973 to 1988

District	α	β	$\bar{R}^2$	DW	F
		$P^1 = \alpha + \beta t$			
TV	0.90	-0.016	0.86	1.06	94.33
		(-9.71)*			
KZ	0.85	-0.006	0.45	1.66	13.46
		(-3.67)*			
		$P^1 = \alpha + \beta t^1$			
QL	0.75	-0.023	0.91	1.38	149.44
		(-12.22)*			
AL	0.80	-0.014	0.73	1.47	42.09
		(-6.49)*			
KT	0.79	-0.017	0.89	1.81	117.97
		(-10.86)*			
EK	0.75	-0.023	0.84	2.75	79.35
		(-8.91)*			
PL	0.80	-0.015	0.77	1.41	52.11
		(-7.22)*			
TC	0.80	-0.009	0.44	1.13	12.81
		(-5.15)*			

Source: 1. Government of Kerala, Bulletin of Animal Husbandry Statistics, (Various Issues)
2. Government of Kerala, Economic Review (Various Issues).

It may be recalled that the farm price of paddy fell rather sharply beyond 1975 (Chapter 4). In the face of a falling farm price of paddy and rising price of straw, P^1 must have fallen over this period. The farm price began rising by 1980 but crossed the level prevailing in the early seventies only by 1982-83. With the rising of the price of paddy, P^1 tended to stabilize in most districts. Thus, the sharp fall in the farm price of paddy beyond 1975 had played a crucial role in depressing P^1.

7. Yield Differential and Intensity of Adoption

The findings of the two previous sections may now be brought together to explain the characteristic movement of the intensity of adoption observed in Section 2 in terms of the model developed in Section 4. Let us begin by rewriting the equation for the difference in profitability between HYV and TV, viz., D, as follows:

$$D = y[P+(s/y)Ps]\left[\frac{Y[P+(S/Y)Ps]}{y[P+(s/y)Ps]} - 1 - \frac{C(X-x)}{y[P+(s/y)Ps]}\right]$$

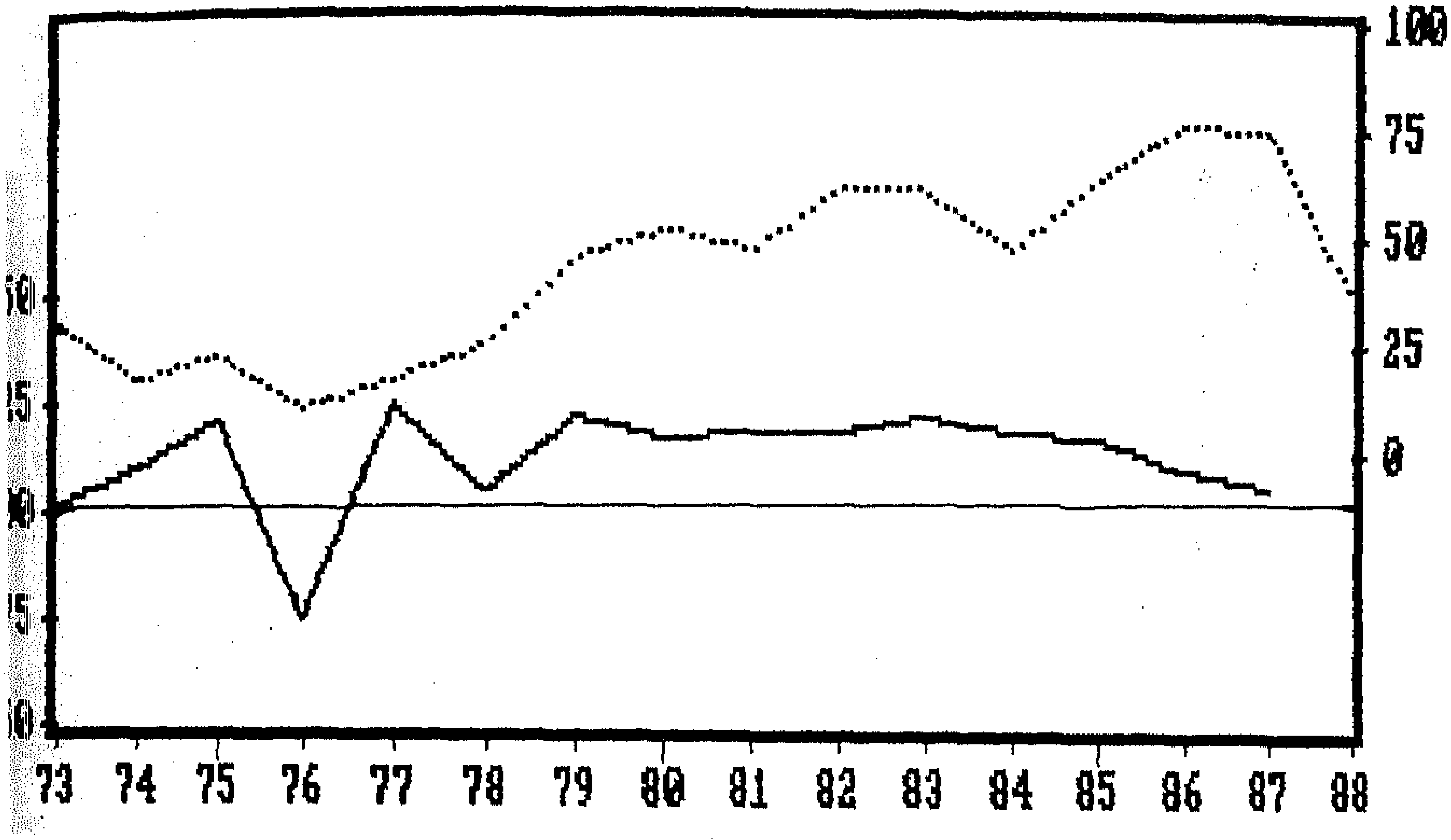
For intensity of adoption to increase or remain at a high level, D has to be +ve. Now, D can be positive only when the expression within the brackets is positive.

Series have been built and discussed for the first term within the brackets (value yield differential) taking S/Y to be one and s/y to be two. Ideally, series should have been built for the last term as well. But paucity of data on (X-x) does not permit that. Whatever is known about (X-x) is presented in Section 4 and going by that, it can be said that (X-x) was not less than 40 kgs. Taking y to be 1600 kgs and considering the rangé of values of C P and Ps over 1973 to 1988 and taking [C/(P+2Ps)] to be between 1 and 2, it may be inferred that the last term within the bracket will be between 0.025 and 0.05. Then, for D to be positive the value yield differential should be greater than 1.05.

Following the discussion of the previous section regarding the straw content of HYV and TV, P^1, the value part of the value yield differential has been computed taking S/Y =1 and s/y = 2. The differential content of straw is not uniform across the three seasons. The summer crop (Punja) is a short duration crop even with the TVs and hence the straw content of TVs is not significantly higher than that of the HYVs in that season. In such a situation, s/y needs to be taken equal to S/Y and the value yield differential would reduce to the physical yield differential. Hence, for the purpose of this chapter, value yield differentials are taken for viripu and mundakan and physical yield differential for punja.

It was observed in Section 2 that there were three distinct patterns with regard to the movement of intensity of adoption. They were movement over a narrow range, rising tendency and falling tendency. There were only two season-districts showing a rising tendency. It may be observed that in both these cases the initial levels of intensity of adoption were one of the lowest, 12 per cent in VQL and 3 per cent in VCN. By 1987, they had increased to 65 per cent and 33 per cent respectively. As the plots point to, in both the cases the value yield differentials showed an increasing tendency. In VQL it increased

QUILON



—— QLVY1 ...... QLIAV

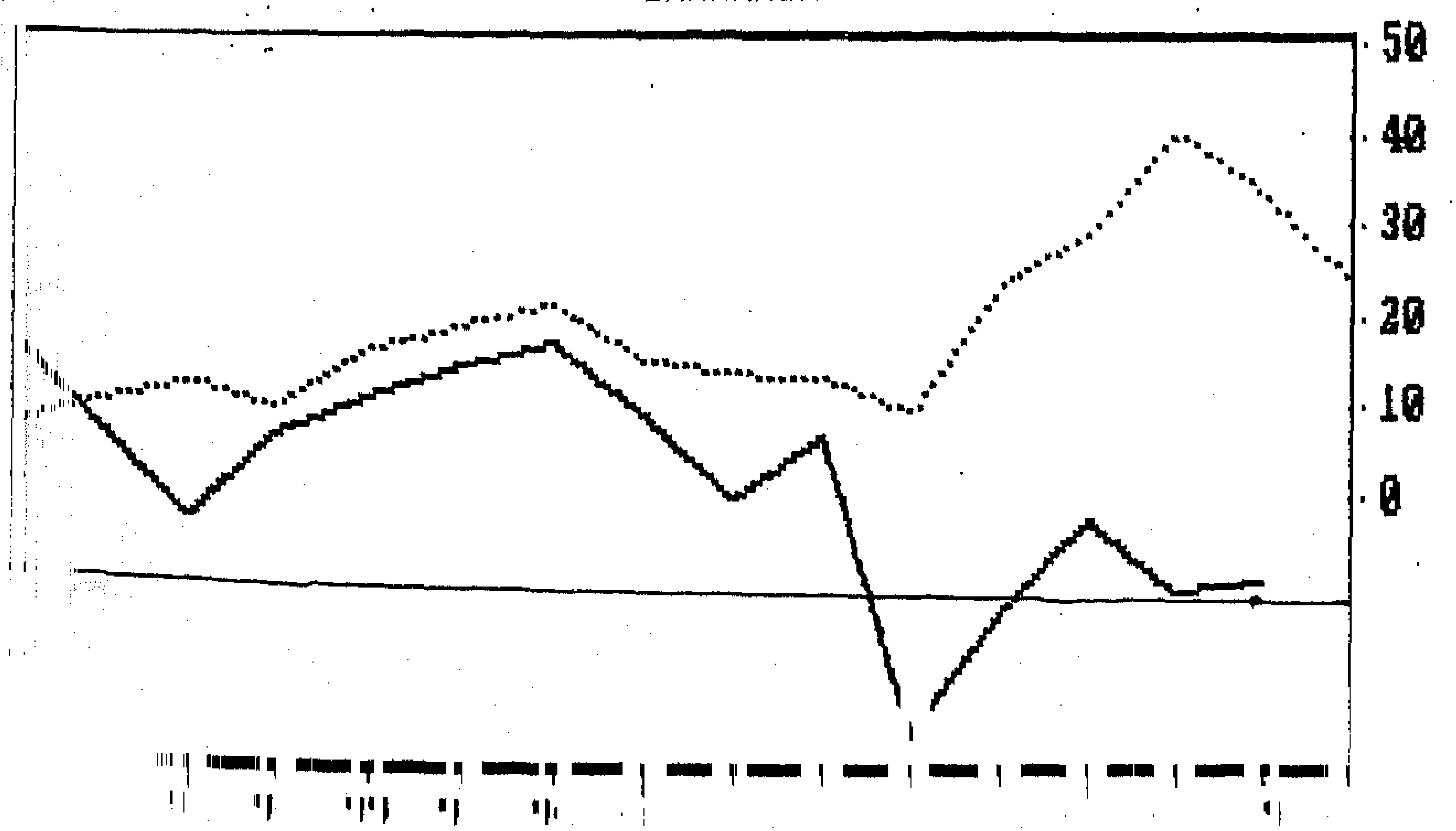
VY1: Value Yield differential; .... IAV : Intensity of Adoption

QL : Quilon CN : Cannanore

V in both stand for Virippu

—— CNVY1 .....CNIAV

CANNANORE



initially and then remained above the value one for the rest of the period. In VCN after the initial dip, it increased and remained above the value one for most of the period. In other words, they had value yield differentials which were above one and remarkably stable. The mean values were 1.11 and 1.13 for VCN and VQL respectively and the respective standard deviations were Ø.12 and Ø.13, which were one of the lowest for comparablė mean levels.

It may be observed that for comparable mean levels of value yield differential the two districts showed very different levels of intensity of adoption. The dip in the value yield differential in VCN in the mid-eighties must have affected the rising tendency of the intensity of adoption. If the value yield differentials had shown a rising tendency, in the face of a downward pressure on P^1, then the physical yield differential must have shown a strong upward movement to counter this downward pressure. In the case of VQL this was pointed to in Section 5. This,then is a necessary condition for the increase in the intensity of adoption.

Going by the discussion so far, it is evident that the intensity of adoption is related to the level of value yield differential and its movement. Thus, the group of district-seasons which reported movement of the intensity over narrow ranges may be explained by the levels of value differential and its stability or lack of it. When the value yield differential for this group was analysed, none reported any systematic pattern and hence the data were summarised in terms of the mean and standard deviation. Then, the mean intensity was regressed on mean value yield differential and standard deviation(SD) for the sixteen district-season combinations falling within this group. The estimated equation was,

$$\text{Intensity} = \underset{(4.00)^*}{-66.67} + \underset{(3.49)^*}{96.36}\ \text{Mean}\ (Y^*/y^*)\ \underset{(2.20)^*}{-54.25}\ \text{SD}(Y^*/y^*)$$

[0.53, 0.46, 7.48]

Both the coefficients have the expected signs and are statistically significant. It is evident from the regression result that when the value yield differential showed no systematic movement over the period the intensity of adoption was related to the mean level of value yield differential and its variation over the period.

In light of the above, when the value yield differential either lies below a certain level through out the period or declines and falls below that level at some point the intensity would be expected to show a falling tendency. The data provided in Table 5.7 for the district-seasons falling in the third group corroborate such an expectation.

The Table needs some explanation. Both columns 2 and 3 are arrived at by running regressions of VYD on either time (t) or on t_1 and t_2 where t_1 = t, upto T and 0, beyond; and t_2 = 0, upto T and t-T, beyond T. Column 4 is taken from the appendix.

Table 5.7

Yield Differential and Intensity of Adoption.

District/ Season	Initial level of Value Yield Differential (VYD)	Year in which VYD moves below 1.05	Year in which Intensity began falling
(1)	(2)	(3)	(4)
VAL	1.29	1982	1984
VKT	1.22	1982	1983
VEK	1.18	1978	1976
VPL	1.16	1985	1979
PPL	1.54	1983	1984
MPL	0.84	NA	1980
PEK	0.93	NA	1977
PTV	1.38	1983	1984
VTC	0.99	NA	Steady fall
VML	1.34	1979	Steady fall
MML	1.16	1976	Steady fall

Note:NA stands for not applicable.

It is evident from Table 5.7 that in most of the cases the downturn in the intensity of adoption had been preceded by the VYD moving below 1.05. However, there are differences some of which have occurred owing to the approximations made. The level 1.05 was fixed taking the yield of TVs to be 1600 kgs. But there is considerable variation across the districts and seasons. For instance, the more appropriate level in VEK would then be around 1.08 and the entry in column 2 would then become 1976. Similarly, the data on straw prices were not available for Malappuram and the data for Palghat(the nearby district) were used. Still VPL and MPL do not have a satisfactory explanation.

Overall, the falling tendency of the ratio of farm price of paddy to the price of straw has had a depressing effect on the value yield differential. Only a high and rising physical yield differential could have countered this falling tendency of the value yield differential. Since, none of these were operating within the rice economy, there was a falling tendency in the intensity of adoption.

8 Conclusion

Going by the share of the different seasons and districts in the gross cropped area under rice, in less than 20 per cent of the area the intensity of adoption was high or was rising. In 80 per cent of the area comprising the major rice growing districts/seasons the picture was one of low or declining intensity of adoption. The root cause of such a dismal picture was either the very low level of yield differential or its falling tendency.

The most striking aspect of the area where intensity of adoption was high or rising was that, either the growth season was punja or the concerned districts were the two northern districts (Kozhikode and Cannanore). Now, punja is a crop grown during the dry season and hence is an irrigated crop. Similarly, the two northern districts are characterised by a brief wet season of about four months where mundakan is also an irrigated crop. This is an often discussed problem. If the environment is conducive - dry season and irrigated crop - HYVs do well; then, the yield differentials are high and the intensity of adoption is high. In Kerala, where 80 per cent of the area has a wet season crop the available HYVs of rice were simply not "adaptable". Can it then be better called a failure of agricultural research - what Swaminathan called the research gap[5] ? This is in striking contrast to the success of NIVs in Kerala.

In the face of such a poor performance on the front of physical yield, the price factors came to paly a decisive role. The massive import of rice on state account since 1975 depressed the farm price of paddy. The spectacular growth on the livestock front by generating demand for straw succeeded in pushing up its price. The two together depressed the value yield differential leading to the fall in the intensity of adoption.

Notes:

1. For the purpose of this chapter,TVs include nationally improved varieties also.
2. Intensity of adoption is defined as the per cent acreage planted with HYVs following Ahmed(1982, p.10).
3. Begun since 1965 where agricultural scientists grow crops in farmers' plots.
4. A ratio of 1:1 for HYVs may not be realistic for the semi- dwarf varieties released in the late eighties and early nineties. But our period of analysis extends only upto 1988 and these varieties did not have much influence during this period.
5. The gap between potential and actual experiment station yield. [See Sinha (ed.), 1989].

APPENDIX
Characterisation of the Intensity of Adoption

V i r i p p u

District	A	B_1	B_2	R^{-2}	DW	T
Kerala	41.88	-35.92 (-10.04)*	-1.49 (-5.31)*	0.84	2.25	1977
TV	16.24	-10.19 (-1.98)***	-0.81 (-.69)	0.14	1.72	1984
QL	43.10	-33.30 (-2.41)**	2.39 (1.71)	0.59	1.39	1979
Linear: $Y=\alpha+\beta t$, 11.86+4.41t (7.60*) R^2 = .82						
AL	47.49	-8.85 (-.80)	-7.01 (-2.77)*	0.32	2.54	1984
KT	89.25	-58.48 (-3.24)*	-9.52 (-2.90*)	0.39	2.09	1983
EK	54.59	-27.11 (-3.17)*	-2.58 (-4.04)*	0.51	2.07	1976
TC	16.78	16.57 (2.60)**	-0.83 (-1.28)	0.56	1.97	1979
PL	76.04	-48.92 (-4.86)*	-7.96 (-7.83)*	0.80	1.50	1979
ML	12.22	11.85 (2.20)**	-0.07 (-0.11)	0.32	2.16	1980
KZ	19.16	-12.19 (-1.80)***	-1.09 (-.70)	0.09	2.46	1984
CN	22.89	-19.58 (-3.21)*	2.48 (1.77)***	0.67	1.27	1984

Source: Government of Kerala, Report on Crop Cutting Experiments, (Various Issues), Department of Statistics, Trivandrum.

Note: 1. * One percent, ** Five percent, and *** Ten percent levels of significance.

2. The period of analysis is 1969 to 1988 for Kerala. The period is from 1973 for the districts. For the virippu season the period is 1973 to 1987; for mundakan and punja it is 1974 to 1988.

<u>Mundakan</u>

District	A	B_1	B_2	R^{-2}	DW	T
Kerala	23.74	-16.43	-1.00	0.60	1.52	1978
		(-5.41)	(-4.2)			
TV	2.87	10.42	1.52	0.47	1.32	1982
		(3.53)*	(3.36)*			
QL	8.46	-5.69	-1.18	0.17	2.40	1984
		(-2.06)***	(-1.85)***			
AL	14.41	8.93	1.28	-0.04	2.87	1980
		(0.97)	(1.21)			
KT	79.10	-46.32	-2.59	0.34	2.55	1981
		(-2.89)*	(-1.23)			
EK	5.16	8.74	1.08	0.22	2.43	1982
		(2.37)**	(1.91)***			
TC	12.15	8.29	-0.14	0.27	2.64	1983
		(1.95)***	(-0.17)			
PL	57.64	-60.30	-7.27	0.78	1.69	1980
		(-6.31)*	(-6.59)*			
ML	10.90	12.86	-0.80	0.63	2.14	1981
		(2.82)*	(-1.33)			
CN	10.87	1.16	3.42	0.39	2.27	1984
		(0.22)	(2.74)*			
KZ	12.14	-2.53	-0.48	0.02	2.36	1976
		(-.57)	(-1.49)			

Punja

District	A	B_1	B_2	$\bar{R}^2$	DW	T
Kerala	60.54	-8.15 (-1.05)	-1.23 (-2.38)	0.17	2.04	1976
TV	59.15	16.62 (1.30)	-11.60 (-3.91)*	0.72	1.98	1984
QL	38.23	-36.95 (-2.45)**	-2.36 (-1.89)***	0.24	2.13	1977
AL	72.87	-8.58 (-.47)	-1.52 (-.80)	-.11	2.83	1979
KT	77.25	-29.34 (-1.60)	1.59 (.37)	0.20	2.02	1984
EK	35.23	-6.82 (-.86)	-2.31 (-3.51)*	0.46	1.54	1977
TC	43.05	16.16 (1.71)	0.23 (.27)	0.12	2.03	1978
PL	57.25	-5.43 (-.90)	-5.60 (-8.05)*	0.87	2.13	1980
ML	46.95	15.79 (1.95)***	1.93 (1.82)***	0.14	2.37	1981
KZ	60.10	4.99 (.77)	-0.06 (-.11)	-0.08	2.26	1977
CN	21.73	23.57 (3.49)*	-0.30 (-.43)	0.61	1.94	1979

CHAPTER 6

IMPORT OF RICE, AREA EXPANSION UNDER RUBBER AND THE DECLINE OF TAPIOCA

1. Introduction

Tapioca is a staple food crop cultivated in several developing countries. In India the crop is mainly cultivated in the chronically food deficit state of Kerala and is an important constituent of the consumption basket. It has played an especially important role in sustaining the calorie intake of lower income groups in times of low availability or high prices of rice.

Tapioca, which had shown fairly high rates of growth in production during the sixties and the early seventies, showed a rapid decline since the mid-seventies. Both supply and demand side factors contributed to the decline in the production of tapioca. The rapid increase in the price of rubber relative to that of tapioca and the shift of area away from tapioca was an important supply side factor. The larger availability of rice through the public distribution system (PDS) and its relatively lower open market price had an important bearing on the demand for tapioca. This chapter attempts to investigate the interplay of these forces in shaping the fortunes of tapioca in Kerala.

The chapter is set out in six sections, including the introduction. Section 2 reviews the studies and sets out the issues in a clear perspective. Section 3 takes up the question of the area shift away from tapioca to rubber. Section 4 goes into the determinants of the yield of tapioca and Section 5 brings together the findings of the preceding three sections and attempts at measuring the determinants of the price of tapioca. Section 6 is the conclusion.

2. A Review of the Literature and the Key Issues

In Kerala the cultivation of tapioca, which accounted for roughly seven per cent of the total cropped area, was concentrated in the southern districts comprising the Travancore region. These four southern districts, namely Trivandrum, Quilon, Alleppey and Kottayam, accounted for almost 65 per cent of the total area and production of tapioca in the state. Tapioca, like coconut, is basically a small-holder crop with over 56 per cent of its area in holdings of less than one hectare (Ninan, 1986, p. 30.). For such small holders it is one of the most important crops occupying 45 to 60 percent of their total cropped area (Ninan, ibid., p. 100); but the proportion of area under tapioca grown as a pure crop is relatively low for them. Ninan's study reported that, "...........in the lowest size group (below 0.5 acres) only 8.7 per cent of the tapioca area is grown as a pure crop while in the highest size group (above 15 acres) this proportion is as high as 95 per cent" (ibid., p.105). Further, it was reported that for holdings above 2.5 acres almost all households sold their tapioca produce and the output sold was above 65 per cent. From these trends it may be inferred that tapioca was a commercial crop for the medium and large farmers but a subsistence crop for the small and marginal farmers:

> "............ marginal and small farmers grow tapioca primarily for self-consumption. But medium and large farmers grow tapioca primarily for the market". (Ninan, ibid., p.202).

A fairly high rate of growth in output of tapioca was reported during 1963-64 and 1974-75 - the rate being 8.51 per cent per annum - contributed in almost equal measure by area and yield. Although increase in yield was reported by almost all the districts of the state, area expansion was confined to the northern districts of Trichur, Palghat and Cannanore and the southern districts of Quilon and Trivandrum (Pushpangadan, 1988, p.9). Since 1974-75 there has been an equally sharp fall in output, at the rate of 9.78 per cent per annum, largely accounted for by the steep fall in area under the crop, at the rate of 7.07 per cent per annum. The decline in area was widespread; all the districts of the state, except Palghat and Cannanore, reported steep fall in area under the crop during the period. The decline in yield was confined to fewer districts during this period (Pushpangadan, op.cit., p.9).

The sharp increase in the output of tapioca till 1974-75 has been attributed to a significant growth in its price and yield (Ninan, op.cit., p. 35). The sharper decline in the output since 1974-75 has been explained by the increase in the price of rubber relative to tapioca and the consequent shift in area (Pushpangadan, op.cit., p.25).

Given that tapioca is grown as a commercial crop by the medium and large farmers such an explanation is consistent. But to clinch the argument it is necessary to show that the shift in area from tapioca has in fact gone in favour of rubber.

In line with the concentration of production, the per capita consumption of tapioca is high in the southern districts. The per capita daily consumption in these districts in 1971 was high, ranging between 0.23 and 0.33 kilograms in the districts of Trivandrum, Quilon and Alleppey and was low, ranging between 0.03 and 0.10 kilograms in the districts of Kottayam, Ernakulam, Trichur and Palghat; the other districts reported figures of around 0.15 kilograms (Government of Kerala, 1972). The consumer surveys conducted in the seventies reported fairly high levels of consumption of tapioca among the lower income groups and distinctly lower levels for the higher income groups. But the various rounds of NSS did not report such differences among expenditure classes. The NSS rounds reported sharp increase in the consumption of tapioca upto a certain expenditure group starting from the lowest and little change beyond. The expenditure elasticities for tapioca obtained from three rounds of NSS data quantify the same. The expenditure elasticities (rural) were 0.289, 0.145, and 0.253 for 1970-71, 1977-78 and 1983 respectively. The elasticity was negative for the urban areas. The expenditure elasticities for the different expenditure groups showed the following tendencies:

> "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........" (George, 1986, p.27).

When consumption of tapioca across size class of holdings was related with the production and sale characteristics, it was reported that the smaller holdings were heavily dependent on purchases. Ninan's study reported that,

"In the case of tapioca almost 95 percent of households with holdings upto 0.5 acres depend on the market to meet the larger part of their tapioca requirements while in the next size class (0.51 - 1.0 acre) 62 percent of the households depend on the market. Thereafter the proportion of households depending on the market for tapioca are not many" (Ninan, op.cit., p. 271).

Thus, consumption of tapioca is characterised by its regional concentration and by the high market dependence of the lower size class of holdings.

As regards data on consumption of tapioca, the two surveys - Operations Research Group (ORG) and Shubh Kumar (SK) - give estimates for one point of time. For inter-temporal comparisons, one may use NSS estimates or estimates of food availability following the CDS food balance sheets. If SK is ignored for its narrow coverage - three locations within a single district - then it may be said that

"There is not much variation in the estimates of rice consumption between the three sets of estimates, being around 1000 calories per capita per day. But in regard to tapioca consumption the CDS estimates differ greatly from the other two. On the average during the sixties according to the CDS data, around 628 calories per capita per day were derived from tapioca consumption. The NSS and ORG estimates of tapioca consumption for rural Kerala were around 300 calories". (Ninan, ibid., p. 46).

But the variations in the estimates of consumption of tapioca from the different sources do not come in the way of inter-temporal comparisons because although the figures themselves are different, the trends are broadly the same as has been argued below.

The data on the consumption of rice and tapioca are presented in Table 6.1. In the case of rice, the availability figures are arrived at by estimating the total imports and combining the production within the state, setting aside 10 per cent for seed and other wastage. In the case of tapioca 75 per cent of the production is taken as the availability for consumption. As is evident from the Table, estimates of the consumption of rice do not vary between

Table 6.1

Monthly Consumption of Rice and Tapioca per Head

(kilograms)

Year	Consumption (NSS)						Availability	
	Rural		Urban		Total			
	Rice	Tapioca	Rice	Tapioca	Rice	Tapioca	Rice	Tapioca
1961-62	9.83	5.16	9.83	1.40	9.83	4.41(100)	9.08	8.41
1973-74	7.33	6.99	7.23	3.64	7.31	6.32(143)	7.41	15.80
1977-78	9.92	5.55	8.47	2.50	9.60	4.90(111)	9.67	13.40
1983							9.33	9.25
1986-87	9.54	1.83	8.57	0.96	9.35	1.66(38)	9.70	7.50

Source: Sunny, 1988, Table 3.
Note : Availability of tapioca is computed setting apart 25 per cent of production for industrial and other uses as in Chapter 4, Table 4.2.

the two sources, in contrast to those of tapioca. But the trend is unmistakable in both. Consumption of rice showed a sharp decline betweeen 1961-62 and 1973-74. Simultaneously there was a sharp increase in the consumption of wheat and tapioca (see Chapter 4, section 2). Obviously, wheat and tapioca were being substituted for rice during the period. With the larger availability of rice in 1977-78, consumption of rice rose to reach the 1961-62 level and consumption of wheat came down, but consumption of tapioca did not come down sharply. In terms of NSS estimates, the fall in the consumption of tapioca was 23 per cent and in terms of availability, the fall was 15 per cent. Beyond 1977-78 neither did the availability of rice nor did its consumption show any increase, but the consumption of tapioca showed a sharp decline reaching 30 per cent and 50 per cent of the 1973-74 levels in terms of NSS and availability estimates respectively. This decline has been attributed to the demand constraint by Ninan (op.cit., p.50) and to the easy availability of rice by George (1986).

> "........... in recent years easy availability of rice in Kerala has resulted in a fall in the demand for cassava for human consumption ......" (George, op.cit., p. 31).

The sharp fall in the ratio of retail price of rice to that of tapioca is then taken as facilitating this shift in demand.

The problem with the above argument is that if the demand for tapioca has fallen mainly on account of a shift to rice, then, the quantity of rice consumed should have shown a commensurate increase.

As is seen from Table.6.1, the quantity of rice consumed has not shown any secular increase since 1977-78 but the quantity of tapioca consumed has shown a secular decline. The causation seems to be the following. As shown in Chapter 4, the price of rice declined beyond the 1975 levels mainly because of the supply of the larger quantity of rice through the PDS. This in itself has not improved the per capita availability of rice in the state. However, for altogether different reasons, the price of rubber relative to tapioca had shown a sharp increase during this period. As the area under tapioca can be substituted by rubber, the rising relative profitability of rubber resulted in a shift of area away from tapioca to rubber. The area shift and the consequent sharp fall in the production of tapioca led to an increase in its price and a decline in the price ratio between rice and tapioca. The area shift away from tapioca to rubber becomes the crucial link which is taken up in the next section.

3. Changes in Area under Tapioca

Given the data base of area under crops in Kerala, it is fairly difficult to arrive at any precise conclusion regarding the area shift. This is owing to the use of two concepts of area. As elaborated in Chapter 2, the area concept used is that of gross area. Net area is not reported for any crop, except probably for the plantation crops. The only net area reported is that of the net area sown in the aggregate. The second difficulty arises because area reported for many tree crops is arrived at by dividing the estimated plant population by a norm.

Hence, reported area changes between two time points are the combined effect of net area change and area change arising out of the changes in intensity of cropping. Keeping these limitations of the data in mind an analysis of the area changes of crops is attempted in this section.

Data on area under crops are presented for four time points in Table 6.2. As the cropping pattern is dominated by perennials, year to year fluctuations are not a major problem and hence averages over trienniums need not be computed. The contrast between the two sub-periods is striking. The first period from 1957-58 to 1974-75 showed both a sharp increase in the net area sown and intensity of cropping whereas the second period from 1975-76 to 1986-87 showed negligible increase in the net area sown and a mild decline in the intensity of cropping. The intensity of cropping, that is, the total cropped area divided by the net area sown, increased from 120 per cent to 137 per cent in the first period and fell to 130 per cent by the end of the second period. The more striking feature is that of the trends in the intensity of cropping of the area under rice. During the first period with practically no increase in the net area under rice, its total cropped area increased by 114000 hectares accounting for about 14 per cent of the increase in the total cropped area in the aggregate. This would indicate that the intensity of cropping of not only rice but all other crops showed an increase. In the second period, net area under rice fell by 99000 hectares and the total area under it by 221000 hectares, which is proportionate to the intensity of rice cultivation.

Table 6.2
Area Under Crops in Kerala

Crops	Area under crops (000 hectares)					
	1957-58	1974-75	Absolute change	1975-76	1986-87	Absolute change
Net Area Sown	1839	2208	369	2189	2207	+18
Total Cropped-area	2211	3028	817	2981	2870	-111
Rice (net)*	395	395	0	396	297	-99
Rice (total)	767	881	114	885	664	-221
Pepper	91	118	27	108	129	+21
Cardamom	28	47	19	54	63	+9
Arecanut	50	93	43	77	58	-19
Cashew	44	105	61	109	134	+25
Tapioca	214	318	104	327	193	-134
Coconut	463	748	285	693	706	+13
Coffee	17	37	20	42	66	+24
Rubber	100	202	102	207	348	+141
Tea	40	38	-2	38	35	-3
Total Fresh Fruits	98	180	82	180	178	-2

Source: Government of Kerala, Statistics for Planning (Various Issues)
* Maximum of the three seasons is taken as the net area sown.

But the fall in the total cropped area under all crops was only 111000 hectares indicating that the intensity of cropping in the non-rice areas must have increased. It is within this overall setting of an increasing intensity of cropping that the changes in area under tapioca need to be viewed.

To begin with in the first period, taking the largely pure cropped areas under rubber, tea, coffee, cardamom and arecanut, it may be seen that they accounted for an increase of 184000 hectares, out of the increase in the net area sown of 369000 hectares. The increase in the net area sown for the other crops was then 185000 hectares. But the increase in the areas under cashew, tapioca, coconut and fresh fruits alone is 532000 hectares clearly indicating that these have come about largely owing to the increase in the intensity of cropping.

During the second period the increase in the net area sown is just 18000 hectares. Consequently, area gains of crops falling under largely pure cropped plots must be at the expense of other crops. The increase in the largely pure cropped areas under rubber, coffee, and cardamon - areas under tea and arecanut have fallen - is 174000 hectares. The fall in the net area under rice is 99000 hectares and the gross area under tapioca is 134000 hectares. There is very limited scope for shifts in area under rice to rubber, coffee, or cardamom. However, area under tapioca can move over to these crops. Even if it is assumed that the entire area loss of tapioca is in the net, which is very unlikely, it does not entirely explain the increase of area under rubber, coffee and cardamom. Further, the sharp drop in the area under rice remains unaccounted for. In order to explain this more fully, the analysis must be carried out at the level of the district.

As is evident from Table 6.3, rice and tapioca showed a loss in area and rubber, a gain in every sub-region. While area under pepper went up mainly in Idukki, the area under coffee increased in Wynad, while the increase in area under cashew was confined to Cannanore and Kasaragod. These crops are largely confined to specific agro-climatic zones. That leaves the four crops, rice, tapioca, coconut and rubber with relevance for entire Kerala. The first thing to be noted is that except in one subregion, the area under rice is shifting over to coconut. In Palghat, it also shifts over to tapioca. Furthermore, in the region south of Ernakulam the sole gain is marked by rubber, with

Table 6.3
Changes in Area under Crops between 1975-76 and 1986-87

Districts	Changes in Area						
	Rice	Pepper	Coconut	Tapioca	Rubber	Coffee	Cashew
Trivandrum	-7.66	0.85	1.45	-22.62	9.33	-.08	0.77
Quilon, Pathanamthitta, Alleppey, Kottayam	-8.91	2.41	-34.06	-73.14	68.06	-.78	2.11
Idukki	-5.58	18.75	4.72	-1.02	11.37	1.92	0.04
Ernakulam, Trichur	-25.40	2.09	19.03	-15.02	22.22	1.07	0.97
Palghat	-17.89	0.66	8.09	3.09	9.42	-0.57	0.24
Malappuram, Kozhikode Wynad, Cannanore Kasaragod	-59.58	0.74	13.34	-26.33	20.73	23.32	20.40
Total	-99	21	13	-134	141	24	25

Source: Government of Kerala, Statistics for Planning (various issues)
Note: 1. Districts have to be grouped because new districts have come into existence during the period.
2. Change in area under rice in the subregions will not add upto the state total because the season recording the maximum for the districts need not be the same as that for the state total.

area under coconut also being reduced in favour of rubber[1] . Even if the entire area under coconut lost is assumed to have been brought under rubber, the bulk of the increase in area under rubber can only be explained as conversion of area under tapioca. In all the other regions too, since coconut is also gaining area, that cannot be a source of increased area under rubber. That leaves the loss of area under tapioca as the major source for conversion into rubber. Thus, the loss of this area has been a major source for the increasing area under rubber in Kerala in the post-1975 period.

One of the major forces making for the crop shift away from tapioca is relative profitability. As has been argued in Chapter 3, when the price of rubber relative to rice was increasing sharply its profitability relative to tapioca was increasing. It may be pertinent here to recall Ninan's finding that the large holders producing mainly for the market are also pure croppers of tapioca. Put together with the empirical finding presented above, it may be concluded that the fall in area under tapioca was largely because of the emergence of rubber as a competing crop since the late seventies.

4. Yield Response to Prices

It is evident from the discussion so far that profitability is one of the main considerations in the cultivation of tapioca, especially among the medium and large holders who sell the bulk of the output in the market. If this is so, then the same profitability consideration should also govern their decisions regarding the level of application of chemical fertilisers and manure, which would in turn determine the yield levels.

Ninan's study showed that among the medium and large cultivators a fairly high proportion applied fertilisers and the quantity of fertilisers and manure used/applied showed a strong positive relationship with the size of holding. This was not the case with the man-days applied per unit of land. His yield response functions showed no statistically significant coefficients for labour though the coefficient of fertiliser was positive and significant. He went on to conclude that,

> "........... when all holdings above one acre were pooled the fertiliser coefficient was positive and significant in both linear and log linear functions. Fertilisers, ... seems to be emerging as a significant contributor to enhancing tapioca productivity" (Ninan, op.cit., p. 126.)

The cost of cultivation studies also reported application of fairly high doses of fertilisers and manure for tapioca. The share of these two inputs in the total cost was roughly 25 per cent and the amount spent per hectare was comparable to that spent on the coconut gardens.

The yield response function of tapioca may be put down in the following form:

$Y = K + Ae^{-BX}$; where Y is the yield, X is the quantity of fertiliser applied and K, A and B are constants.

It may be noted that $\frac{dY}{dx} = -B\,(Y-K)$. If tapioca cultivators are profit maximisers, then they would apply fertilisers to the point where profit is maximised.

That is,

$\text{Profit} = Y.P - X.C$; where P is the farm price of tapioca and C is the price of fertiliser.

and at the point of profit maximisation,

$$\frac{d(\text{Profit})}{dx} = 0$$

Taking the expression for $\frac{dy}{dx}$ this may be written as,

$$Y = K - \frac{1}{B}\frac{C}{P}$$

If the tapioca cultivators seek to maximise profit, then there should be a relationship of the above type between the yield of tapioca and the ratio of the price of fertiliser to tapioca.

In order to test the above hypothesis, an equation of the form

$$Y_t = a + b \frac{C_t}{P_t}$$

was run taking the data from 1971-72 to 1989-90[2]. However, there was a problem regarding the prices to be used in the equation. The tapioca crop takes ten months, the main crop being planted in April-May and harvested in January-February. As the agricultural year is from July to June, the fertiliser price is the one actually paid out and it is of the previous year. However, the output price is of the current year. Thus, it is with a certain expectation of price that the planting is done and it may be assumed that the actual price realised is the expected price.

The estimated coefficients were,

$$Y_t = \underset{(20.86^*)}{200.92} - \underset{(-3.456^*)}{3.815} \frac{C_{t-1}}{P_t}$$

$$[\ 0.43,\ 0.39,\ 11.95\ ]$$

Instead of Yt , log Yt was taken and a similar equation was run. (The reason for this shall become evident in the next section). The estimated coefficients were,

$$\log Y_t = 5.319 - 0.023(C_{t-1}/P_t)$$
$$(91.73^*) \quad (-3.45^*)$$
$$[0.43, 0.39, 11.95]$$

A slightly modified form of the equation, viz.,

$\log Y_t = b_0 + b_1 C_{t-1} + b_2 P_t$ was also run.

The estimated coefficients were

$$\log Y_t = 5.21 - 0.067 C_{t-1} + 0.312 P_t$$
$$(100.53^*) \quad (-3.61^*) \quad (4.34^*)$$
$$[0.56, 0.50, 9.49]$$

As is evident, the data fits the equation well with the F value being statistically significant. The coefficient of the price ratio is also significant clearly bringing out the fact that the quantity of fertiliser applied is governed by the relative prices and that it is the quantity of fertiliser applied which determines the yield level.

A question may arise at this stage as to the effect of rainfall, its quantum and distribution, on yield. Tapioca being a crop of approximately ten months' duration, is mostly planted with the first rains in April-May; the effect of rainfall was tested by taking the quantum of rainfall during April-May, June-August, September-October, and November-December separately and together as the dependent variable. None of the equations were significant. Hence, it could be concluded that rainfall did not play much of a role in influencing the yield of tapioca in Kerala.

5. Price Determination of Tapioca

Having taken up consumption, area, and yield questions in Sections 2 to 4 respectively, the question of the price of tapioca is taken up in this section.

As was argued in section 2, it was the sharp increase in the availability of PDS rice (PDSR, in lakh tonnes) which brought down the consumption of tapioca, especially between 1973-74 and 1977-78. The depressed market price of rice might also have played a role. The wheat off-take through the PDS or its consumption had not shown any significant increase over the period. The demand equation for tapioca may then be set as follows,

$$D_t = C_0 + C_1 \; PDSR_t + C_2 \; (p_t / P_t) \; ;$$

where p_t is the open market price of rice and P_t that of tapioca.

Ideally, the demand equation should have an income term. But it has not been included here for the reasons elaborated in Chapter 4, namely the non-availability of a disposable income series. Instead, time has been included to capture not only the income effect but also changes in taste, etc.

We may also write it in a modified form as,

$$\log D_t = C_0 + C_1 \; PDSR_t + C_2 \; p_t + C_3 \; P_t + c_4 \; Time$$

On the supply side, production (S_t) which is the supply, is a joint effect of area and yield. That is,

$$S_t = A_t Y_t$$

The equation for area, following the arguments of section 3, may be set as

$$A_t = a_0 + a_1 PR_{t-1} + a_2 P_t + a_3 p_t$$; where PR_{t-1} is the price of rubber.

The price of rice enters the equation to take into account the wage rate following the wage-price relationship worked out in Chapter 3. The equation is modified as

$$\log A_t = a_0 + a_1 PR_{t-1} + a_2 P_t + a_3 p_t$$

The equation for yield, as set out in Section 4, is

$$\log Y_t = b_0 + b_1 C_{t-1} + b_2 P_t$$

Now,

$$\log S_t = \log A_t + \log Y_t$$

and under equilibrium conditions demand equals supply. That is,

$$\log S_t = \log D_t$$

i.e., $(a_0 + b_0) + a_1 PR_{t-1} + b_1 C_{t-1} + (a_2 + b_2) P_t + a_3 p_t =$

$$C_0 + C_1 PDSR_t + C_2 p_t + C_3 P_t + C_4 \text{ Time}.$$

Rearranging the terms,

$$(a_2 + b_2 - C_3) P_t = (C_0 - a_0 - b_0) - a_1 PR_{t-1} - b_1 C_{t-1} + C_1 PDSR_t + (C_2 - a_3) p_t + C_4 \text{ Time}.$$

Thus, we get the equation of the price of tapioca as,

$$P_t = d_0 + d_1 PR_{t-1} + d_2 C_{t-1} + d_3 PDSR_t + d_4 p_t + d_5 \text{ Time}.$$

The estimated coefficients of the above equation were,

$$P_t = -0.092 - 0.031PR_{t-1} - 0.009C_{t-1} - 0.0039PDSR_t + 0.28p_t + 0.06Time$$

(-0.62) (-1.44) (-0.25) (-0.36) (4.04*) (2.75*)

[0.93, 0.91, 33.21]

The problem with time is that PR_t is time correlated (r^2 = 0.94). Hence, in the presence of time, PR_{t-1} drops out.Dropping time and rerunning the equation,

$$P_t = -0.282 + 0.026PR_{t-1} - 0.002C_{t-1} + 0.011PDSR_t + 0.032p_t$$

(-1.93) (1.79***) (-0.041) (0.979) (3.21*)

[0.89, 0.86, 26.59]

Although the coefficients of both C_{t-1} and $PDSR_t$ showed some change they were not statistically significant. A different equation was run dropping both

C_{t-1} and PDSR. The coefficients were,

$$P_t = -0.242 + 0.0308\ PR_{t-1} + 0.238\ p_t$$

(-2.58) (4.02*) (3.47*)

[0.88, 0.87, 56.54]

As is evident the coefficient of PR_{t-1} greatly improved.

It is understandable that the coefficients of PDSR and C_t are not statistically significant. PDSR affects the price of rice, p, directly and significantly but not that of tapioca. The fertiliser price drops out of the picture mainly because the period taken up for study is one in which the dominant effect on the production side was that of area and not that of yield. Yield had not shown any sharp decline. Thus, the price of tapioca is largely influenced by the price of rice on the one side and that of rubber on the other. Increase in the price of rice by pushing up the demand for tapioca has a positive influence on the price of tapioca. Increase in the price of rubber by shifting area away from tapioca and by bringing down the supply, has a positive influence on the price of tapioca.

Having obtained an equation for the price of tapioca in terms of the prices of rice and rubber, the question of the ratio of the price of tapioca to that of rice may be taken up.

$P = -a+bPR+cP$, where a, b, and c are positive fractions.

The ratio of the price of tapioca to that of rice may now be written as,

$$(P/p) = (-a/p) + b\ (PR/p) + c$$

Differentiating,

$$(p/P)d(P/p)/dt = a(1/p)(dp/dt) + b.PR\ [(1/PR)(dPR/dt) - (1/p)(dp/dt)]$$

$$= ar + b.PR\ [R-r]$$, where r and R are the growth rates of prices of rice and rubber respectively.

If rice price increases sharply and rubber price does not, that is $r>R$, then, what happens to the growth rate of the ratio in the above equation depends on exact values of PR, R and r. If R is small and r is large then, PR will not increase very much and if the initial situation is one where $a>b.PR$ then $ar+b.PR\ [R-r]$ may still be positive, but small. Instead, if $R>r$ then, even when the initial situation is one where $a>b.PR$, PR will begin rising and change the above inequality for the given values of a and b. Further, if rice price is falling ($r<0$) when the price of rubber is rising (R>Ø), then from the point at which the inequality changes sign, the growth rate of the ratio will be positive. Simultaneously, if rice price also begins rising then, the growth rate will remain positive. This is what has taken place from the mid-seventies in Kerala and has made for an increase in the price ratio of tapioca to rice.

6. Conclusion

Tapioca is substitutable on the consumption plane by rice and on the production plane by rubber. Consequently, the prices of rice and rubber enter the price of tapioca. How it affected the profitability of tapioca relative to rubber has been gone into in Chapter 3. The consequence of such a movement of profitability has been the shift of area under tapioca to rubber. This chapter provided the evidence of such area shift. Further, an attempt was made to explain the movement of the price ratio of tapioca to rice.

Notes

1. The districts south of Trichur report increasing incidence of root (wilt) disease. And in some districts this has lead to a sharp drop in productivity leading to the conversion of area under coconut into other crops.

2. A longer period could not be taken because data on fertiliser prices were available only from 1971-72.

CHAPTER 7

TECHNOLOGY, PRICE AND CYCLES IN THE PRODUCTION OF PERENNIAL CROPS

1. Introduction

Through chapters 3 to 6, the discussion has been confined to the food group, which is also the group of seasonal and annual crops. In this chapter the group of cash crops, which is that of perennial crops as far as Kerala is concerned, is taken up for discussion. This discussion has centred around two issues in the relevant literature; first, the 'violent' fluctuations in the prices of commodities and, second the supply response to price changes.

The first issue, known as the "commodity problem", has attracted the attention of economists worldwide. The literature on it has grown voluminous. But at the end of nearly five decades of research on the subject, a distinguished researcher, while referring to the price decline of the early eighties, had the following to say, "No comprehensive investigation has yet been undertaken of the relative weight of different causes of the current price decline". (Avramovic, 1987: 645).

As for the second issue, namely the supply response, in the sixties and seventies numerous models for perennial crops were developed. Dowling and Jessadachatr summarise the models in the following words,

"In the perennial crop models developed in the past few years there are three structural equations. A vintage production model is constructed where potential output depends only upon the number (area) of different age plants. Investment takes place until the cost of planting just equals the discounted expected future profit stream, and a short run output determination equation allows for excess capacity (unharvested crops, untapped trees, or uncollected fruit) and short/run output adjustments based on price. The detailed specificities of these structural equations differ from model to model, but the reduced form equations bear many similarities, actual output depending upon lagged output, lagged prices and weather variables". (Dowling and Jessadachatr, 1979:75)

They all end up by computing the short run and long run price elasticity of supply.

The two sets of studies have grown, rather, in parallel streams. The first set of studies focus on the price fluctuations and then go on to study their impact on macro-economic goal attainment, their desirability and so on. The second set of studies take the price movements for granted and proceed to set up models of behavioural response to the price situation. No systematic effort seems to have been made to integrate the two sets of studies. By integration is meant relating the price movements to the characteristic movement of supply on the one hand and the relating of the movement of supply to the movements of price on the other. The movement of demand necessarily need enter any such integration. This chapter is an attempt at such an integration. The discussion is basically of the long run movements and hence the short run influences are totally abstracted.

Keynes, way back in 1938, while noting the "violence" of the price fluctuation for primary commodities and arguing for international control had pointed out that "the natural conditions of production of different commodities differ so widely, e.g. between annual crops, tree crops and mining undertakings, that no plan can claim to be applicable to all commodities" (Keynes, 1974). A similar point has been made by Kalecki in the context of 'cost-determined' and 'demand-determined' prices (Kalecki, 1965). He called them the conditions of supply. The natural conditons of production of tree crops or perennial crops are characterised by long gestation lags and specific yield profiles. What the gestation lag does is to translate any response in terms of area changes or introduction of a variety with significantly higher yield into production changes with a time lag no shorter than the gestation lag. Consequently, adjustments in supply, in response to demand changes, are always marked by a time lag, and a characteristic of the demand-supply situation being one of long periods of demand exceeding supply followed by equally long or longer periods of supply exceeding demand. It is this situation which gives rise to the "violence" of the price fluctuations which in turn makes for phases of area expansion typical of perennial crops.

Unlike seasonal and annual crops, perennial crops are characterised by the necessity for some form of rejuvenation of the gardens/plantations at the end of their life span-economic or biological. This might take various forms depending upon the specific nature of the tree and its cultivation. What is of analytical interest and relevance for the study's purpose is replanting undertaken on completion of a tree's life cycle. One immediate implication of replanting is that the area replanted goes out of production over the gestation period. In case replanting is marked by phases consequent to the phases of past area expansion this might generate certain patterns of growth of production.

Yield growth in agriculture is often attributed to the application of chemical fertilisers, irrigation and water control, and the introduction of varieties with higher yield potential. Given the agro-climatic environments in which perennial crops are grown, new varieties of plant materials are the most important of the three above components. But these in turn are characterised by their own specificities as far as perennial crops are concerned. The spread of any new variety is inextricably linked with the phases of area expansion and phases of replanting. The higher yield potential of a new variety introduced gets translated into higher average yield only during that phase when the rapid area expansion or rapid replanting get translated into rapid increase in production. Thus, although replanting might have a moderating effect on both, the phases of area expansion and yield increases,the introduction of new plant materials with higher yield might get translated into phases of rapid increases in production giving rise to demand-supply disequilibrium.

Under conditions of a more or less steady growth in demand combined with an uneven time profile of growth in production due to replanting and/or new planting in phases, the outcome is one of production exceeding demand over a period, followed by production falling below demand. The net result of such patterns of growth in production is the somewhat cyclical movement of prices. When production falls below demand, price will tend to rise rather sharply, thus stimulating new planting. When production overtakes demand and remains above it the price will either tend to fall or remain stagnant. Nothing much can be done about the production from the already planted trees, but new planting will be discouraged. Thus, the price movement of perennial crops will also be marked by phases, a phase of rapid increase followed by one of relative stagnancy or decline.

The chapter has seven sections including the introduction and conclusion. Section 2 sets out the basic model of supply response to a change in the demand situation in terms of area change. The result is a clear enunciation of the phases in the growth of production. The basic model abstracts from replanting and yield growth. Replanting is incorporated into the model in section 3 and a particular type of yield growth, namely, that arising out of the introduction of new plant material at some point of time is incorporated into the model in section 4. Section 5 establishes the link between the phases of area expansion and the demand-supply situation. Section 6 takes up the price question. Section 7 is the conclusion.

2. The Basic Model

To begin with, the growth of demand is assumed at a known constant rate b. Then demand at any point of time t, C_t may be expressed as $C_t = C_0 e^{bt}$ where C_0 is the demand at some initial point.

For simplicity we abstract from stockholding, imports/exports and assume constant yield. Then production at any point of time t, P_t (which is also the supply) may be expressed as

$$Pt = \int^{t-7} A_t \ Y_t dt.$$

where A_t is the area brought under the crop at time t, Y_t is the yield of that area and 7 is the gestation lag.

A gestation lag of 7 is taken for ease in comprehension. This may apply for natural rubber but for other crops it has to be different. The results do not get altered if some 'n' is taken instead of 7.

Differentiating P_t,

$$\frac{dP_t}{dt} = A_{t-7} \ Y_{t-7}$$

If constant land yield is assumed (the assumption will be partially relaxed in a later section) and without loss of generality, is taken as unity, then we may write,

$$\frac{dP_t}{dt} = A_{t-7} \quad \ldots\ldots\ldots \ (1)$$

If it be required that demand equals supply at all points of time, then we require $P_t = C_t$ for all t.

That is, $P_t = C_0 e^{bt}$

Differentiating,

$$\frac{dP_t}{dt} = A_{t-7} = P_t.b.$$

That is,

$$\frac{1}{P_t}\frac{dP_t}{dt} = \frac{A_{t-7}}{\int^{t-7} A_t dt} = b$$

That is, area needs to grow at the same rate b in order to maintain the demand-supply equality. Thus, the gestation lag in itself need not lead to any demand-supply disequilibrium, given a steady growth in demand.

Equation (1) may be rewritten as,

$$P_t.b = A_{t-7}$$

$$P_t = A_{t-7}/b$$

$$= A_0 e^{(t-7)b}/b \quad \ldots\ldots\ldots (2)$$

under steady growth at a rate b.

Now, suppose that consumption or demand grew at a rate b_1 $(b_1 > b)$ from time point T. This could occur in various ways.One possibility is that there is an increase in the overall demand which is shared by all the producers.The other possibility is that even when overall demand had not changed production had been seriously affected in one of the major producing areas owing to disease,pest attack,or destruction of the crop. The remaining producers would then face an increasing demand. Then,

$$C_t = \{ C_0 \, e^{tb} \quad \text{for } t \leq T$$
$$\{ C_T \, e^{(t-T)b_1} \quad \text{for } t > T$$

In response to a change in demand from time point T any action can be initiated only from T. Whatever action has been initiated till T, in particular, expansion of area, will get reflected in production till T +7 and the action initiated from T comes into bearing from T+7. Implicit in this is the assumption that the yield of the existing trees cannot be changed; it is fixed. This is a simplifying assumption on which some clarifications are offered in section 4.

These may be translated into algebraic equations. If area expansion has been initiated at a rate different from b after T, then equation (2) may be written as,

$$P_t = (A_0/b) \, e^{(t-7)b} \quad \text{for } t \leq T+7.$$

Till time point T both demand (C_t) and production (P_t) grow at a steady rate b so as to maintain demand-supply equality. That is,

$$C_t = C_0\ e^{tb} = P_t = (A_0\ /b)\ e^{(t-7)b} \text{ for } t \le T$$

At $t = T$, $C_T = C_0 e^{Tb} = P_T = (A_0\ /b) e^{(T-7)b}$ ....(3)

Beyond $t = T$, $C_t = C_T\ e^{(t-T)b1}$ ....(4)

and $P_t = (A_0/b) e^{(t-7)b}$

$= (A_0/b) e^{[t-T+T-7]b}$ till T+7.

Substituting (3) above

$P_t = P_T\ e^{(t-T)b}$ till T+7 ....(5)

$= C_T\ e^{(t-T)b}$

$= C_t\ e^{(t-T)b - (t-T)b1}$

by substituting eq.(4)

$= C_t\ e^{(t-T)\ (b-b1)}$

$< C_t$ because $(b-b_1) < \emptyset$.

Thus, beyond $t = T$, the demand-supply equality is not maintained. Demand is greater than supply. If the demand-supply gap has to be closed, area needs to grow from T onwards at a rate higher than b. But at what rate?

Suppose area grows at the rate b_1, which is the new rate of growth of demand. Then,

$P_t = P_{T+7}\ e^{b1(t-T-7)}$

and $C_t = C_{T+7}\ e^{b1(t-T-7)}$ ....(6)

for $t > T+7$.

At $t = T$, $P_T = C_T$ following equation (3).

At $t = T+7$, $P_{T+7} = P_T\ e^{7b}$

and $C_{T+7} = C_T\ e^{7b1}$ following equations (4) and (5).

Beyond T+7,

$$C_t - P_t = C_{T+7}\ e^{b1(t-T-7)} - P_{T+7}\ e^{b1(t-T-7)}$$

$$= e^{b1(t-T-7)}\ (C_{T+7} - P_{T+7})$$

$$= e^{b1(t-T-7)}\ C_T\ (e^{7b1} - e^{7b})$$

$$> 0, \text{ as } b_1 > b.$$

Thus, even if area grows at the rate b_1 beyond t = T, production cannot meet the demand. Hence, area needs to grow at a rate b_2 (greater than b_1) beyond T. This would mean production grows at a rate b_2 beyond T+7. In algebraic terms,

$$P_t = P_{T+7}\ e^{b2\ (t-T-7)}$$

and $C_t = C_{T+7}\ e^{b1\ (t-T-7)}$, for t > T+7,

corresponding to equation (6).

Then,

$$C_t - P_t = C_T\ e^{7b1}\ e^{b1(t-T-7)} - C_T\ e^{7b}\ e^{(t-T-7)b2}$$

beyond T+7.

Solving the above equation for demand-supply equality,

$$e^{b1(t-T)} = e^{7b+(t-T-7)b2}$$

Equivalently, $b_1\ (t-T) = 7b + (t-T-7)b_2$

$$(t-T-7)\ (b_1 - b_2) = 7(b-b_1)$$

$$t = T + 7 + 7(b-b_1)/(b_1-b_2)$$

That is, if area expands at a rate b_2 beyond T (equivalently, if production grows at a rate b_2 beyond T+7) then, at $t = T + 7 + 7(b - b_1)/(b_1 - b_2)$ production would equal demand and beyond $t = T + 7 + 7(b - b_1)/(b_1 - b_2)$ production would surpass demand.

It may be noted that the length of time required for production to meet demand, in addition to the gestation lag of 7, that is, $7(b - b_1)/(b_1 - b_2)$, is inversely proportional to $(b_2 - b_1)$. The higher the rate of area expansion b_2 compared to b_1, the shorter is the duration required, and the lower b_2 ($b_2 > b_1$) the longer is the duration required for production to meet demand.

Let $T_1 = T + 7 + 7(b-b_1)/(b_1 - b_2)$. Then production equals demand till T. Between T and T_1 demand exceeds production and beyond T_1 production exceeds demand. At T_1 demand equals production. That is,

$$P_{T1} = C_{T1}$$

$$\text{and } P_t = P_{T1}\ e^{(t-T1)b2}$$

$$C_t = C_{T1} e^{(t-T1)b1} \quad \text{for } T_1 \le t \le T_1 + 7.$$

$$P_t - C_t = P_{T1}\ [e^{(t-T1)b2} - e^{(t-T1)b1}]$$

$$> \emptyset \text{ as } b_2 > b_1 .$$

In order to bring down the difference the area expansion beyond T_1 needs to be at a rate below b_1, say b_3, where $b_3 < b_1$. This would get reflected as a slower growth of production beyond T_1+7.

$$P_t = P_{T1+7}\ e^{(t-T1-7)b3} \qquad \text{for } t > T_1+7.$$

$$C_t = C_{T1}\ e^{(t-T1)b1}$$

For equality between demand and production at some point t, $P_t = C_t$ needs to be solved.

$$P_t = C_t$$

$$P_{T1}\ e^{7b2} .\ e^{(t-T1-7)b3} = C_{T1}\ e^{(t-T1)b1}$$

Since $P_{T1} = C_{T1}$, the above may be written as

$$7b_2+(t-T_1-7)b_3 = (t-T_1)b_1 .$$
$$= (t-T_1-7)b_1+7b_1$$
$$7(b_2 - b_1) = (t-T_1-7)(b_1-b_3)$$
$$t = T_1 + 7 + 7(b_2-b_1)/(b_1-b_3)$$

It is evident that a change in demand growth from its steady path sets off phases of production growth which result in phases of demand exceeding production and demand falling short of production.

Given the growth rates, these phases are of the following durations. Between T and $T + 7 + 7(b-b_1)/(b_1-b_2)$ demand exceeds production; between $T + 7 + 7(b-b_1)/(b_1-b_2)$ and $T+7+7(b-b_1)/(b_1-b_2)+7+7(b_2-b_1)/(b_1-b_3)$ production exceeds demand and so on. Thus, the gestation lag, representing the inability of area changes to get translated into production changes, sets off phases of production growth as response to a one point change in the rate of growth of demand.

3. The Model with Life of the Tree as Constant

In section 2, it was assumed that the trees planted once are there for ever; that is, trees have an indefinite life-span. This is not a realistic assumption to make, for any variety has a normal life-span. In such a situation, for normal production to continue certain forms of replenishment are necessary.

Generally three forms of replenishment of perennial crops are discussed: (i) replanting at the end of life-span; (ii) underplanting before the end of life-span; and (iii) replanting as and when plants die. As forms (ii) and (iii) above do not seriously affect the analysis of section 2, only form (i) is dealt with. It needs to be noted that replanting could be at the end of a fixed number of years or it could be a purely economic decision to terminate the crop life-cycle, considering the costs and returns. For the purpose of this analysis, abstracting from this question of economic life the life of the tree is taken to be 25 years. Again, 25 years is taken as a figure for easy comprehension.It can be some 'N' and the results would still hold.

Under the assumption of constant life the equation for production may be written as

$$P_t = \int_{t-25}^{t-7} A_t.dt + \int_{t-25}^{t-7} R_t.dt.$$

Where R_t is the area replanted at time t and under the assumption of constant life

$$R_t = A_{t-25} + R_{t-25} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$dP_t/dt = A_{t-7} - A_{t-25} + R_{t-7} - R_{t-25}$$

$$= A_{t-7} + R_{t-7} - R_t \quad \ldots\ldots\ldots\ldots (8)$$

Compared to equation (1) the difference is that replanting adds the term $R_{t-7}-R_t$ on the R.H.S. This term is equivalent to $A_{t-32} + R_{t-32} - A_{t-25} - R_{t-25}$ on account of equation (7). Ignoring $R_{t-32} - R_{t-25}$, because at some initial point it has to be zero, we may write

$$R_{t-7} - R_t = A_{t-32} - A_{t-25}$$

Following equation (1) of section 2 this may be written as:

$$R_{t-7} - R_t = dP_{t-25} /dt - dP_{t-18} /dt$$

Following section 2, we may write

$P_T = C_T$

$P_t = P_T\ e^{(t-T)b}$, $t < T+7$

$= P_{T+7}\ e^{(t-T-7)b2}$, $T+7 \leq t \leq T_1+7$

$= P_{T1+7}\ e^{(t-T1-7)b3}$, $T_1+7 \leq t \leq T_2+7$ and so on.

In order to find the sign of $R_{t-7} - R_t$, that is $dP_{t-25}/dt - dP_{t-18}/dt$, we need to find the sign of $dP_{t-7}/dt - dP_t/dt$ for various values of t. If both t and t-7 are below T+7, or between T+7 and T_1 +7, or between T_1 +7 and T_2 +7 and so on $dP_{t-7}/dt - dP_t/dt$ is of the form $(1-e^{7b})dP_{t-7}/dt$ which is < 0 for any +ve value of b.

Now, suppose t is above T+7, say t = T+10, but t-7 is below T+7. Then, $P_t = P_{T+7}\ e^{3b2}$; $P_{t-7} = P_{T+7}\ e^{-4b}$,

and $dP_{t-7}/dt - dP_t/dt = P_{T+7}\ (+be^{-4b} - b_2\ e^{3b2})$

$= P_T\ e^{3b}\ (b - b_2\ e^{3b2+4b}) < 0$ because $b < b_2$

Now, take t = T_1 +10.

$P_t = P_{T1+7}\ e^{3b3}$; $P_{t-7} = P_{T1+7}\ e^{-4b2}$

and $dP_{t-7}/dt - dP_t/dt = P_{T11+7}\ [b_2 - b_3\ e^{3b3+4b2}]$

> 0 whenever $b_2/b_3 > e^{3b3+4b2}$

Since the path of P_t has been fully traced and that it has been found to be increasing in distinct phases, $dP_{t-25}/dt - dP_{t-18}/dt$ can be positive or negative. So, on account of replanting the actual increase in production is greater/smaller than the increase on account of area expansion depending on whether $dP_{t-25}/dt - dP_{t-18}/dt$ is positive or negative.

An illustration of the effect of replanting on production is provided below by choosing different sets of (b, b1, b2, b3,b4...). As is evident from Table7.1 when the growth of demand changes at some point of time and when the response is in terms of a higher growth in area, growth in production is marked by distinct phases of high growth followed by low growth. Replanting can lead to an accentuation of these growth phases by sharply bringing down production - as during the years 24 to 33 in case II - or by boosting production increases - as during years 36/37 to 42/43 in cases I and II. These may in fact come about at the wrong moments. That is, production may be pulled down during a period marked by small increases in production when the demand is in fact higher than production - as during the years 25 to 36 - or production may be boosted during a period marked by sharp increases in production when the demand is already lower than production - as during the years 41 to 43.

Table7.1
Effects of Replanting

	I				II			
Year	C_t	P_t	$P_{t-25}-P_{t-18}$	P^l_t	C_t	P_t	$P_{t-25}-P_{t-18}$	P^l_t
0	100	100	-	-	100	100	-	-
1	105	100			102	101		
2	110.25	106.09			104.04	102.01		
3	115.76	109.27			106.12	103.03		
4	121.55	112.55			108.24	104.06		
5	127.63	115.93			110.41	105.10		
6	134.01	119.41			112.62	106.15		
7	140.71	122.99			114.87	107.21		
8	147.75	132.83			117.17	111.50		
9	155.13	143.46			119.51	115.96		
10	162.89	154.93			121.90	120.60		
11	171.03	167.33			124.34	125.42		

Table 7.1 (Cont'd)
Effects of Replanting

	I				II			
Year	C_t	P_t	$P_{t-25}-P_{t-18}$	P^1_t	C_t	P_t	$P_{t-25}-P_{t-18}$	P^1_t
12	179.59	180.71			126.82	130.44		
13	188.56	195.17			129.36	135.65		
14	197.99	210.78			131.95	141.08		
15	207.89	227.65			134.59	146.72		
16	218.29	245.86			137.28	152.59		
17	229.20	265.53			140.02	158.70		
18	240.66	286.77			142.82	165.05		
19	252.70	309.71			145.68	165.05		
20	265.33	309.71			148.59	165.05		
21	278.60	309.71			151.57	165.05		
22	292.53	309.71			154.60	165.05		
23	307.15	309.71			157.69	165.05		
24	322.51	309.71			160.84	165.05		
25	338.64	309.71	-6.84	302.87	164.06	165.05	-3.29	161.76
26	355.57	309.71	-7.54	295.33	167.34	165.05	-3.45	158.31
27	373.35	309.71	-8.29	287.04	170.69	165.05	-3.62	154.69
28	392.01	309.71	-9.12	277.92	174.10	165.05	-3.57	151.12
29	411.61	309.71	-9.90	268.02	177.58	165.05	-3.98	147.14
30	432.19	309.71	-10.98	257.04	181.14	165.05	-4.16	142.98
31	453.80	334.49	-12.03	269.79	184.76	165.05	-4.37	138.61
32	476.49	361.25	-6.71	289.84	188.45	165.05	-1.35	137.26
33	500.32	390.15	-8.58	310.16	192.22	165.05	-1.41	135.85
34	525.33	421.36	-8.20	333.17	196.07	171.65	-1.47	140.98
35	551.60	455.07	-7.84	359.04	199.99	178.52	-1.53	146.32
36	579.18	491.47	-9.56	385.88	203.99	185.66	5.02	158.48
37	608.14	530.79	14.46	410.74	208.07	193.09	5.21	171.12
38	638.55	573.25	15.61	469.21	212.23	200.81	5.43	184.27
39	670.48	619.11	16.87	531.94	216.47	208.84	5.64	197.94
40	704.00	668.63	18.18	599.63	220.80	217.19	5.87	212.16
41	739.20	722.13	19.67	672.81	225.22	225.88	6.11	226.96
42	776.16	778.87	21.24	750.79	229.72	234.92	6.35	242.35
43	814.97	842.30	22.94	837.16	234.32	244.31	0	251.74
44	855.72	909.68	0	904.54	239.01	254.09	0	261.52
45	898.50	982.45	0	977.31	243.79	264.25	0	271.68
46	943.43	1061.05	0	1055.91	248.66	274.82	0	282.25
47	990.60	1145.93	0	1140.79	253.63	285.81	0	293.24
48	1040.13	1237.61	-24.78	1207.69	258.71	297.25	0	304.68
49	1092.13	1336.62	-26.76	1279.94	263.88	297.25	0	304.68
50	1146.74	1443.55	-28.90	1357.97	269.16	297.25	0	304.68

Note: Values of

	b	b1	b2	b3	b4
I	.03	.05	.08	0	.08
II	.01	.02	.04	0	.04

Thus, when the expansion of area under a perennial crop is characterised by distinct phases, if the replanting is carried out at the end of the life-span(held as constant) it could lead to further accentuation of the phases. The two together would then result in sharply distinct phases of growth of production.

4. Technological Change and Yield Growth

Since the Second World War, growth in agricultural production has increasingly been accounted for by the growth in yield. And this growth has come about largely because of the expansion of irrigation, application of chemical fertilisers, and the introduction of high-yielding varieties of plant material. In the case of many of the perennials in Kerala, growth on account of expansion of irrigation is not an important factor and application of chemical fertilisers is a subject of interesting controversy[1]. That leaves the introduction of HYVs as the major technological change for raising the yield of the crops.

Unlike the seasonal and annual crops, introduction of HYVs in the case of perennial crops is marked by its own specificities. It may not be meaningful here to talk of adoption rate, its ceiling and the time required for reaching a certain level because these can only be brought about through the process of area expansion, replanting and area going out of the crop, each of which has its own time structure. Hence, yield change occurring on account of the introduction of HYVs also needs to change occurring on account of the introduction of HYVs also needs to be analysed within the very same time structure. This section is an attempt at carrying out such an analysis in its basics.

Let Y_t be the yield per unit of the area under the crop reaching the yielding stage at time point t and y_t be the average yield over the entire area in the yielding stage. Then, y_t is an average of Y_t distributed over all age groups. In algebraic terms,

$$y_t = \int^{t-7} A_t \, Y_t \, dt \Big/ \int^{t-7} A_t \, dt$$

or,

$$y_t \int^{t-7} A_t \, dt = \int^{t-7} A_t \, Y_t \, dt \quad \ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Differentiating

$$y_t A_{t-7} + \int^{t-7} A_t \, dt \,.(dy_t /dt) = A_{t-7} \, Y_{t-7}$$

$$(1/y_t)(dy_t /dt) = A_{t-7} \left(\frac{Y_{t-7} - y_t}{y_t}\right) \Big/ \int^{t-7} A_t \, dt \quad \ldots.(10)$$

Equation (10) clearly brings out the fact that the rate of growth of average yield is a product of the rate of growth of area and the differential between yield of area reaching the yielding stage and the average yield. In other words, change in the average yield cannot be analysed independent of the change in the area under cultivation.

Generally, trees are characterised by a phase of increase in the initial years of the bearing stage followed by stable yield during the peak bearing years.Towards the close of the biological life-span, yield begins to decline.Abstracting from this yield profile of the tree by age, Y_t may be assumed to be of a particular form. Y_t may be assumed to be characterised by discrete jumps. In substantive terms, a particular at some point of time T a new variety with yield potential $Y_1 (Y_1 >> Y_0)$ becomes available. From then on, only the new variety is planted. If variety (Y_0) has been used over a long period of time, then the average yield y_t would be equal to Y_0. The average would only change from T.

Equation (10) may now be written as,

$$\frac{1}{y_t}\frac{dy_t}{dt} = \frac{(Y_1 - Y_0)\, A_t}{Y_0 \int^T A_t\, dt} \quad \text{at} \quad t=T$$

$$\text{and} \quad = \frac{(Y_1 - y_t)\, A_t}{y_t \int^{t-7} A_t\, dt} \quad \text{beyond T}$$

Let us recall the phases of area expansion - b_2 phase, b_3 phase and so on of Section 2. When the area expansion is at a higher rate, growth of average yield is also higher, given the differential$(Y_1 - Y_0)$. This will obviously bring down $(Y_1 - y_t)/y_t$ sharply. When the area expansion is at a lower rate, the rate of growth of average yield is lower. Although this would bring down $(Y_1 - y_t)/y_t$ slightly, the rate of growth of average yield itself will remain low, owing to the fact that the rate of area expansion is low.

In terms of the phases of area expansion, in the b_2 phase the rate of growth of average yield will be high initially and will decline as the average yield climbs up. In the b_3 phase the rate of growth of average yield will be low and this rate will come down only slightly.

Differentiating equation (9) we may write,

$$\frac{1}{P_t}\frac{dP_t}{dt} = \frac{y_t A_{t-7} + \int^{t-7} A_t \, dt . dy_t \; /dt}{y_t \int^{t-7} A_t \, dt}$$

$$= A_{t-7} \Big/ \int^{t-7} A_t \, dt + \frac{1}{y_t} \frac{dy_t}{dt}$$

Hence, rate of growth of production is the sum of rate of growth of area and rate of growth of average yield. And the pattern of growth of average yield holds for the growth of production as well, with the sole difference that the rates themselves will be higher by b_2, b_3 etc. as the case may be.

Now, to introduce the question of replanting in the discussion of the rate of growth of average productivity. We may begin by rewriting equation (9) as,

$$P_t = y_t \int_{t-25}^{t-7} (A_t + R_t)\, dt = \int_{t-25}^{t-7} (A_t + R_t) Y_t \, dt \qquad \ldots\ldots(11)$$

Differentiating,

$$\frac{1}{P_t} \frac{dP_t}{dt} = \frac{(A_{t-7} + A_{t-32} - A_{t-25})}{\int_{t-25}^{t-7} (A_t + R_t)\, dt} + \frac{1}{Y_t} \frac{dy_t}{dt} \qquad \ldots\ldots(12)$$

The area term on the R.H.S. of equation (12) is same as what had been obtained in Section 3. Its interpretation there was that, whether the rate of growth of production was greater or less than b_2 , b_3.... depended on the area replanted and area reaching the yielding stage. This was due to the fact that the effective area reaching the yielding stage was greater or less than the new area, depending upon the difference between the replanted area reaching the yielding stage and replanted area going out of production.

Now, there is an additional term on the R.H.S. of equation (12) on account of the yield change, the equation for which may be obtained by differentiating the last part of equation (11):

$$\frac{1}{y_t}\frac{dy_t}{dt} = \frac{A_{t-7}\ (Y_1 - y_t)}{y_t \int_{t-25}^{t-7} (A_t + R_t)\,dt} + \frac{A_{t-32}\ (Y_1 - y_t) + A_{t-25}\ (y_t - Y_0)}{y_t \int_{t-25}^{t-7} (A_t + R_t)\,dt} \quad \ldots\ldots(13)$$

The first term on the R.H.S. of equation (13) is the same as what was obtained in equation (10). The second term will always be positive because $Y_1 \geq y_t$ and $y_t \geq Y_0$. Then, the pattern obtained on the movement of the rate of growth of average yield here remains more or less the same as that in the basic model; with that the pattern of growth of production as well. The only difference is that the growth of effective area reaching the yielding stage is influenced by the pattern of replanting.

5. Phases of Area Expansion and Production

In Section 2, it was argued that when production falls below demand area expansion takes place at a rate (b_2) above the rate of growth of demand (b_1) and during the next $7+7(b-b_1/b_1-b_2)$ years production catches up with demand. As production moves above demand the rate of growth of area falls below the rate of growth of demand (b_1) to a level b_3. This brings production below demand during the next $7+7(b_2-b_1/b_1-b_3)$ years and this process repeats with different rates of growth of area.

In Section 2, the argument about the phases of production considered only the 'area effect', as it were. In the subsequent two sections, replanting and average yield changes respectively were introduced. While replanting at the end of a constant life-span carried forward the phases of area expansion in one way with its own time structure, yield changes by being proportionate to the rates of area expansion carried it forward in another way. What is clearly brought out in the three sections above is the centrality of the phases of area expansion. The phases of replanting are dependent on this aspect, as are the phases of movements of average yield. Thus, the phases of area expansion play a central role in the phases of production.

In this whole exercise, the rates of area expansion had been taken arbitrarily. Is there anything within the system which sets off the different rates of growth of area? If the changes in the rate of area expansion were a response to the situation with regard to (P_t/C_t), then a simple step to take is to set the rate of growth of area, denoted by a_t, as a function of (P_t/C_t). Suppose,

$a_t = \alpha + \beta f(P_t/C_t)$ and let $f(.)$ be an indicator function which takes values Ø,1, and -1 depending upon $P_t = C_t$, $P_t < C_t$ and $P_t > C_t$ respectively.

Then,

$$a_t = \alpha \quad \text{for } P_t = C_t$$

$= \alpha + \beta$ for $P_t < C_t$

$= \alpha - \beta$ for $P_t > C_t$.

In terms of the growth rates of section 2 this would mean $b = \alpha$, $b_2 = \alpha+\beta$, $b_3 = \alpha-\beta$, $b_4 = \alpha+\beta$..........
Given the growth rates, the length of the phases may be computed using the formula $T+7+7(b-b_1 / b_1 - b_2)$ and that determines the path of production.

By setting f(.) as an indicator function no account is taken of the variation in (P_t / C_t). One of the simplest ways to take it into account is by setting $f(P_t / C_t) = (P_t / C_t)$. In that case, irrespective of whether P_t / C_t is on its upward path or downward path a_t will take the same value for a given value of P_t / C_t. This is inadmissible because if $P_t / C_t < 1$ and on its downward path a_t should be higher and a_t should be lower if it is on its upward path. So, the function f(.) should necessarily have a term with $d(P_t / C_t)/dt$ in addition to (P_t / C_t). That is,

$$a_t = \alpha + \beta_1 (P_t / C_t) + \beta_2 \, d(P_t / C_t)/dt.$$

$$a_t = \alpha + \beta_1 (P_t / C_t) + \beta_2 (P_t / C_t \cdot 1/P_t \, dP_t / dt - P_t / C_t \cdot 1/C_t \cdot dCt/dt)$$

$$= \alpha + \beta_1 (P_t / C_t) + \beta_2 (P_t / C_t) (a_{t-7} - b_1),$$

following Section 2 above.

It may be seen that high and increasing (P_t / C_t) will pull down a_t and low and falling (P_t / C_t) will push up a_t. Then, β_1 and β_2 should have negative signs. If C_t increases steadily, at a rate b_1, then any sharp increase in a_{t-7}, equivalently a sharp increase in P_t, will pull down a_t. Similarly, any sharp fall in a_t , equivalently a sharp fall in P_{t+7} , will push up a_{t+7}. Thus, the movement of a_t is a function of its own lagged value, the whole setting off distinct phases.

With this the complete system is set out. Phases of area expansion lead to phases of growth of production which results in periodical demand-supply disequilibrium. These phases of growth of production in turn lead to phases of area expansion.

The system as set out is entirely on the physical plane - area, production, consumption. But these in themselves are not the signals for the numerous cultivators. The signals are price movements and area expansion is a response to a certain movement of prices. In a way, the equation for a_t contains this play of prices. Suppose, $a_t = \phi(1/p_t \cdot dp_t/dt)$ where p_t is the price at time point t. That is, area expansion is a function of the rate of growth of price. Now, prices tend to increase when $P_t < C_t$ and tend to decrease when $P_t > C_t$. In symbols, $1/p_t \cdot dp_t/dt$ = some function of (P_t/C_t). Price changes are not only dependent on P_t/C_t but also on $d(P_t/C_t)/dt$. For the same value of P_t/C_t price change will be different depending upon whether P_t/C_t is on its downward path or upward path. Similarly, for the same value of $d(P_t/C_t)/dt$ price change will be different depending upon whether P_t/C_t is > 1 or <1. In symbols,

$$1/p_t \cdot dp_t/dt = \text{some function of } (P_t/C_t, d(P_t/C_t)/dt)$$

and

$$a_t = \phi(1/p_t \cdot dp_t /dt) = \text{some function of } [P_t /C_t , d(P_t /C_t)/dt]$$

Thus, by taking $a_t = \alpha+\beta_1 (P_t /C_t) + \beta_2 d(P_t /C_t)/dt$, we are in fact taking it as a function of price. So, even without taking it as an explicit function of price it can be argued that it is infact the area response to price changes.

6. The Price Cycles

The question posed at the very beginning of the chapter was that of the "violent" fluctuations of prices. So far, no attempt has been made to take up this phenomenon explicitly, although it was implicit in the equation for a_t , the rate of growth of area, in the previous section. To answer to the question requires its explication, which is taken up here.

It was indicated earlier that,

$$(1/p_t)(dp_t /d_t) = \text{some function of } [P_t /C_t , d(P_t /C_t)/dt].$$

Taking a simple linear form of the function, it may be written as,

$$(1/p_t)(dp_t /d_t) = a_0 +a_1 (P_t /C_t)+a_2 d(P_t /C_t)/dt.$$

As for high and increasing value of (P_t /C_t), there will be a downward pressure on price, coefficients a_1 and a_2 should have negative signs. And as no change in price is expected when $P_t = C_t$, $a_0 +a_1 = 0$, or $a_0 = -a_1$.

Following the basic model set out in Section 2 above, the equation for change in price may be written as,

$$(1/p_t)(dp_t/d_t) = a_0 - a_1 (P_t/C_t) + a_2 (P_t/C_t)(B-b_1)$$

where B is the rate of growth of production and b_1 is the steady rate of growth of consumption.

The above expression may be rewritten as,

$$(1/p_t)(dp_t/d_t) = a_0 (1-P_t/C_t) + (P_t/C_t) a_2 (B-b_1).$$

Following the phases of growth of production of Section 2, it is possible to construct a table for the values of $(1/p_t)(dp_t/d_t)$. These are provided in Table 7.2.

Table 7.2

The Movements of Price

Period	P_t/C_t	$B-b_1$	$(1/p_t)(dp_t/d_t)$
T to T+7	<1	$b-b_1 < 0$	high positive
T+7 to T_1	<1	$b_2-b_1 > 0$	low positive
T_1 to T_1+7	>1	$b_2-b_1 > 0$	low negative
T_1+7 to T_2	>1	$b_3-b_1 < 0$	high negative
T_2 to T_2+7	<1	$b_3-b_1 < 0$	high positive

As is evident, price movement is cyclical and at the turning points, that is, where P_t/C_t crosses the value one from below and above, the increase and fall is rather sharp.

7. Conclusion

The Model clearly points to the conditions of supply for generating the characteristic movement of production and prices. The assumption is that demand was not subject to such fluctuations. With the exception of natural rubber, the other commodities, namely cocoa, coffee, arecanut and cardamom are for final consumption, and this by its very nature has a stability which would mitigate against violent fluctuations. As natural rubber in India does not compete with synthetic rubber, demand for it has also shown a steady increase.

The specific condition of supply is the gestation lag. Yield profile according to age of the tree may also be important but it may not alter the conclusions in any significant way. Its inclusion in the model would however complicate the equations and the transparency of the results would be lost. Hence, the whole question of the yield profile has not been incorporated in the model.

The model as developed is a logical construction. If empirical validation is a criterion for the evaluation of the model, then, that will have to wait for the next chapter, which deals with the subject.

Notes

1. It is with interest that one has been reading the discussion on the effects of the application of chemical fertilisers in rubber cultivation. The general view seems to be that yield of rubber does not respond (even with a time lag) to the aplication of fertilisers the way seasonal crops do. Instead rubber trees responded to certain balancing of the nutrient status of the soil, after careful analysis of the soil.[The Planters' Chronicle, March and May 1991; also personal communication from Jacob Mani, UPASI R & D Centre, Kottayam.]

CHAPTER 8

THE PHASES OF PRODUCTION OF NATURAL RUBBER, ARECANUT AND CARDAMOM IN INDIA

1. Introduction

It was argued in Chapter 7 that the characteristic movement of productivity, production and prices of perennial crops was owing to the distinct phases of area expansion. These phases in turn are an outcome of the specific character of the production response to changes in demand. As any response takes time to get translated into production, owing to the gestation lag, the magnitude of the response has to be greater than the magnitude of the change in demand. By its very nature the greater magnitude calls for a correction, in the nature of pulling the magnitude below the demand growth. It is this specificity which manifests itself in the phases of area expansion.

Chapter 7 was entirely on the logical plane, devoid of any empirical substantiation. This chapter is devoted precisely to this aspect. The crops considered for empirical estimation of the equations of the model are natural rubber, arecanut and cardamom. All the three crops are important in the Kerala context. There is a regional dimension to the selection of crops; natural rubber is grown largely in the central and southern districts of the state, arecanut is an important crop of the northern districts, and cardamom is grown in the high ranges of the state. The gestation lags are also different for the different crops. It is around seven years for rubber, around five years for arecanut, and just about three years for cardamom. The rates of growth of demand are also different for the different crops. It is fairly high for rubber, which is an industrial raw material, and low for arecanut, but the demand for both is almost entirely internal (to India). Cardamom is an export crop, the demand for which grew fast in the seventies but with Guatemala emerging as a competitor in the eighties the demand for Indian cardamom has come down.

The equations estimated are different for the different crops, the consideration being the availability of reliable data. For natural rubber, data on production, productivity, area new planted, area replanted, productivity and price are available over a period of fifty years. In the case of arecanut, the data on area and production are available over the last thirty years ; but the data on area is not comparable over the entire period for the reasons gone into in Chapter 2. And for cardamom, the data on area are not reliable, and hence could not be used. The data on production and prices of cardamom however are fairly reliable. An attempt has been made to estimate most of the equations in the case of rubber; for arecanut and cardamom only the production equations are estimated. Non-availability of data has made for the exclusion of pepper. The data on area and production are so unreliable that the official estimates of production are often lower than the exports(see Chapter 2 and the Appendix). Estimation has been carried out using the all-India data rather than the Kerala data. Kerala is the largest producer of most of the crops, and the pattern is not different from the all-India pattern and the present focus is on the movements of price which calls for an analysis of the aggregate supply.

The chapter is organised in six sections. Following this introduction, Section 2 estimates the phases of growth of area, productivity and production of natural rubber. Section 3 takes up the question of the sensitivity of the decision to replant natural rubber, to the movements of price. Section 4 estimates the phases of growth of production of arecanut. Section 5 is a similar exercise for the production of cardamom. In this case the sensitivity of production to rainfall is also tested. Section 6, the conclusion, deals with the implications of the phases of growth of production to price.

2. Phases of Growth of Area, Productivity and Production of Natural Rubber.

This section is devoted to the empirical estimation of the various equations of the model for natural rubber in India. The first equation estimated is of growth of area. As per the model, if the growth rate is high in one phase it should be low in the next and so on.So, it should be possible to identify distinct rates of growth for sub-periods.Sub-periods are identified after careful scrutiny of graphs of annual increases of area,total area and the annual percentage changes of area. This is the method followed throughout the chapter.

In order to test for such a growth pattern it is necessary to define a few dummy variables.

Let, $D1 = \begin{cases} 1 & 0 \le t < T1 \\ 0 & \text{ow.} \end{cases}$

$D2 = \begin{cases} 0 & 0 \le t < T1 \\ 1 & T1 \le t < T2 \\ 0 & T2 \le t \end{cases}$

$D3 = \begin{cases} 1 & t > T2 \\ 0 & \text{ow.} \end{cases}$

If the model holds, an equation of the form for the rate of growth of area, $a_t = b1\ D1 + b2\ D2 + b3\ D3$ should give a good fit for some values of T1 and T2.

The estimated equation for the annual percentage change of area under rubber is the following:

<u>1955-1989</u>

$$a_t = 0.129D1 + 0.025D2 + 0.054D3$$
$$(19.61)^* \quad (5.43)^* \quad (9.64)^*$$

$$[0.84,\ 0.83,\ 83.30^*]$$

Here a_t is the annual percentage change in area and D1,D2 and D3 are defined taking T1 = 1963 and T2 = 1979. As already indicated,T1 and T2 are chosen initially by viewing the graphs. Exact values are chosen in such a way that R^2 is maximised. It is amply evident from the estimated equation that growth of area is characterised by distinct phases of low and high growth. The period, 1955-63 was one of rapid expansion in area under rubber. This was followed by slow growth over a long period, 1964-79, to be followed again by rapid growth beyond 1979.

Corresponding to the phases of growth of area, the phases of growth in yield and production would appear after a lag of few years. In the case of natural rubber the gestation lag is said to be seven years and the period for stabilisation of yields is ten years. Hence, corresponding to the rapid area expansion of 1955-63, yield and production growth should occur during 1964-1972. In order to test the phases of growth of production and yield it is not proper to take the percentage annual change because yield -consequently production - is subject to year to year fluctuations on account of weather and other factors. Hence, other procedures have to be adopted.

Let us define two dummy variables D1 and D2 as follows;

$$D1 = \begin{cases} 1 & t \leq T1 \\ 0 & \text{ow.} \end{cases}$$

$$D2 = \begin{cases} 1 & t \geq T1 \\ 0 & \text{ow.} \end{cases}$$

Let Y be of the following form.

$$Y = A + B1D1*t + B1T1D2 + B2D2*(t-T1)$$

$$\text{i.e. } Y = A + B1(D1*t + T1D2) + B2D2*(t-T1)$$

$$= A + B1DUM1 + B2DUM2 \quad \text{Where } DUM1 = D1*t + T1D2$$

$$\text{and } DUM2 = D2*(t-T1).$$

The equation stands for the following process. A is the value of the variable at the initial point of time. B1 is the annual increase of the value upto T1. The value at T1 is A+B1*T1. From then on, the annual increase is by B2. t stands for time. If Y is in the natural log form, then B1 and B2 are the growth rates for the periods 0 to T1 and T1 to the end of the period respectively.

The equations were run for yield and production over 1948-74. The estimated equations were,

$$LYield = 5.708 + 0.01395\ DUM1 + 0.06208\ DUM2$$
$$\qquad (6.618)^{*} \qquad (29.445)^{*}$$

$$[0.99,\ 0.99,\ 891.65^{*}]$$

$$LPRO = 9.673 + 0.047\ DUM1 + 0.124\ DUM2$$
$$\qquad (14.695)^{*} \qquad (38.482)^{*}$$

$$[0.99,\ 0.99,\ 1850.04^{*}]$$

Here, the first sub-period was upto 1961 and the second sub-period was 1962 to 1974. It is evident from the estimated equations that in the first period the yield growth was very low (1.40 per cent), whereas, in the second sub-period, when the area rapidly expanded since 1955 came into the yielding stage, the yield also started growing rapidly, the growth rate being 6.21 per cent. Similar was the pattern with regard to growth of production. It was 4.7 per cent in the first sub-period followed by 12.3 per cent in the second sub-period.

Similar equations were run for the period 1974-89 dividing the period into two sub-periods, at the year 1984. The estimated equations were,

$$LYield = 6.608 + 0.0137 DUM1 + 0.0346\ DUM2$$
$$\qquad (3.891)^{*} \qquad (4.492)^{*}$$

$$[0.87,\ 0.84,\ 41.47^{*}]$$

$$LPRO = 11.786 + 0.0286\ DUM1 + 0.0978\ DUM2$$
$$\qquad (7.002)^{*} \qquad (10.985)^{*}$$

$$[0.97,\ 0.96,\ 192.48^{*}]$$

The yield growth in the second sub-period, that is, beyond 1984, is higher but its sharp upward movement had not yet begun probably because the period is too short. But production shows up the distinction rather sharply; it was low at 2.86 per cent till 1984 but increased to 9.78 and beyond.

Thus, over the entire period, 1948-1989, growth of area, yield and production were characterised by distinct phases. The rapid area expansion of the periods 1955-63 and 1979 and after - got translated into fairly high rates of growth of yield and production after a time lag of seven years. The periods of rapid growth of yield and production were 1962-74 and 1984 and after. Overall, the estimated equations brought out the centrality of phases of area expansion in explaining the phases of growth in yield and production.

Turning now to the determinants of a_t, the explanatory variables P_t/C_t, and $d(P_t/C_t)/dt$ were used as explanatory variables and equations were run. The first equation estimated was of the form:

$a_t = b + b1(P_t/C_t)$ and the coefficients were

<u>1954-1989</u>

$$a_t = 0.209 - 0.1765(P_t/C_t)$$
$$(-4.26)*$$
$$[0.35,\ 0.33,\ 18.17*,\ 0.39]$$

As is evident, the coefficient of (P_t / C_t) is statistically significant (at one percent) and has the expected sign and the F value is also significant. But the DW statistic has a value 0.39.

The second equation estimated was of the form

$a_t = b + b'_1 [P_t / C_t] + b2[P_t / C_t (1/P_t\ dP_t /dt)]$ and the coefficients were:

$$a_t = 0.0202 - 0.133\ P_t / C_t - 0.448\ P_t / C_t\ (1/P_t \cdot dP_t /dt)$$

(-3.393)* (-3.167)*

[0.50, 0.47, 16.51*, 0.95]

The coefficient of $P_t / C_t\ (1/P_t \cdot dP_t /dt)$ was also statistically significant (at one percent) and of the expected sign. The addition of this term greatly improved the R^2.

At the next stage, a term of relative profitability was added. The term added was real price (wholesale price of rubber divided by the wholesale price index of all commodities). The estimated equation was the following.

$$a_t = 0.051 - 0.0875(P_t / C_t) - 0.223P_t / C_t\ (1/P_t \cdot dP_t /dt) + 0.0015 \text{ Real price}$$

(-2.511)** (-1.690) (4.006)*

[0.67, 0.64, 20.84*, 1.57]

When price was explicitly introduced in the equation the coefficient of P_t / C_t $(1/P_t \cdot dP_t / C_t)$ turned insignificant and that of (P_t / C_t) turned significant at 5 percent. Thus, it may be inferred that a_t responded basically to price signals. As long as P_t / C_t and its rate of growth were used to capture the price signals they were significant. But with the introduction of price on its own the other two either became weak or statistically insignificant.

3. Effect of Price on the Decision to Replant.

The aspect not covered in the equations estimated so far was that of replanting. Turning to it now, it is proposed to test whether the area replanted in any year is determined by the completed age of the garden, or whether the movement of price has any effect on the area replanted. In other words, is the entire area that completes a certain age replanted immediately, or does the area replanted deviate from the entire area.

In order to test the sensitivity of area replanted to price changes, the following procedure was adopted. Data are available on the area planted (new area planted plus area replanted) from around 1937. Also, the total area under rubber as of 1937 is known.Assuming the life-span of the tree to be 20 years, it can be said that the total area under rubber as of 1937 is the area which has completed 20 years as of 1957. Let us call it V_{1957} . It stands for the area due for replanting as of 1957, if 20 years is assumed to be the life of the tree.It is possible that some of this area has already been replanted in the intervening period. Then the difference between V_{1957} and the area replanted during the intervening period(cumulative total of area replanted as of 1957) is the area due for replanting as of 1957, and may be represented as $RPDV_{1957}$. In general terms,

$$V_t = (\text{Cumulative total of area planted})_{t-20} .$$

$$RPDV_t = V_t - (\text{cumulative total of area replanted})_t .$$

If the area once planted with rubber does not go to other crops, then, $RPDV_t = 0$ which implies that price did not influence the decision to replant; replanting takes place at the end of the biological life of the tree.If RPDV is different from zero and shows some distinct pattern, then there is reason to suspect that the area replanted is sensitive to the movement of the price of rubber.

Taking 20 years as the life-span, a series RPDV was constructed from 1957 to 1989. It was found that the series showed positive values for the entire period. Further, the series showed very little variation from 1957 to 1965, a strong downward movement from 1965 to 1972 and a strong upward movement from 1972 to 1989. This pattern may be interpreted in the following terms. During the period 1965 to 1972, the area replanted each year was higher than the area that had completed 20 years and was coming up for replanting. The period from 1972 was marked by the area replanted each year being lower than the area completing 20 years and becoming available for replanting.In other words, cultivators were postponing their decision to replant even when the trees had completed 20 years. Going by the same logic, the period prior to 1973 must have witnessed the replanting of the cumulative area. It is interesting to note that the pattern remained unaltered when instead of 20 years, 21 to 25 years as the life-span were tried successively.

Now, one major difference between the two periods was that 1964 to 1972 saw a rapid increase in production and largely stagnant prices, while the period after 1972 witnessed a rapid increase in the price of natural rubber. Hence, an attempt was made to relate the pattern of replanting with the movement of price. The regression equation for the purpose was set up as follows. The period taken for analysis was 1965 to 1989. DPRICE was defined as 0 upto 1973, and beyond that year, as the wholesale price of natural rubber. D1 was defined as natural numbers 0, 1, 2 .....8 from the year 1965 to 1973 and as 8 for all the years beyond 1973. The equation was of the following form:

$$RPDV = C_1 + C_2 D_1 + C_3 \text{ DPRICE}.$$

In the above equation C_1 stands for the initial value of RPDV. C_2 is the annual chane till 1973. $C_1 + C_2$ 8 is the value of RPDV in 1973. C_3 is the change in RPDV for a unit change in price.

The estimated coefficients were,

$$RPDV = \underset{(7.26*)}{21657.76} - \underset{(-4.95*)}{3620.20 D_1} + \underset{(17.46*)}{6478.66 \text{ DPRICE}}$$

[0.94, 0.94, 249.11, 1.57]

As is evident, the data fits the equation well. The intercept is positive and significant and D_1 has a strong negative coefficient indicating that the period of stagnant price was one of intense replanting. Over and above replanting the area completing 20 years of age, an area of 3620 hectares was being replanted every year till 1973.Beyond 1973 for every one rupee increase in the price of rubber, 6479 hectares which had completed 20 years and became due for replanting, was not being replanted.

It was seen in the previous section that growth of new planting was high during the upswing of price and low during the downswing of price. Now, it is seen that replanting was also marked by phases; low levels of replanting during the upswing of price were followed by high levels during the downswing. Thus, replanting moderated the phases of area expansion.

The finding that area replanted is sensitive to the movement of price, points to the need for incorporating replanting through price into the model developed in the previous chapter.

4. The Phases of Production of Arecanut

With the partition of India in 1947 vast areas growing arecanut in the eastern region became part of Pakistan. This created a situation where domestic production fell far below domestic demand. The gap was bridged by resorting to imports. The late fifties and the early sixties witnessed a gradual decline in the imports owing mainly to the foreign exchange crisis (Das, 1985). The declining imports resulted in a steady increase in the price of arecanut, setting off a massive area expansion in the sixties to be followed by a massive increase in production after a time lag. By the early seventies, there was a strong downward pressure on the price and this put a stop to the area expansion. But increase in production continued upto the early eighties. But price started looking up only in the late eighties.

The equation set up for testing the phases of production is the following.

$$\text{Production} = A_0 + A_1 D_1$$

Here D_1 takes value zero from 1966 to 1969 and 1,2 ,3... 13 from 1970 to 1982. After 1982 the value is taken as 13. The estimated equation for the period 1966-86 is,

$$\underset{}{\text{LARPR}} = \underset{(347.71*)}{4.92} + \underset{(19.16*)}{0.0321}\, D_1$$

[0.95, 0.95, 367.03, 1.47]

Before proceeding to interpret the results it needs to be noted that the residuals for 1975 to 1979 show negative signs. For the rest of the years positive and negative signs do not occur consecutively. This could be because of the change in the method adopted for arriving at the area estimate in Kerala in 1975.(See Chapter 2). The area figures in fact showed a sharp decline between 1974-75 and 1975-76. And as Kerala accounted for about 50 per cent of the all-India area under arecanut the production estimates are also affected to that extent.

As is evident, production which was stagnating around 137000 tonnes till 1969 increased at 3.21 per cent per annum from then on. This came to a standstill from 1982 onwards.

The price of arecanut showed a sharp downturn from 1973. Taking 1973 to be the year in which production surpassed demand and assuming a value of 2 per cent for demand growth, what the estimated equation suggests is that demand will overtake production only by 1987-88. That the upswing in price began around 1987 confirms the above rates.

5. The Phases of Production of Cardamom

Cardamom is a spice grown in the high ranges of Kerala, 80 per cent of its production being exported, mainly to the Persian Gulf countries. As the crop is cultivated as an undergrowth in the forests, and as the bulk of the land under the crop is leasehold or encroached forest land, the data on area under the crop are not very reliable. However, production data seem to be reliable and for the purpose of estimation only this data has been used.

A preliminary look at the data suggested three distinct phases, 1964-69, 1970-76 and 1977-87. But an important difference when compared to rubber or arecanut was that cardamom production showed violent year to year fluctuations. Taking the phases first, an equation of the form,

$$\text{Prod.} = A_0 + A_1 D_1 + A_2 D_2$$

Where D_1 = 1, for the period 1970-76,

0, o.w.;

and D_2 = 1, for the period 1977-87

0, o.w.;

was run. The estimated coefficients were,

$$\text{Prod.} = 2283.33 + 674.53D_1 + 739.87D_2$$

8.24* 1.79*** 2.26**

[0.45, 0.40, 8.75, 1.50]

Production of cardamom, which averaged 2283 tonnes during 1964-69 jumped by 675 tonnes by 1970 and continued to remain at that level till 1976; the next jump in 1977 was by 740 tonnes.

Although the movement of production itself was in phases, the variation explained by such a fit was only 45 per cent. This was largely because of the violent year to year fluctuations in yield mentioned above. As elaborated in Chapter 2, yield data on cardamom are unreliable and hence no attempt was made to relate it with rainfall. Instead, an attempt was made to test the relationship between fluctuations in production after eliminating the effects of area expansion and the quantum of rainfall. For this purpose, a residual variable was defined as,

$$RES = Prod. - 2283.33 - 674.53D_1 - 739.87D_2 \; .$$

Needless to say, such a residual will not only subsume the rainfall effect but also other effects due to changing age composition of plants, changes in the application of fertiliser, etc. This variable was regressed on the rainfall received (state average for Kerala) during four distinct periods, viz., April-May (AM), June to August (JJA), September-October (SO) and November-December (ND). The variables SO and ND did not have much of an influence on RES, but AM and JJA separately did influence RES. The estimated equations were:

$$RES = \underset{-1.80^{***}}{-1265.98} + \underset{1.83^{***}}{0.789 JJA}$$

[0.16, 0.11, 3.36, 1.57]

$$RES = \underset{-2.22^{**}}{-875.95} + \underset{2.35^{**}}{2.84\ AM}$$

[0.24, 0.19, 5.54, 1.73]

When both AM and JJA were taken together, it turned out that only AM had a significant influence on RES. The estimated equation was,

$$RES = \underset{-2.26^{*}}{-1530.42} + \underset{1.81^{***}}{2.31 AM} + \underset{1.18}{0.51 JJA}$$

[0.29, 0.21, 3.53, 1.71]

Thus, rainfall during the dry summer months had a beneficial effect on the production of cardamom.

The very short gestation lag of two to three years, together with the influence of weather on production and the weak data base do not facilitate easy and clear identification of the phases of rapid growth and relative stagnancy. Although relative stagnancy over periods of moderate length is discernible the phases of rapid growth turn into almost sudden jumps over one to two years. And, if these years happen to be abnormal years in terms of weather, then, the influence of economic and weather variables get confounded. All the same, the existence of distinct phases of growth of production confirms the model in the case of cardamom.

6. Conclusion

It is now possible to turn to an explanation of the second part of the price question addressed in Chapter 3. It was observed that there were two distinct sub-periods - 1964 to 1975, and 1975 to 1987 - in terms of the movement of prices. The explanation for the movement of the price of the food group was the large-scale import of rice into the state of Kerala. The phases of production explain the movement of the prices of tree crops.

The price of rubber which was increasing throughout the fifties showed a reversed trend after 1963, coinciding with the rapid growth in production set off by the rapid growth in area from the mid-fifties. The next upward movement in price began only after 1973, by which time demand had caught up with production which had slowed down its rate of growth. This marked the beginning of a second cycle of increasing price and set off rapid area expansion.

A similar pattern may be observed in the case of arecanut as well. The increasing price of the sixties, consequent to the gradual reduction in imports, had set off a phase of rapid expansion of area. When this area expansion got translated into a phase of rapid growth in production by the end of the sixties, the price began its downward movement. A reversal had not come about till the end of the eighties.

In the case of cardamom, the cycles were of shorter duration. The sharp declines in the price around 1970 and 1978 were clearly related to the sharp jumps in production observed around the same period. In between there were upswings in price which set off rapid area expansion, and the expansion of production. The period of the cycle itself was shorter, owing to the very short gestation lag and the rapid growth in the demand for the commodity (Nair et al,1989). Thus, in the case of all the three crops the price cycles could be related to the phases of production and area growth confirming the validity of the model developed in the previous chapter.

CHAPTER 9

SELECTIVE ADOPTION OF AGRICULTURAL TECHNOLOGIES BY A LITERATE SOCIETY : AN ASSESSMENT

1. Introduction:

As compared to the earlier periods of human history, increases in agricultural production during the twentieth century have greatly been the outcome of increases in yield - in output per unit of land area. According to Ruttan,

> "During the 20th century, agriculture has been undergoing a transition from a resource-based sector to a science-based industry. Growth in agricultural output is increasingly based on development of scientific and technical capacity to invent new mechanical, chemical and biological technologies...."
> [Ruttan, 1982:3]

Diffusion of technologies among farmers forms the link between development of technologies and increases in yields.

Development of technologies has taken place under two different systems. In as much as agriculture is a process dominated by the environment, farmers are engaged in a continuous process of innovation (informal R & D). "The great strength of informal R&D lies in the users of the technology innovating to meet their own needs by drawing on detailed knowledge of their environment and exploiting the opportunities offered by natural selection" (Biggs and Clay, 1981:325-6). But there are certain clear limitations of the informal R&D system and over the last few decades formal R&D systems have evolved. Formal R&D systems make for the systematic generation (often guided by government objectives) and channelling of technology. Massive resources flow for the establishment and maintenance of formal R&D and information from agriculture may become a vital input for formal R&D. But "new technologies emanating from the formal system are screened by farmers and often adapted by their informal R&D before adoption in the production process" (Biggs & Clay, op.cit.). It is to these technologies developed in the formal R&D system and their diffusion that are being considered here.

Ever since Schultz argued that education spreads the process of technological diffusion and makes a substantial contribution to agricultural productivity, empirical studies by Rogers (1962), Wozniak (1984) and Rahm and Huffman (1984) for the U.S.A. and studies by Jamison and Lau (1982), Jamison and Moock (1984), Nerlove(1985), Duraisamy(1989) and Strauss et al (1989) for developing countries have lent support to his view. Although the larger worth of education is sometimes mentioned - "Education increases a person's awareness of his environment...... It also enhances his ability to identify alternatives and to <u>assess and compare</u> the benefits and costs associated with each of the alternatives,...... Education also in general increases the facility and speed with which new skills and techniques can be learned and new alternatives, <u>when judged desirable</u>, can be adopted and implemented"(Jamison and Lau, 1982:195)(emphasis added) - the focus has mostly been on "education enhancing the probability of <u>adopting a new, presumably superior, technology</u> (Jamison and Lau, op.cit) (emphasis added). This chapter turns to the larger worth of education in the sense of "it enhancing a person's ability to identify alternatives and to assess and compare, and adopt when judged desirable" and how it leads to selective adoption of technologies in particular situations. Such selective adoption of technologies by a fairly literate society can then be taken as a good assessment of the desirability of the technologies evolved by the formal R&D systems.The chapter is a study of crop production in Kerala with the above perspective.

The conventional explanation of the poor yield performance of crops in the face of a growing formal R&D system would be that yield performance is poor because adoption of technologies by the farmers is poor.The index often used for measuring the availability but non-adoption of technologies by farmers is the index of potential utilisation, which is the ratio of the average yield(over a geographical unit) to the yield of the best managed plot. Next, the factors responsible for the poor adoption are explained usually in terms of soil moisture' environment, weak extension support, lack of enterprise on the part of the farmer owing to small size, lack of resources, lack of knowledge etc.

In this chapter, it is argued that index of potential realisation is not appropriate if the crop is grown in widely varying agro-climatic zones under divergent agronomic conditions and the best managed plot is confined to a single zone.Technologies developed may be appropriate for some zones but not for others.In other words, if technologies are not of the 'widely adaptable' type then, the index may fail to capture the constraints set by the divergent agronomic conditions.Also, in the presence of inter/mixed cropping of varying intensities the index may not be appropriate.And if it can be shown that extension organisation, relative prices , and landholding size do not explain the observed variation in adoption behaviour across crops then, the non-adoption may in fact be due to the non-availability of desirable technologies rather than lack of knowledge or lack of enterprise.

As for knowledge aspect all that need be noted is that Kerala is a highly literate society (Table 9.1) and the state has achieved a fairly significant scale of infrastructure development.

Table 9.1

Literacy Rate in Rural Kerala
(Percentages)

Age group	Persons Males Females	1971	1981	1991
	P	54.14	61.78	NA
35+	M	68.69	75.29	NA
	F	39.89	48.96	NA
All age groups	P	59.28	69.10	78.10
	M	65.57	74.13	80.90
	F	53.10	64.25	75.40

Source:Census of India, 1971, 1981 and 1991.

"Even the remotest villages are linked with the rest of the state by bus transport. By now allthe villages in the state are electrified. The total number of post offices exceeded 4000, that is, one serving an area of about 9 sq.km. and a population of about 6000. Over 35 Malayalam newspapers, with a total circulation of 2.2 million (for a population of slightly over 25.4 million), are published in Kerala; besides these several periodicals, numbering around 600, are also published. The library movement in Kerala has firmly established a network reaching out to the villages: in the mid-seventies, over 3700 libraries functioned in the State with a total membership of over 7 lakhs" (Panikar and Soman, 1984:5). The high levels of literacy and fairly significant scale of infrastructure development have made for the speedier spread of information in the state. The chapter is organised in seven sections. Following this introduction, Section 2 sets out the yield performance of the various crops in the state over a period of about thirty years.Section 3 discusses the Research and Extension Systems for the different crops.Section 4 discusses the complex combination of physical environments and landholding patterns under which these diverse crops are grown in the state. Section 5 provides a brief account of the price environment in which the cropping and related activities are carried out. Section 6 makes an attempt to draw patterns from out of the complex combinations introduced in sections 3 to 5 and brings out the main argument of the paper. Section 7 is the conclusion.

2. Yield Changes of Crops and Livestock in Kerala

This section discusses the changes in yield of crops and livestock in Kerala so as to provide a background for the discussion carried out in the following sections.

The changes in the yield of rice in Kerala is taken up first. As is evident from Table 9.2, the performance of rice in Kerala is comparable to the overall performance in India. The level of yield in Kerala which was about 15 per cent above the all-India average for the triennium ending 1954-55 went upto about 36 per cent above the average by the triennium ending 1961-62. This level was maintained till the triennium ending 1972-73. By 1982-83 it had however, come down to about 26 per cent above the all-India average, falling further to 11 per cent by the triennium ending 1988-89. The same story is confirmed by the rankings as well. It may thus be concluded that the performance of rice in Kerala had been above the all-India level till the mid-seventies but has deteriorated since then.

Milk production

Turning now to milk production, the performance of Kerala is outstanding. As is evident from Table 9.3, in terms of annual percentage increase in milk production between 1961 to 1981-82, Kerala has showed one of the best performances among the states of India. Kerala could also boast of a fairly high percentage of milch cattle in the higher milk yield brackets (1 litre and above) next only to Punjab, Haryana and Gujarat. As the percentage of high milk-yielding cattle of the total number indicates, this sharp increase in production of milk is owing to a fairly high increase in the productivity of milch cattle (roughly a fourfold increase in 22 years) and not due to any significant increase in their numbers (Table 9.4).

Table 9.2
Yield of Rice Across the States of India

State	Yield for the triennium ending (tonnes/ha.)				
	1954-55	1961-62	1972-73	1982-83	1988-89
Andhra Pradesh	1.156	1.276	1.450	2.039	2.228
Assam	1.002	0.948	1.010	1.074	1.089
Bihar	0.652	0.809	0.902	0.840	1.062
Gujarat	0.609	0.761	0.923	1.227	1.098
Haryana	1.510	1.165	1.713	2.558	2.393
Karnataka	1.067	1.361	1.762	1.984	1.942
Kerala	1.009	1.350	1.535	1.629	1.725
Madhya Pradesh	0.682	0.821	0.777	0.779	0.889
Maharashtra	0.927	1.040	0.951	1.497	1.372
Orissa	0.850	0.919	0.876	0.896	1.061
Punjab	1.474	1.056	1.948	2.953	3.088
Tamilnadu	1.173	1.451	1.969	2.018	2.826
Uttar Pradesh	0.601	0.747	0.787	1.087	1.479
West Bengal	1.029	1.064	1.189	1.197	1.715
All India	0.877	0.995	1.112	1.293	1.541
100 Yield for Kerala / All India Yield	115.05	135.68	138.04	125.99	111.94
Rank of Kerala	7	4	5	6	6

Source: Ranade, C.G.(1986) Table 4 and Directorate of Economics and Statistics, <u>Area and Production of Principal Crops in India</u> (Various Issues)

Other crops

Before turning to the changes in yield of other crops, almost all of which are perennial crops, it is necessary to go into two methodological issues. The first issue relates to the phases of yield change. Such phases are clearly related to the phases of area expansion as shown in Chapter 7. As such, changes in yield need necessarily be interpreted through phases of area expansion. Simple trend fitting, then, is dropped as a convenient tool of analysis. Instead of presenting the rates of growth, the reported yield figures for a few points of time are presented in Table 9.5.

Table 9.3

Changes in Milk Production and Percentage of Milch Cattle in the Higher Yield Bracket

States	Annual Percentage Change in Milk Production 1961 to 1981-82	Percentage of Milch Cattle with a milk yield of 1 litre & above (1975-76, rural)
Andhra Pradesh	1.77	5.73
Assam	10.41	16.54
Bihar	0.31	25.98
Gujarat	2.26	60.35
Haryana	-	72.70
Jammu & Kashmir	6.66	44.80
Karnataka	5.51	13.23
Kerala	15.20	51.09
Madhya Pradesh	5.86	7.06
Maharashtra	0.81	12.00
Orissa	-1.49	2.85
Punjab	2.04	70.47
Rajasthan	1.52	46.79
Tamilnadu	3.82	16.29
Uttar Pradesh	2.04	20.16
West Bengal	7.77	30.50

Sources: Singh,C.B. Patil, R.K. and Sharma, S.P. , 1987.

Table 9.4

Productivity of Milch Cows in Kerala

Year	Average Milk Yield (in Kgs)
1964-65	0.510
1977-78	1.317
1980-81	1.462
1983-84	1.795
1986-87	1.976

Source: Thara S. Nair(1988) Table 4.1

The second issue relates to 'pure' versus 'inter' or 'mixed' cropping. As against rice, tea or rubber which are grown as 'pure' crops, the yield of which can be discussed unambiguously, most of the other crops are grown as 'inter' or 'mixed' crops. That is, while the area where rice, tea or rubber is cultivated has just that crop, the area with coconut cultivation may also have pepper, arecanut, cocoa and many other crops as well. Hence, it may not be quite realistic to talk of the yield changes in any one of these crops neglecting the others. Unfortunately, the system of data collection is such that yield data for only individual crops are available and the discussion is necessarily in terms of these figures, to the neglect of the reality of 'inter' or 'mixed' crop production.

The phases of yield growth for rubber have been worked out in Chapter 8.It was seen that 1955-63 was a phase of rapid area expansion and this got translated into a phase of yield growth over 1962-74. The next phase of area expansion began in 1979 and has been continuing; the corresponding phase of yield growth had begun in 1985. The period 1962-74 showed a yield growth rate of 6.21 per cent per annum and the period beyond 1984 reported a yield growth rate of 3.46 per cent. The two phases together, then, show a three-fold increase in yield of trees reaching the tapping stage. In the case of tea, there had not been any sharp increase in area and hence no phases could be distinguished. Tea showed an increase in yield of about 54 per cent over 1962 - 1988 the bulk of which occured in the seventies and eighties.

When phases of area expansion are taken into account and the yield of perennial crops, other than rubber and tea are analysed, it was found that none of these crops showed any signs of increases in yield. It was a picture of stagnancy all through. The per palm yield of coconut has shown a steady decline over 1961-62 - 1973-74, and has not shown any increase since then. Although changes in the age composition of bearing palms over the years could explain the decline in yield till 1973-74, there is no sign of an increase at any stage[1]. Similar are the stories of pepper, cardamom, cashewnut and coffee. No systematic analysis of the effect of the changing age composition of trees or vines on yields could be carried out owing to the serious limitations of the data on area indicated in Chapter 2. A slightly better picture is obtained of tapioca which showed a 31 per cent increase in yield over the period. The trend itself is similar to that of rice.

With this, three groups of crops or agricultural activities may be identified. The first group reporting very good performance consists of rubber, tea and livestock. The second group consisting of rice and tapioca showed a performance above the all-India level till the mid-seventies and rapid deterioration since then. All the other perennial crops showed very poor performance. What is the explanation for such disparate performances in yield increases ? As yield increases are largely governed by technological diffusion, an examination of the process of generation and diffusion of technologies might provide an insight into this issue.

Table 9.5

Changes in Yield of Crops in Kerala

Year (Triennium ending)	Rice	Tapi-oca	Rubber	Tea	Coffee	Pepper	Carda-mom	Cashew	Coconut
	Indices of Yield Per Hectare of Crops								
1962-63	100	100	100	100	-	100	100	100	100
1967-68	98	102	132	-	100	87	91	100	90
1972-73	114	113	184	114	92	87	60	100	80
1977-78	111	115	210	126	106	100	89	79	76
1982-83	121	113	214	141	115	108	102	51	76
1987-88	128	131	247	154	92	101	80	59	78

Source : 1. Government of Kerala, Economic Review, (Various Issues)
2. Government of India, Indian Rubber Statistics (Various Issues)
3. Government of India, Indian Tea Statistics (Various Issues)
4. Government of India, Indian Coffee Statistics (Various Issues).

Note : 1. The rice yield, is average over three seasons.
2. For coconut, yield per bearing palm is taken.
3. For rubber yield, the tappable area is taken.

Table 9.6

Crop Yield: Rice (Kharif) (1974-75)

States	Highest Yield in National Demonstration (q/ha.)	State average (q/ha.)	Ratio Highest/ State Average
Andhra Pradesh	93.72	15.35	6.10
Assam	47.35	6.76	7.10
Orissa	48.18	3.56	13.53
Tamilnadu	57.91	18.29	3.17
Madhya Pradesh	63.00	5.32	11.84
Kerala	31.75	13.56	2.34
West Bengal	27.19	8.99	3.02
Bihar	53.79	5.81	9.26
Uttar Pradesh	53.62	15.22	3.52
Maharashtra	37.95	10.56	3.52
Gujarat	54.65	4.84	11.29
Haryana	52.80	14.25	3.70
Punjab	57.58	20.72	2.78

Source: Swaminathan, M.S. (1989), Table 13.2.

If generation of technologies by the formal R&D system is taken for granted, then the problem is simply one of diffusion. Often, the strength of diffusion is measured in terms of the index of potential realisation, where the index is defined as the ratio of the average yield (over some geographical unit) to the yield of the best managed garden or plot. The best managed plot is assumed to represent the potential at a given technology level of the formal R & D system.

To begin with rice, Kerala's performance needs to be viewed in the light of the overall performance of the Indian rice economy in the recent past. This has been largely shaped by the infusion of new technology developed in the formal R&D system, that is, the HYV technology. In order to popularise the new seed varieties the government has initiated the National Demonstration Programme (NDP) since 1965. For the purpose of computing the index, yield from the NDP was taken as the best managed plot. As is evident from the data for the year 1974-75 (Tables 9.6 and 9.7) the ratio of the highest yield from NDP to the state average yield is the lowest for Kerala in all the three crop seasons. This may be taken to mean that given the highest yield in NDP as the potential realisable by the scientists under the farmer's environment, potential realisation is the highest by the Kerala farmers. This was confirmed by the index of potential realisation computed by Mukherjee [as presented in Swaminathan, 1981: Table 9]. As is evident from Table 9.8, the performance of Kerala is well above the all-India average. Kerala is well above the all-India average. While the all-

India index of between 46 and 56 in the states of West Bengal, Tamilnadu, Punjab, Jammu and Kashmir, Haryana, Karnataka and Kerala. It may be noted from the three tables that the potential yield is one of the lowest in Kerala compared to the other states.

Similar indices of potential realisation were computed for the other crops grown in Kerala (Table 9.9).

Table 9.7

Crop Yield: Rice (Rabi) 1974-75

States	Highest Yield in National Demonstration (q/ha.)	State Average (q/ha.)	Ratio
Andhra Pradesh	53.79	15.35	3.50
Orissa	49.00	7.60	6.45
Tamilnadu	55.01	19.58	2.81
Kerala	33.00	15.65	2.11
Karnataka	38.77	26.66	1.45
	Summer Rice		
Andhra Pradesh	47.52	17.75	2.68
Orissa	45.75	12.76	3.58
Kerala	33.99	19.29	1.76
Bihar	28.96	10.08	2.87
Karnataka	52.88	25.80	2.05

Source: Swaminathan, M.S. (1989), Table 13.3

Table 9.8

Potential Yield, Indices of Potential Realisation of Rice (Unhusked) in Different States (Averaged over 1974-75 to 1977-78)

State	Potential Yield (tonnes/ha.)	Index of Potential Realisation
Assam	4.70	31.7
Andhra Pradesh	6.27	36.7
Bihar	5.08	27.1
Gujarat	6.91	27.3
Haryana	6.60	48.6
Himachal Pradesh	4.06	44.0
Jammu & Kashmir	4.70	53.0
Kerala	4.91	46.1
Karnataka	5.68	46.9
Madhya Pradesh	4.19	26.2
Maharashtra	4.11	50.8
Orissa	4.72	27.0
Punjab	6.81	56.0
Tamilnadu	5.57	55.6
Uttar Pradesh	5.18	26.7
West Bengal	3.45	54.3
All India	5.07	34.5

Source: Swaminathan, M.S. (1981), Table 9.
Note : It is not very clear whether the average is over seasons as well.

Table 9.9

Indices of Potential Realisation

Crops	Index
Rice	46.10
Coconut	22.72
Arecanut	25.76
Pepper	21.18
Cashewnut	31.40
Cardamom	24.00
Tea	56.22
Coffee	47.62
Rubber	39.50

Source: For Rice from Table 9.8 above.
For other crops M.K. Muliyar, 1983; Table II.

Going by the values of the indices, tea, coffee, rice and rubber fall under the group of best performers. The rest of the crops fall under the group of poor performers. This grouping closely follows the grouping of crops in terms of yield performance. The performance of crops in terms of growth of yield may then be related to the diffusion of technologies as measured by the index of potential realisation. High growth in yield is clearly related to better diffusion of technologies. The question then is, has the organisational structure behind the generation and diffusion, that is the Research and Extension System, anything to do with better diffusion?

3. Research and Extension Systems

The research and extension systems of various crops are different. These systems have evolved largely in response to the specific landholding pattern and the needs of the different crops, and fall into a few broad types. An elucidation of these is attempted in this section.

The research and development of tea in South India is looked after by United Planter's Association of South India. The tea planters "have formed into an association and created the research and extension systems which function under a single executive who is answerable to the association. Here the research system is fully aware of the needs of the clients or they are made known to the system, which facilitates the production of only appropriate technology. Once the appropriate technology is developed, it is communicated to the clients through the extension system without losing much time. This is possible because the research and extension systems are functioning under a single head or policy maker on one side and the clients themselves are looking for the new technology on the other side" (Muliyar, 1983; 4-5).

A slightly different research and extension system is in operation for coffee and rubber. For both these crops research and extension systems are looked after by autonomous bodies, called Commodity Boards, under the Commerce Department, Government of India. The heads of the research system and extension system are under the same organisation, Hence, a smooth flow of information from the research system to the extension system and vice-versa can be expected. All the developmental activity is also routed through the extension system for both these crops. In the case of coffee, marketing of the crop is looked after by the Board; in the case of rubber various subsidies and loans are processed through the extension system. Further, in the case of rubber, quality plant materials are also provided through the Board.

As against the research and extension system operating under a single body, as in the case of tea, coffee and rubber, research is the responsibility of state agricultural universities and the Central Plantation Crops Research Institute (under the Indian Council of Agricultural Research) in the case of cardamom, coconut, arecanut, cashewnut and pepper; extension system for the crops consists of

Directorate of Extension at the national level and Agriculture /Horticulture Departments at the state level. Similar is the organisation for rice and tapioca as well. Research is carried out in research stations under the ICAR and in the state agricultural universities. The extension system is under the Directorate of Extension and Department of Agriculture. Some of these commodities also have commodity boards with research and extension wings under them, which are either too young or too weak to have any impact. Overall, the only link between the research system and the extension system is the training programmes organised at the research institutes for the benefit of the personnel of the extension system.

In the case of livestock, organised attempts to improve the genetic quality of cattle in Kerala began on a scientific basis during the First Five Year Plan. During this period the Key Village Scheme was introduced, the main focus of which was the upgrading of the local cattle by setting up Artificial Insemination (AI) Centres. The major technology generating agency was set up in 1963, namely the Indo-Swiss Project (ISPK), the first bilateral project to be initiated in India for integrated dairy development. "Ever since it has operated as the major technology generating and input servicing agency..... The development of frozen semen technology by ISKP marked a breakthrough in the history of cattle breeding in the State" (Thara Nair, 1988,p.13) In order to reach the frozen semen to the cattle-holder the state has built up a large infrastructure network consisting of bull stations and bull mother farms, Regional Semen Banks and AI Centres. The frozen semen produced in bull stations is supplied to about 1400 AI Centres controlled by the Animal Husbandry, Dairy Development and Milk Marketing Federation through six Regional Semen Banks. The Semen Banks distribute frozen semen to all the AI Centres, supply liquid nitrogen, maintain the quality of frozen semen, and collect data from AIs for evaluation.

On the whole, there are two broad types of Research and Extension Organisations. In the first type, both the research and the extension system is under a single body having close interaction with the farmers. This is the type found in the case of tea, coffee, rubber (and partly cardamom in recent years). The second type is one where the research system works under the ICAR and SAUs and the extension system is under the Directorate of Extension and the Departments of Agriculture /Horticulture. In this type there is only a tenuous link between the research system and the extension system on the one hand and the research system and the farmers on the other. Livestock falls under a slightly different pattern in which a well-defined input is distributed through an elaborate organisation.

It may be observed that the crops which have an integrated research system are those which reported higher levels of potential realisation. Can it then be said that crops with integrated research system report better diffusion of technologies and those which do not have any integrated research system report poor diffusion of technologies? The cases of rice and livestock, which do not have integrated research systems, but are among the better performers, points to factors beyond such a simple association. The vitality of research appears to be the significant factor. It may be pertinent here to quote Birkhaeuser et al(1991) without however reading too much into the impact of extension:

> "Because much of extension is conditioned on bringing farmer's knowledge upto the level facilitated by advances in research, extension will not have a high pay off unless the research effort has been successful" (Birkhaeuser et al,1991:611).

Before proceeding to the discussion of the success of the research efforts, it is necessary to specify the agro-climatic zones in which the crops are grown, as also the landholding pattern, both of which have a bearing on the issue.

4. Agro-Climatic Zones, Cropping Systems and Landholding Pattern.

As elaborated in the Appendix, tea, coffee, cardamom and rubber (to a large extent) are grown in one or two agro-climatic zones' spread over contiguous areas. Tea ,coffee and cardamom are confined to the high ranges and rubber largely to the high lands. All these crops, with the exception of cardamom, were introduced into the state by British planters in the nineteenth and early twentieth centuries. Initially, they were grown on large estates. Planters' associations were established early on for the sake of information exchange and to protect their interests. Over time, the area expanded with a proliferation of large number of small holdings. As already indicated, in the post- independence period commodity boards have been set up to support the development of these crops. Consequently , for them closely knit Research and Extension Systems exist under the respective commodity boards.

The rest of the crops have a much longer history. Many of the important crops enter the consumption basket in various ways. They are grown wherever there are human settlements under widely varying agronomic conditions. Unlike the plantation crops, they do not have closely knit Research and Extension Systems.

Turning to the landholding pattern,tea, coffee, cardamom and rubber are mostly plantation crops and it is believed that absorption of technology is speedier because the size of holdings is larger. There are fewer numbers spread over contiguous areas and hence it is easier to canvas technology related to them. In the case of the rest of the crops the numbers involved are larger and they are spread over widely dispersed areas in divergent zones. Hence it is difficult to canvas the technologies developed in the formal research system.

From the data on landholding pattern (Table 9.10), it may be seen that large holdings continue to characterise only tea and cardamom, while other crops are found in small holdings. In trying to relate the landholding pattern with technology absorption, it is found that no clear association exists between the two (Table 9.11). Taking predominantly large holding crops, it is observed that there were both good performers (tea) and poor performers (cardamom). Similarly, taking crops with a fairly high index of realisation it may be seen that the group included crops dominated by small holders (coffee and rubber). Thus, size distribution in itself is not an important factor in the speed of technology absorption. This leaves Research & Extension systems and diversity of physical environments within which the crops are grown as the parameters for further investigation.

Now that diversity of physical environments under which crops are grown has emerged as an important factor it is necessary to have a proper perspective of the index of potential realisation.If a crop is grown in a homogeneous agronomic environment or that the technology referred to is 'widely adaptable', this simple index is meaningful. If a low value for the index is observed, indicating poor absorption, the blame can squarely be placed on the cultivators. It is an entirely different matter however, when it comes to crops grown under diverse agronomic environments- which may also mean that adaptation cannot be all that wide. In such a situation a low value for the index may indicate poor research and extension, in the sense of inability to generate technologies suitable for diverse environments, or poor absorption. On the methodological plane, this immediately questions the usefulness of the index. Under these conditions, an overall index of potential realisation is not meaningful. What is needed are indices of both potential and actual yields for specific agro-climatic environments. This places tea, coffee, cardamom and livestock (also rubber) in one group and the rest of the crops in another, because, either these crops are grown in tracts falling within a specific agro-climatic zone (tea, coffee, cardamom), or that such differences do not affect the activity to any significant extent (livestock). This is not the case with the rest of the crops. They are grown under highly diverse physical environments. The problem thus needs to be formulated differently and not through the index of potential realisation.

Table 9.10

Distribution of Area by Size of Holding

Size of Holdings (ha.)	Percentage of Total Area by Crop and by Size				
	Coconut (1970-71)	Rubber (1985-86)	Coffee (1987)	Tea (1987)	Cardamom (1980)
below 1	54.90				
1 - 2	21.90	58.79	63.48	-	21.20
2 - 4	15.40	9.13	12.42	-	16.20
4 - 20	7.80	-	9.96	-	32.30
20+	0	12.41*	14.14	10.10#	30.20
	-	19.66**	-	89.90	-

Source: Government of Kerala, <u>Statistics for Planning</u> (Various Issues).
* 4 to 40 hectares; ** above 40 hectares
\# below 50 hectares and the rest area above 50 hectares.

Table 9.11

Association Between Performance of Crops and Size of Holding

Size of Holdings	Index of Potential Realisation	
	High	Low
Predominantly Small	Coffee, Rice, Rubber, Livestock	Coconut, Arecanut Pepper, Cashew
Predominantly Large	Tea	Cardamom

If it could be shown that in a crop dominated by small holdings absorption is speedy whenever technology is desirable, then low absorption could be taken as an indicator of poor development of technology in the formal R & D system. However, for a conclusive argument, a discussion of the price environment prevailing for the different crops and activities needs to be carried out. This is proposed for the next section (Section 5) before proceeding to take up the varied experience with the absorption of technologies in Section 6. The crops and activities taken up in Section 6 are rubber, livestock, coconut, cardamom, tapioca and rice and hence the discussion in the next section is confined to them.

5. The Role of Price in the Adoption of Technology

Following the conclusions of Chapter 5, the importance of relative price movement in the adoption of technology need hardly be emphasized. There it was shown that the depressed price of rice together with the rapidly rising price of paddy straw since the mid-seventies had been instrumental in depressing the profitability of HYVs relative to that of the TVs (traditional varieties). Given the low yield differential between HYVs and TVs in many districts of the state, the movement of the ratio of price of straw to that of rice in favour of straw explained the 'disenchantment' with the HYVs. By and large it explained the lack of any significant yield growth of rice in the state in the eighties referred to in the previous section. The story of tapioca is also closely related to the movement of the price of rice. As seen in Chapter 6, fertiliser use in tapioca had responded to the movement of tapioca price relative to the price of fertiliser. The depressed price of rice by dampening the price of tapioca had adversely affected fertiliser use, affecting its yield. Thus, in the case of both rice and tapioca the favourable price situation had a significant role to play in the observed yield growth till the mid-seventies.

Turning to milk production, given that feed cost forms the major component in the cost of production of milk, a favourable movement of milk price relative to feed price would provide an incentive to the intensification of milk production. It has been shown that from the sixties the price movement had been in favour of milk. (George and Nair, 1990, p.29). Further, it is argued that it was under conditions of faster growth of milk price relative to that of feed concentrate that the cross-breeding technology was introduced in Kerala. Under these conditions, the technology was advantageous to the farmers:

> "This technology resulted in higher productivity of milch animals since their feed conversion efficiency is superior compared to the non-descript animals. Therefore, the higher cost of maintenance of crossbred animal is more than compensated by their higher level of milk yield. Also, the marginal revenue from feed will be higher than marginal cost, which will act as an incentive for the farmer to maintain a crossbred milch cow in the place of local milch cow" (George and Nair, Ibid. p.29)

The other necessary condition for the adoption of this technology was a well-developed outlet for the marketed surplus. The high levels of commercialisation of milk production in Kerala provided this condition.

As regards the price environment for the other three crops, namely coconut, rubber and cardamom, an earlier study on coconut may be quoted,

> "Over the last three decades or so, the price of coconut has been moving at a rate much higher than the prices of other major commodities produced in Kerala (of which the more important ones are paddy, tapioca and rubber). Compared to the prices of paddy and tapioca, both of which behave somewhat similarly, the price of coconut was declining till 1969-70. Since the early 1970s, there was a turn around and the price of coconut showed a mild increase till 1975 followed by a rather sharp increase since then .... Although relative to the price of rubber the price of coconut has been showing a mild increase all through the 1960s, the early seventies have turned the balance firmly in favour of coconut". (Narayana et al, 1991, p.49)

It is evident from the above that the price situation had been more favourable to coconut than rubber since the early seventies.

The movement of the price of cardamom is quite comparable to that of coconut. The ten-fold increase in the price of coconut over the 1954-86 period, is comparable to the increase in the price of cardamom which has also been roughly ten-fold (Nair et al, 1989, p.33). But the increase in the prices of both the commodities had been marked by fluctuations, owing to the phases of production in the case of cardamom and owing to the sporadic imports of coconut oil in the case of coconut.

On the whole, the price situation had been highly favourable to milk production, coconut and cardamom. For rice and tapioca, it had been favourable till the mid-seventies after which the trend had reversed.

6. Agricultural Research and Absorption of Technologies: Varied Experience.

To begin with the case of one of the small-holder dominated crops reporting high yield growth, namely rubber is taken up. The intensity of adoption of high yielding varieties by small holders (less than 20.23 hectares) and by estates (more than 20.23 hectares) is examined. The data are presented in Table 9.12.

Table 9.12

Use of HYVs by Small Holders & Estates in Rubber

Period	Percentage of Total Area New Planted/Replanted using HYVs	
	Estate	Holdings
55-56 to 60-61	100	50.05
60-61 to 65-66	100	83.11
65-66 to 70-71	100	91.69
70-71 to 75-76	100	100.00
75-76 to 80-81	100	100.00
80-81 to 85-86	100	100.00

Source: Government of India, Indian Rubber Statistics (Various Issues)

As is evident, in the late fifties the percentage was significantly lower for holdings but during the sixties this gap was bridged. From the seventies there was no difference at all between the small holders and estates in the use of HYVs. So, it cannot be said that small holders were slow to adopt technologies developed by formal R & D systems.

It could, however, be argued that rubber is a special case, in that its cropping is regulated by certain government rules which require the small holder to adopt plant materials certified by the Rubber Board, the administrative wing of the government. To argue the point, some other activity has to be taken up which is predominantly carried out by small holders but where such government regulation is absent. For this purpose, the case of livestock is significant.

One of the main factors making for the rapid increase in the yield of milch cattle in the state is the improvement of the genetic quality of cattle. Organised attempts in this direction were made during the Second Five Year Plan (1956-60). As mentioned earlier, the delivery of technology to the farm level was made possible by building up a large infrastructure network. The adoption of cross breeding technology at the farm level has been impressive going by the AIs carried out. It has increased from 5.11 lakhs in 1973-74 to 11.90 lakhs in 1985-86. Further, the extent to which AIs are being utilised is widespread. Given the variation in the density of the AI Centres across the districts of the state the distribution of crossbred cows by the type of service shows a state average of 88 per cent and a variation between 80 to 98 per cent. This is very high for any state.

The rapid adoption of AI has resulted in the rapid improvement of the genetic quality of cattle in the state as is indicated by the percentage of crossbred cattle to all cattle, or percentage of crossbred cows to adult female (Table 9.13).

This has led to the improvement in the breeding efficiency of the milch animal herd along with the rise in the yield of milk per animal in milk making for rapid increases in the yield.

Table 9.13
Cross-bred Cattle in the Total Cattle Population(in Percentages)

States	% of CB cattle to all cattle	% of CB cows to adult females
Andhra Pradesh	8.33	20.93
Bihar	17.02	31.71
Gujarat	23.42	55.81
Haryana	19.42	32.50
Himachal Pradesh	8.07	9.09
Jammu & Kashmir	12.55	20.00
Karnataka	8.50	16.67
Kerala	33.80	41.67
Madhya Pradesh	11.07	19.19
Maharashtra	10.05	18.52
Orissa	9.05	17.19
Punjab	25.19	36.59
Rajasthan	13.09	23.76
Tamilnadu	16.00	25.71
Uttar Pradesh	14.10	33.33
West Bengal	8.38	20.75
All India	12.79	24.07

Source: Thara S Nair, op.cit., Table 1.1
Note : The Table is based on NSS 37th round data.
The livestock census of 1982 reported a figure of 46.91 per cent for Kerala while it was below 20 per cent for all the other states.

As is evident, Kerala farmers are no laggards when it comes to the adoption of technology.The significance of such rapid adoption is to be understood in the face of a none- too- hospitable delivery system of the technology in the state. One of the recent studies reported that "there appeared to be little formal training and extension offered to farmers in most of the areas studied". The study continued on the status of extension and feedback:

> "The CDS study reports a high farmers' awareness of health treatment and vaccination requirements. However the veterinarian's potential as an agent of livestock development through disseminating information and monitoring milch stock, often remains unrealised. Also, extension material is conspicuously absent at the village level. A conscientious effort by institutions in obtaining field and farm level feedback has not been observed. Farm/Village-level views and needs are not adequately incorporated and represented in the planning and implementation of cattle development activities".
> (George et al, 1989: 40)

From this, it becomes evident that the delivery system or extension system is neither very efficient nor responsive. But yet when the technology is judged desirable and the price environment is favourable (see Section 5 above) these do not come in the way of its adoption. The high level of farmers' awareness owing to higher levels of education, wider media coverage and infrastructural development (see Section 1 above) seems to have led to the speedier adoption of technology.

Now, let us take two crops which have not performed well, namely coconut and cardamom. This set includes one crop with predominance of small holders and another with predominance of large holders. Coconut is an important commercial crop with various end-uses and hence research was initiated on some aspects of this crop a few decades ago. To quote from this author's earlier study, "In India, varietal improvement was tried way back in the 1920s. While other countries improved upon these early findings, systematic improvement of the planting stock was attempted in India only in the 1960s and 1970s. A variety of hybrids involving diverse parents have been produced and tested since then......" (Narayana et al,1991:81)

Scientists who have produced these new varieties claim that the "hybrids are much superior to the native West Coast Tall". But the limited information that is available points to increasing rejection of these varieties. Since the Department of Agriculture is the sole agency for the distribution of HYVs of coconut seedlings in the state, its activity should be a good indicator of the acceptance of the HYVs by the farmers. Table.9.14 tells this story. Referring to these figures a recent study concluded,

"........their (departments') figures would indicate that the programme has suffered a setback in recent times. The departments' reorientation to West Coast Tall, the local variety, appears to be in tune with the cultivators' preference. The performance of hybrid varieties in the field has not been very satisfactory.............................Even the disease resistance of these varieties is also in doubt. 20 to 40 percent of these palms in some of the experimental stations have been affected by disease. Thus, the impact of HYVs in coconut production appears to be minimal........" (Sivanandan, 1985)

The reason for such rejection is partly to be found in the methods adopted for evaluating the HYVs in the research stations. Referring to a typical evaluation an earlier study on coconut had the following to say,

"......Although the average for four years shows the superiority of all the hybrids except WCTxGB over West Coast Tall, addition of one more year similar to 1982 changes the rankings substantially. Also in particular years,- 1982 and 1984 - some of the hybrids do not perform any better than the WCT.

Hence, even though hybrids have been evolved, the parameters used in assessing their qualities and recommending them over WCT are not always clearly spelt out" (Narayana et al, ibid.p.62).

The weakness in evaluating the yield characteristics of tree crops before recommending them has found reflection in the increasing rejection of HYVs by farmers. Obviously, the HYVs have not been judged desirable by farmers.

Table 9.14

Number of Seedlings Distributed by the Department of Agriculture in Kerala

Year	Number of Seedlings distributed (in lakhs)					
	WCT	TxD	DxT	LO	Others	Total
1978-79	6.84	3.39	0.08	0.90	0.38	11.59
1979-80	7.68	4.35	0.14	1.84	0.01	14.26
1980-81	9.27	4.93	1.18	1.96	0.06	17.40
1981-82	24.42	4.31	0.15	1.93	0.04	30.85
1982-83	24.53	2.68	0.13	Nil	Nil	27.34
1983-84	18.26	1.49	0.04	0.23	Nil	20.03
1984-85	12.69	1.28	0.08	Nil	Nil	14.05

Source: Narayana et al op.cit. Table 5.11

The attitude of the farmers to the other technologies developed by the scientists is no different. The conclusions of this author's earlier study on coconut may be quoted,

"On the whole, farmers have been rejecting the technologies developed by the research stations. The propagation of hybrids has come to a standstill owing to improper methods of evaluation of the same. Disease control seems to have made no progress owing to weak research results. Fertiliser and other trials have not impressed the farmers as is reflected by the low levels of input use and the consequent decline in yields. The large scale rejection of new technologies evolved by the research stations clearly points to a certain lack of direction in the whole research effort ....." (Narayana et al,1991, 96-7)

The experience of coconut in Kerala clearly illustrates the farmers' ability to assess and compare the benefits and costs associated with each of the technologies developed by the research stations. Such an assessment greatly facilitated by the level of education and spread of communication, has only resulted in rejection of the technologies developed by the scientists.

Turning to the other crop which had shown poor performance, namely cardamom, the state of research had been summarised by a recent study. Regarding chemical fertiliser trials, the study concluded that "limited results on the fertiliser response of cardamom are available". (Nair, et al, 1989: 111). Regarding the control of one of the major diseases, namely Katte, scientists suggest "systematic roguing of the disease-affected plants and adopting phytosanitary measures" (Nair et al, ibid). But how discerning the cultivators are is evident from the following:

"But some cultivators are of the view that removing the Katte affected plants is not economical if the incidence is in the fourth or fifth year, for, in that case, one is wasting all the production that one would have gotten out of the plantation. So, what they suggest is the total removal and replanting after extracting the production for a few years. This way, one gets a new plantation free of Katte, whereas, in the earlier case, one continued with an old plantation all along"(Nair et al, ibid, 111)

This brings out in clear terms the need to take into account the economics specific to tree crops in advocating technologies. Obviously, the scientists had missed this point.

The state of research on selection and improvement of plant material was also at a low key. After over three decades of research, the state of research as of the mid-eighties was summarised in the following words,

> "The work carried out so far relates to the identification of the different types and breeding work is in progress. But the expected pace could not be maintained...... As to the current state of work, three selections have been made at Mudigere, namely P1, P2, P3, and their evaluation is in progress. Also a hybrid with high yield potential has been evolved and tested at this centre (i.e.at Mudigere)"(Nair et al, ibid: 111).

It is only in the late eighties that tissue culture seems to have led to a major breakthrough. Given this state of research, impact on productivity may not be very strong.

In the case of tapioca, the yield levels achieved by the cassava farmers do not seem to have been the result of their acceptance of HYVs. As late as 1981, in one of the evaluations of their 'Lab to Land' programme, the Central Tuber Crops Research Institute(CTCRI) had the following to say, regarding farmers who were not part of the programme,

> " With regard to non-programme farmers, non-availability of planting materials and lack of knowledge on the improved cassava cultivation were found to be the important limiting factors in the adoption of cassava hybrids".
> [CTCRI,Two Decades of Research, 1983,p.186]

The evaluation went on to add,

> "The technological constraints comprising yield and quality aspects were placed, third in order of magnitude by farmers. However, among them the taste of HYVs not on par with some local varieties' was considered to be the most important bottleneck in adopting these varieties".

The aspect of taste needs to be taken into account. In Kerala, "most of the small farmers reserved a large part of their produce for household consumption " (CTCRI, Two Decades of Research,1983,p.182) and even the portion marketed is mostly for consumption. This realisation came to the scientists only after two decades of research as is evidenced from their assessment of the attitude of farmers:

> "However, both (irrigated and unirrigated farmers) have expressed unfavourable attitude towards marketing, early harvesting and quality aspects. Hence, there arises an urgent need for evolving varieties of acceptable quality and calls for improving the cassava market system to benefit the cultivators".(CTCRI, Two Decades ofResearch,op.cit.: 183)

The unfavourable attitude towards marketing of cassava seems to be related to the aspect of cooking quality which has not been incorporated into the HYVs and that seems to be the major constraint in the absorption of technology by farmers.

The crop which showed a yield growth similar to tapioca was rice. A major component in explaining the yield performance of rice was the adoption pattern of HYVs. This may be brought out in the following way. Overall yield Y may be expressed as a weighted average of yield of HYV, y_h and yield ofthe traditional variety y_t. In symbols,

$Y = ay_h + (1-a)y_t$ where a is the proportion of area under HYV. The yield change between two time points, say Ø and 1, may then be decomposed into its various components as,

$$Y1 - Yo = (a_1 - a_\emptyset)(\alpha_1 - 1)y_t 1 + a_\emptyset(\alpha_1 - \alpha_\emptyset)y_t 1 + [a_\emptyset(\alpha_\emptyset - 1) + 1](y_t 1 - y_t \emptyset)$$

where $\alpha = y_h/y_t$

The first two terms are the effects of changes in adoption rate and yield differential (of HYV over TV) respectively. In the Kerala context, the two effects together explained 56 percent and 94 percent of the overall yield increase during 1961-62 to 1972-73 and 1972-73 to 1982-83 respectively. Whereas, in the first period, the yield differential effect dominated, in the second period, it was the adoption rate. In the third period, 1982-83 to 1988-89, the contribution of the two effects were negative and the yield differential which went up from 1.36 in 1972-73 to 1.43 in 1982-83 had come down to 1.25. Along with it, the adoption rate also showed a decline. Thus, the performance of rice was crucially related to the adoption of HYVs.

As shown in Chapter 5, the explanation of the low or declining adoption of HYVs was in terms of the adverse movement of the price of rice relative to that of paddy straw given the low yield differential. Wherever the yield differential was high or rising the price ratio did not seriously affect the adoption thereby undermining a high level of yield differential as being crucial for adoption. As was seen in Tables 9.6 to 9.8, the yield levels of HYVs were one of the lowest in Kerala. Thus, the low intensity of adoption of HYVs of rice in Kerala was clearly a reflection of the failure on the part of research.

The patterns emerging out of the analysis of six crops falling within three groups may be set out as follows. The first group showed that when technology was desirable adoption was speedy, irrespective of whether there was effective extension or not. It also brought out the fact that, size, namely small holdings in itself did not hamper adoption. The second group brought out the equally strong rejection of technologies when judged undesirable. The rejection pointed to the weakness of the research system to properly incorporate certain special characteristics of tree crops in the development of technologies. In the third group the case of tapioca brought out the need to incorporate specific qualities desired by cultivators in evolving varieties. For all the crops, the price environment was generally favourable. Only for the third group from the mid-seventies the price environment turned adverse. The adverse price environment could depress the adoption in the case of rice only because the yield differential of HYVs over traditional varieties was low.

7. Conclusion

The varying yield performances of crops in a state like Kerala with high rates of literacy and good communication facilities, where cultivation is carried out under diverse physical and societal environments needs to be explained. One possibility is to construct indices of potential realisation and then argue that poor performance was because of poor absorption of technologies by cultivators. The problem with such an approach is that it crucially turns around the assumption that the technologies developed by the research system are superior and widely adaptable. If the physical environment under which crops are grown vary widely and crops exhibit certain specific characteristics, it may not be realistic to make such an assumption. The other alternative is to argue that literate societies have the ability to assess and to adopt if judged desirable. In such a case varying performance could be owing to the failure of the research system to come up with technologies judged desirable by the cultivators.

It has been that adoption of technologies was not associated with large size of holdings or fairly responsive extension system.The most successful cases were characterised by smaller size of holdings (rubber) and a none-too-responsive extension organisation (livestock). In other cases, the homogeneous physical environment and the integrated research and extension system made for the speedier adoption (tea and coffee). But, all of it rested on the strength of research effort. Homogeneous physical environment in itself did not lead to adoption (cardamom). The problem was more complex in the case of other crops because these were grown under diverse physical environments. The research system has not succeeded in coming up with technologies judged desirable for the widely varying environments under which these crops are grown.

Notes

1. For a careful analysis of this aspect see Narayana and Nair, 1989; 162-165.

CHAPTER 10

SUMMARY AND CONCLUSIONS

The distribution of area by agro-climatic zones and the specificity of the crops grown has left its imprint on the data base of the Kerala economy. Chapter 2 attempted to provide a fairly detailed account of the reliability and comparability of the estimates of area under different crops, production and yield. It was seen that the data on area are not comparable over long periods owing to the changes effected in the sampling design. Further, for many crops falling under the inter/mixed cropping system the area estimates are derived from the estimates of plant population leaving little scope for any careful analysis of cropping pattern and intensity of cropping. With respect to the estimates of yield, it was found that crop-cutting experiments were suitable for field crops characterised by point output. But such experiments were not appropriate when the harvest was spread over a season or over the year. Thus, the yield estimates of many crops grown in Kerala are not reliable. Poor estimates of area under crops and unreliable estimates of yield have often given rise to official estimates of production which are at variance with the trade estimates.

The plantation crops, namely, tea, coffee, cardamom and rubber fall into a different category. As certain registration procedures for these crops do exist, the area and production data have been compiled by the commodity boards on the basis of returns filed by growers, dealers and auctioneers, as the case may be. These are reliable only to the extent the registration process is effective. It has been argued that for some of the crops these were not very effective.

The reliability and comparability of the data set clear limits to the analysis. These limits were clearly spelt out in the chapter. It was pointed out that for certain crops area estimates were reliable while for others it was the production estimates. The analysis in the later chapters took due note of the limits set by the data and the weakness of the results obtained had much to do with these "noise".

Having discussed the data base and clarified the limits within which the analysis could be carried out, Chapter 3 got into the analysis proper. The first question taken up was the factors shaping area shift away from food crops. More specifically, the relation between money wage rate and the price of rice was analysed. The estimation of the relationship showed that a deterministic time trend existed, which was modified by a coefficient during periods of price rise. The net result of such a relationship was a general upward thrust on money wage rate. But the increase in money wage rate did not fully compensate the price rise during periods when prices increased.

The implications of the relationship were far and wide. It set rice apart from the other cash crops in the sense that changes in the price of rice affected the profitability of all the crops through its effect on money wage rate, whereas changes in the price of other crops affected only their own profitability. An equally important implication was that price and yield changes were on par for all the crops other than rice; for rice they were not on par. Changes of equal magnitude in price or yield would have the same effect on the profitability of all other crops. In the case of rice, the effect of a rise in yield on profitability would be greater than the effect of a corresponding rise in price. In the latter case, part of the price increase would flow into the hands of the labourers as a wage increase and the increase in profits would be smaller to that extent.

The area shift away from rice and tapioca observed since the mid-seventies was then explained in terms of the changes in profitability, given the yield and price changes. The yields of rice and tapioca did not show much of an increase; and the price of rice was falling since the mid-seventies. Although by the early eighties the price of rice had begun to rise, the level of money wage rate too had risen sharply by then. This pushed down the profitability of rice and tapioca, whereas the rising prices of coconut and rubber was pushing up their profitability, resulting in massive area shift away from the food crops.

The analytical frame set out in this chapter, to bring out the changes in profitability opened up questions of changes in price and yield of crops. These were taken up in the subsequent chapters. The first crop taken up was rice and the movement of the farm price of rice considered first.(Chapter 4). The specific aspect which distinguished Kerala from the other states of the Indian Union was the chronic food deficit and universal coverage of the Public Distribution System (PDS). It was observed that the share of PDS rice in the total rice consumed in the state had shown a sharp increase in the mid-seventies. The PDS supply was entirely imported; the domestic procurement had by then become negligible. As the PDS covered all income classes, and as higher income classes were not discriminated against, either, in the quantity alloted or price charged, the larger offtake from the PDS meant lesser demand in the open market and consequently depressed prices. The data on farm prices showed that the Kerala farm price which was 70 to 90 per cent higher than the price in the neighbouring states till the mid-seventies, dropped sharply since then. By the late eighties it was only 30 to 55 per cent higher. The empirical estimation confirmed the significant role of PDS supply in depressing the price of rice.

The next issue taken up for analysis was the poor yield growth of rice, especially since the mid-seventies. Elsewhere in India, yield growth during this period had largely been achieved owing to the adoption of high-yielding varieties (HYVs). Hence, the movement of the intensity of adoption of HYVs in Kerala was focused on in Chapter 5. At the very outset, characterisation of the movement of the intensity of adoption at the state level and at the district level for all the three crop seasons, showed that the general tendency was one of decline from about the late seventies. An explanation for such a fall was offered in terms of the yield differential between HYV and TV (including NIVs[nationally improved varieties]) and the ratio of the price of paddy straw to that of paddy. The yield differential was fairly low and did not show much of an increase over the period in any district. The rapid increase in milk production in the state on a relatively lower food crop base generated increasing demand for paddy straw, pushing up its price. Consequently, the ratio of the price of paddy straw to that of paddy showed either a sharp increase throughout the period in some districts, or a sharp increase till the early eighties followed by relative stagnancy thereafter in other districts. The price ratio operating on the already low yield differentials affected the profitability of the HYVs adversely, leading to the observed declining tendency in the intensity of adoption.

With Chapter 6 the discussion moved on from rice to another crop of the food group, namely tapioca. Tapioca has been regarded as an inferior food item and a substitute for rice in periods of lower availability. If this were true, then, the larger availability of rice should have resulted in lower demand for tapioca and falling price since the mid-seventies. The falling price would have led to a fall in production. However, it was observed that the steep fall in production was not matched by such a steep fall in price. In fact, the price of tapioca relative to rice was rising. An explanation for the phenomena observed was provided in terms of supply side factors. The sharp rise in the price of rubber relative to that of tapioca and the suitability of the area under tapioca for the cultivation of rubber had set off a process of area shift away from tapioca. The sharp fall in the area under tapioca resulted in a similar fall in production. Although availability of rice had shown an increase in the late seventies, there had been no significant increase in availability or consumption since then. Consequently, the demand for tapioca was not falling but rising, leading to a rise in its price relative to the price of rice. But the increase in the price was not large enough to make tapioca cultivation more profitable than rubber and an area shift away from tapioca was seen.

Chapter 3 to 6 were devoted to the analysis of the crops in the food group. Chapter 7 and 8 unfolded the analysis of cash crops which in the Kerala context were also perennials. The two issues analysed were the 'violent' fluctuations in prices and the area response. An attempt was made to incorporate the two distinct characteristics of perennials, namely gestation lag and life of the tree, into the analysis. Beginning with a certain characterisation of the growth of demand, the impossibility of maintaining supply-demand equilibrium was shown. Logically, the situation had to be one of excess demand or excess supply.

Confining to the supply side and abstracting from the yield question initially, it was showed that the growth of area under the crop would occur in distinct phases. A phase of rapid growth or expansion would be followed by a period of relative stagnancy to be followed by another phase of rapid expansion. These phases of area expansion were then translated into phases of growth of production with a time lag. Following these phases of area expansion, introduction of yield improving technology such as high yielding variety of plant material, also resulted in phases of yield growth. The phases of yield growth in turn generated phases of replanting either at the end of the physical life or the economic life of trees. These phases of replanting either moderated or exacerbated the phases of production depending upon whether the phases of replanting coincided with the phases of area expansion or not. Overall, phases of production is a reality of perennial crops and the long price cycles are a direct resultant of the somewhat steady growth in demand on the one side and phases of growth of production on the other.

The analysis in Chapter 7 was carried out entirely on a logical plane, while Chapter 8 was at the level of empirical testing. As the data on demand were hard to come by for many crops empirical testing for them was not possible, the exception being natural rubber for which data on demand was available. The other crops analysed were arecanut and cardamom. In all the three cases the data used were of the all-India level mainly because the issue emphasised was the movement of prices and it is the overall demand and supply which governed price movements. The effort was largely confined to confirming the phases of area expansion, phases of growth of production and yield. In the case of natural rubber, all the three could be confirmed; and for arecanut and cardamom only phases of production could be confirmed. The periods considered also varied, governed largely by the availability of data.

The analytical frame set out in Chapter 3 had yield performance of crops as one of its key elements. But the question of yield performance was taken up only to a limited extent in Chapters 5 and 6. Chapter 5 took up the specific question of diffusion of HYVs of rice in Kerala and provided an explanation for the characteristic movement of the intensity of adoption. Chapter 6 analysed the yield response of tapioca to the price of fertiliser relative to that of tapioca. It was in Chapter 9 that the larger question of yield performance of crops in its entirety was taken up.

The Chapter began by setting out the yield performance of the various crops over a period of 30 years. It was observed that livestock and rubber reported exemplary yield growth; tea, rice, and tapioca reported moderate yield growth; and the rest of the crops did not report any yield growth at all. The better yield growth of rubber and tea, the higher index of potential realisation and the existence of integrated research and extension system seemed to validate the conventional argument that research laboratories possessed the needed technologies but their adoption depended on the enterprise of the farmer and adequate extension service. However, it was found that the most successful cases of technology adoption were not associated with either larger size of holding or responsive extension organisation. Rubber was characterised by smaller size of holdings and livestock by a none-too responsive extension organisation. This suggested that the alternative argument was more relevant, namely that, literate societies had the ability to assess and adopt technologies when judged desirable. The cases of coconut, tapioca and HYV rice confirmed the alternative argument.

To turn now to the larger insights provided by the present study's findings. At the very outset a wage-price relationship was established which was different from the conventional way of looking at the movement of money wage rate. In the conventional discussion money wage rate is taken as a given, influenced largely by demand-supply factors, and wage bargaining by unions. The present finding that money wage rate has a strong relationship with the movement of the price of rice not only set the price of rice apart from the other prices but also brought out certain intricate relationships. It showed that the price of rice entered the profitability of not only itself but of every other crop. For the other crops, price and yield changes had the same effect on profitability; but not for rice. For rice, changes in yield were entirely passed on as changes in profitability; but changes in price were passed on through the changes in money wage rates.

The primacy of the price of rice was well-understood. The need to hold the price of rice was significant not only to maintain the consumption levels of the labourers and poor but also to make other cash crops profitable. What was not so well-understood was the effect it would have on adoption of technology in the production of rice itself. When livestock farmers could get hold of a technology - cross-bred cattle - which was more efficient in converting feed and fodder into milk, and when the price of milk was moving in favour of livestock holders, the rising demand generated for the main dry fodder, namely paddy straw, pushed up its price. The lower straw content of HYVs relative to TVs, the relatively low yield differential of HYVs over TVs in the agro-climatic conditions specific to Kerala, together with the movement of the price of straw relative to that of paddy, worked against the adoption of HYVs. This is an important finding which clearly brings to light the intricate inter-connections among price and technology variables and the dangers inherent in influencing one variable by policy intervention while ignoring the inter-connections.

Policy intervention in the case of rice affected the price of tapioca as well. Together with poor technological support in terms of HYVs, the profitability of the crop became significantly lower than natural rubber, which had witnessed very high growth in yield and a sharp increase in its price since the mid seventies. The shift of area away from tapioca resulted in a steady decline in its production. Although the PDS supply had shown a sharp jump in the late seventies, thereafter no sharp increase was observed. This showed up in the per capita rice consumption not showing any perceptible increase in the eighties. The higher market dependence among the lower income classes must have obviously meant there was demand for tapioca. As the production declined owing to area shift, the price began to rise. It would be interesting to study the implications of this price rise for the consumption levels of the lower income classes.

An important implication of the finding about the phases of growth in the case of perennials is that it explains the so-called stagnancy of the state domestic product in agriculture since the mid-seventies.

In a situation of area shift away from seasonals and annuals to perennials the phases of growth of production came about only with a gestation lag. In the meanwhile, the production of both the seasonals and annuals which were losing area showed a declining tendency. The fall could be compensated if yield increases were large enough. Even then, overall output may not have showed much of an increase. This was the situation prevailing in Kerala since the mid-seventies and it was a repeat of the situation which prevailed during the fifties and early sixties. It was merely a structural specificity of an agriculture dominated by perennials. Nothing more need be read into it. In order to arrive at further conclusions from the reported average yield data, it is necessary to derive the yield series of the new planted / replanted / underplanted area, which is a detailed exercise on its own, given the scanty data base.

One point which came out rather sharply from the present analysis was that the direction pursued by public funded research in agriculture needed to take into account more fully the structural specificity of the crop and the economy, and agro-climatic zones within which it was grown. Whenever this was not done, despite the claims of the researchers, adoption of technology had been poor. This was evident in the case of both rice and tapioca. Instead of the dwarf and semi-dwarf HYVs which were introduced in Kerala, if research laboratories had come out with varieties which had straw content comparable to that of TVs, the story of adoption would probably have been different. Similarly, if tapioca varieties with better cooking qualities had been evolved the response of the cultivators would have been different. This was not a problem with rubber or livestock. The product was homogeneous and the research output of the laboratories was quickly adopted.

Turning now to the areas in which further work is indicated, the first issue is the wage-price relationship. What are the factors which explain such a strong relationship between the money wage rate and the open market price of rice? Is there any difference across the districts of the state? If so, what are the factors which make for these differences? Do demand and supply factors explain the difference, or has it anything to do with wage bargaining by unions ? What effect has the increasing PDS supply of rice had on this?

Closely related to the question of the movement of the price of rice is the question of private trade in rice in the state. It has played an important role in Kerala for over a century. But not much is known about it. The estimates of imports of rice on private trade account are crude. The states from which they are procured, the modes of transport used, the margins involved are all issues on which little is known.

While discussing the growth of yield of rice, it was indicated that the performance of Kerala was better than many other states throughout the 1950s and 1960s, but the era of the HYVs witnessed a serious setback. Leaving out the role of price in this, the relatively better performance of Kerala in the first period had a lot to do with the spread of the nationally improved varieties developed in the research stations within the state. How is it that the same research laboratories, some of which were in existence since the 1940s, could not come up with HYVs suitable for the state?

One of the main findings of the study is the poor performance of the formal R & D system. The question that immediately arises is why has the performance been so poor. There are no systematic studies which have taken up this question. Although in the case of allied agricultural activity of livestock there have been systematic studies, no other crop or agricultural activity has been subjected to such analyses. This is an important lacuna in our understanding and some of the questions raised in this study cannot be answered satisfactorily without taking up this aspect of the problem.

Appendix

Agro-climatic Zones, Cropping Pattern, and Export Orientation of Kerala's Agriculture

This appendix provides a descriptive account of the diversity of physical environment, the diversified cropping pattern and the export orientation of the agriculture of Kerala. The appendix is intended to provide a background for the discussion in the body of the thesis.The appendix is organised as follows. Section 1 outlines the agro-climatic zones of the state with their characteristics, the distribution of area by agro-climatic zones and by districts. Section 2 describes the cropping pattern in relation to the distribution of area by agro-climatic zones, the changes in the cropping pattern occurring over the last 35 years and the specificity of the changes in cropping pattern. Section 3 discusses the export orientation of the crops grown in the state. It discusses the share of Kerala in the all-India production, its share in Indian exports, and the share of exports in production within the state.Section 4 presents the conclusion.

1. Agro-climatic Zones

The state located in the south-west portion of India, is naturally well delineated. The Arabian Sea provides a long coast-line on the west and the Western Ghats with their array of pinnacles on the east protects the state from the dry winds of the eastern plateau. The mountainous lands behind the Western Ghats form the Highlands which range in elevation from 1000 to 2000 metres above sea level. They are highly suitable for plantation crops like tea,coffee and cardamom and to a limited extent, for rubber in the lower elevations. The Lowland is a strip of land running along the coast having near level topography and sandy to sandy loam soil. Rice is grown in the low-lying areas and coconut is grown in the raised lands called garden lands. The soil in this region is laterite or its variations. The crops grown in this region include rice, tapioca, banana, pepper, ginger, lemon grass, coconut, arecanut and rubber.

The physiographical features have influenced the rainfall and topography of the state, which in turn has led to the evolution of soil complexes and cropping patterns. The undulating terrain makes for a landscape of hills and valleys. The valleys have been terraced and levelled to grow rice. The choice of crops in these areas is limited to the water loving ones. The land above the valleys is well-drained but remains moist and is generally put under crops like banana, plantains, arecanut and coconut. In one word, the topography prefixes the cropping pattern and limits the scope for crop shift.

The diversified agriculture of the state has its physical basis in the diversity of physical environments. Some of the crops are grown only in particular physical environments whereas many crops are grown in highly diverse physical environments. It is necessary to provide an overview of the diversity of physical environments and crop specialisation.

In the discussion of crop specialisation the diversity of agronomic environments needs to be taken into account. The variables making for the divergence in agronomic environments in Kerala are altitude, rainfall, soil type and topography [Government of Kerala, 1974: pp.X-XI]. Taking the combination of these four parameters the state was delineated into thirteen fairly homogeneous agro-climatic zones [Government of Kerala, op.cit.]. These are shown in Table 1.

Altitude plays an important role in shaping the climate. Hot humid climate is experienced in the areas roughly up to 500 metres above mean sea level(MSL) and in areas above 1000 metres humid sub-tropical to temperate climate is found. The areas falling between 500- 1000 metres above MSL are largely covered by tropical forests. In humid, temperate conditions tea, coffee and cardamom are grown.

The state has rainfall over a fairly long period of the year. There are two distinct rainy seasons namely, the South-West monsoon (from June to August) and the North-East monsoon (September to November end). These two seasons make up about 90 per cent of the annual precipitation in the state. As one moves from south to north, the quantum of annual rainfall increases but the number of months over which it is spread decreases.Regularity, intensity and the early onset of the monsoon plays an important role in the cultivation of rice across the districts of the state. Where the monsoon sets in early the peak is seen in June, in the area roughly south of Trichur. For the rest of the state the peak is in July. Accordingly, the sowing of the first crop is delayed in the northern half of the state by three to four weeks.

Soil-types vary across the regions of the state. Sandy soil, alluvial soil, laterite soil and its variations, forest soil, peaty soil and black soil are the important soil groups found in the state. Sandy soils are found in the coastal strip; clay content is high in the valleys. The midland belt from south to north is dominated by laterite soils with the B-horizon or hard pan. Red loam is met with in some areas. Peaty soil is found in Kuttanad, in the regions along the Vembanad lake and the Kole lands of Trichur, Malappuram and Cannanore districts. But laterite soil and its variants are the predominant types of soil in the state. As the process of hard pan affects the plant growth, perennials like coconut, arecanut, rubber, pepper...etc. grown on the slopes and hill tops are generally poor in growth. Since the hard pan prevents percolation of water, the water table is at a lower depth in the summer months. In such a situation, cashewnut is found to be the naturally preferred crop as its root system can penetrate the hard pan.

Topography is an important factor which influences the soil conditions, the drainage capacity of the soil and moisture availability. The first model(I) describes the lay out in the lowlands. In these areas the land surface is level and is an admixture of low lying fields and level garden lands, usually one to two metres above the fields. Vast expanses of paddy fields are seen interspersed with garden lands in the proportion of 2:1 to 1:1.

Table 1

<u>Agro Climatic Zones of Kerala</u>

Zone	% of area	Altitude	Rainfall Pattern	Soil type	Topography Model
I Onattukara	1.6	low	I	Sandy loam	I
II Coastal Sandy	4.8	low	I	Sandy loam	I
III Southern Midland	10.0	low	I	Laterite with B-Horizon	III
IV Central Midland	8.2	low	I & II	Laterite	IIa
V Northern Midland	11.2	low	II	Laterite	IIb
VI Northern Midland (Malappuram)	13.1	low	II	Laterite	IIc
VII Highland	27.4	low	I	Laterite with B - Horizon	III
VIII Palghat	3.9	low	II	Red loam	II
IX Red loam	1.0	low	I	Red loam	III
X Chittoor Blacksoil	1.6	low	II	Black soil	IIa
XI Kuttanad	0.9	low	I	Peat (kari)	I
XII River Bank Alluvium*	-	-	I	Alluvium	I
XIII High Ranges	15.9	High	I & II	Red loam	III

Source : Government of Kerala, <u>Agro-climatic zones and Cropping Pattern, April-1974</u>, Trivandrum.

Altitude: Low- Sea level to 500 metres; High-Above 1000 metres.

Rainfall: <u>Pattern I</u> - Both South West and North East Monsoons active. Moderately distributed. SWM-June Maximum. <u>Pattern II</u> - Both ill distributed. SWM - July maximum.

Topography: Model I Extensive Valleys, level and raised garden lands
" IIa, Valleys less extensive, Hills moderate gradients, slopes mild gradients.
" IIb, Valleys less extensive, Hills moderate gradients, egg shaped hump, slopes steep.
" IIc, Valleys less extensive, Hills table tops, slopes steep.
" III Narrow valleys, Hills with steep gradients.

*(The Zone River Bank Alluvium is found scattered in several blocks all along the banks of the major rivers).

The second model(II) refers to the layout of the land in the midland region. The valleys are not as extensive as in the lowlands. The valleys are shaped, levelled and rice is grown in the two seasons, namely autumn and winter. The land lying immediately above the paddy fields up to three to four metres is well drained and moist for most parts of the year and plantains, arecanut and coconut are grown. Above this belt where the slopes are mild, the land is terraced, levelled and upland rice, sweet potato and tapioca are grown. On the hilltops cashewnut is grown. Due to the presence of hard pan other crops do not come up well there.

In the third model(III), the proportion of hills to valleys is much greater with narrow valleys occupying less than one - fifth of the land surface. The hills are taller and the slopes are steeper. As the slopes are steep and the rainfall is high, the hard pan is absent. The valleys are shaped and levelled to cultivate two crops of rice. On the slopes at lower elevation arecanut and in the upper belts, coconut and rubber are grown.

Another factor to be considered in the context of the second model is the combination of the shape of the hump of the hill and the gradient of the slope. The first variant(IIa) is characterised by slopes of mild gradient merging gradually into the hill top. The lower portions of the slopes are generally terraced while the upper portion is left unprotected. The second variant(IIb) is characterised by the egg- shaped hump and steep slopes. As the slopes are steep, terracing is difficult. The third variant(IIc) is characterised by steep slopes rising into a plateau which is either of a mild gradient or near table top conditions.

The narrow stretch of coastal land of the state is interspersed with lakes, lagoons, estuaries and marshes. They lie at sea level or 1 to 2.5 metres below MSL. These submersible areas of the backwater systems found in the districts of Alleppey and Kottayam are known as 'Kuttanad' and in the districts of Trichur and Malappuram as 'Kole'. Although Kole lands are broadly similar to Kuttanad, there are certain distinguishing features. The average level of Kole fields is slightly higher than that of Kuttanad fields. They are more like extensive trough formations interspersed by garden lands. Taking advantage of certain natural factors such as the recess in the rainfall during August-September and tidal action, an ingenious way of raising a rice crop in these lands has been developed. These areas together with the vast expanse of area in Palghat form the main paddy growing areas in Kerala. Together they are distributed over the agro-climatic zones, I, II, IV, and VIII to XII. Because of the very specificities indicated these areas cannot be shifted to the cultivation of crops other than rice.

Table 2

Distribution of Area by Agro-Climatic Zones Across Districts
(in Percentages)

Dists. Zones	TVM	Qln	Pta	Alp	Kty	Idi	Ekm	Tcr	Plgt	Mlpm	Kz	Wy	Can	Kas
I	-	12	-	24	-	-	-	-	-	-	-	-	-	-
II	-	-	-	34	6	-	19	13	-	9	-	-	-	-
III	45	66	45	24	32	-	-	-	-	-	-	-	-	-
IV	-	-	9	-	-	1	58	46	19	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-	-	59	-	100	-
VI	-	-	-	-	-	-	-	-	-	54	41	-	-	100
VII	37	22	39	-	62	25	23	41	18	37	-	-	-	-
VIII	-	-	-	-	-	-	-	-	40	-	-	-	-	-
IX	18	-	-	-	-	-	-	-	-	-	-	-	-	-
X	-	-	-	-	-	-	-	-	16	-	-	-	-	-
XI	-	-	7	18	-	-	-	-	-	-	-	-	-	-
XIII	-	-	-	-	-	74	-	-	7	-	-	100	-	-
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Same as in Table 1.

The distribution of area by agro-climatic zones across the state's districts is provided in Table 2. It may be seen that only three of the districts are coterminous each with an agro-climatic zone; in the rest of the districts area is distributed over numerous zones with their own specificities.

In sum, the small state of Kerala has climate ranging from humid tropical to humid temperate. The soil types also vary very widely, but laterite is the predominant type. And the state has vast areas below mean sea level which can only be cultivated by careful de-watering. The agro- climatic specificities have given rise to a highly diversified agriculture in the state with limited scope for crop shift. The crop shifts can only take place within the narrow boundaries of the agro-climatic zones.

2. Cropping Pattern:

The diversity of physical environments has led to the emergence of a highly diversified agriculture in the state. Taking the area under crops across districts (Table 3), it may be seen that some of the crops are grown only in particular districts which fall largely under specific agro-climatic zones. For instance, areas under tea and cardamom are largely concentrated in Idikki and that under coffee in Wynad. Similarly, the area under cashew is confined to Kasaragod, Cannanore and Malappuram. Although rubber and tapioca are grown in all the districts they are concentrated in the districts south of Trichur. Such crop specialisation by zones is not to be found in the case of other crops such as rice, coconut, tapioca and pepper; they are grown in almost all the districts and under diverse agro-climatic environments.

Now, the distribution of crop area by districts (Table 3) may be superimposed on the distribution of area by agro-climatic zones(Table 2). Reading the two tables together, it may be inferred that areas under tea, coffee, and cardamom are almost entirely confined to the two districts of Idikki and Wynad both of which fall under the agro-climatic zone called High Ranges. A similar pattern exists in the case of cashew, the area being confined to the three northern districts falling in the agro-climatic zone, northern midland. Although rubber is cultivated in all the districts its concentration is in the Highlands. Such sharp specialisation by agro-climatic zones is not to be found in the case of the other crops such as rice, coconut, arecanut and pepper. Still rice is the most important crop in the districts of Alleppey, Ernakulam, Trichur, Palghat and Malappuram wherein the bulk of the areas fall under agro-climatic zones I, II, IV, and VIII to XII.

Table 3

Percentage Distribution of Gross Cropped Area by Crops Across Districts,1989-90

Dists. Crops	Tvm	Qln	Pta	Alp	Kty	Idi	Ekm	Tcr	Plgt	Mlpm	Kz	Wy	Can	Kas
Rice	10	13	11	38	12	2	28	35	45	21	7	14	8	11
Tapioca	17	15	9	5	6	3	3	2	3	5	2	1	2	2
Coconut	41	34	23	36	20	8	26	36	11	35	55	3	33	31
Arecanut	1	1	1	1	1	1	2	3	1	4	3	1	4	8
Pepper	2	4	5	2	4	17	3	3	1	3	7	15	12	6
Cashew	2	3	2	3	1	ne	1	3	3	7	2	1	14	18
Rubber	9	15	31	2	43	17	23	4	6	7	7	3	9	11
TCC	ne	ne	ne	ne	ne	39	ne	ne	ne	ne	ne	47	ne	ne

Source: Government of Kerala(1991) Agricultural Statistics of Kerala,1989-90

Note : TCC : Tea, Coffee and Cardamom.

Table 4

Percentage of Gross Area under Major Seasonal Annual and Perennial Crops

Major Crops	1956-57	1960-61	1965-66	1970-71	1975-76	1980-81	1985-86
Rice	35.3	33.2	31.5	29.8	29.4	27.4	23.8
Pulses	2.0	1.9	1.7	1.3	1.3	1.2	1.0
Tapioca	10.3	10.3	9.0	10.0	11.0	8.5	7.6
Coconut	21.0	21.3	23.0	24.5	23.2	22.6	24.2
Arecanut	2.3	2.3	2.5	2.9	2.6	2.1	2.0
Pepper	4.2	4.3	3.9	4.0	3.6	3.7	3.7
Cashew	2.1	2.3	3.4	2.5	3.7	4.9	4.8
Rubber	3.8	5.2	5.9	6.1	6.9	8.2	11.3
Tea	1.8	1.6	1.6	1.3	1.3	1.3	1.2
Coffee	0.7	0.7	0.9	1.1	1.4	2.0	2.3
Cardamom	1.4	1.2	1.1	1.6	1.8	1.9	2.1
Other crops	15.2	15.7	15.6	13.9	13.8	15.8	16.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Government of Kerala, Statistics for Planning (Various Issues), Department of Economics and Statistics, Trivandrum.

Now, we may turn to the question of crop shift. It is evident from Table 4 that no crop accounted for a quarter of the gross cropped area and that rice and coconut are by far the dominant crops. It is also evident that significant changes in the cropping pattern have come about over the last three decades. The importance of rice and tapioca has come down, the fall being rather sharp beyond 1975-76. Coconut has gained but slowly. Rubber and cashew have had phenomenal gains over the period. The increase in the share of rubber has been very sharp since 1975-76.

How has the agro-climatic specificity of the land under crops affected crop shift?

A broad idea about this aspect may be had by comparing the area share of some of the important crops by regions between 1970 and 1985-86. As is evident from Table 5, the fall in the area under rice is relatively higher in Trivandrum and the districts north of Palghat. The main paddy growing central region from Quilon to Palghat reported much lower fall in area. The northern districts which reported fall in the area under rice also reported rise in the area under coconut and tapioca. The central districts which reported rise in the area share

Table 5
Area Share (%) of Crops Across Regions Between 1970 and 1985.

Dists.\Crops	Rice		Tapioca		Rubber		Coconut	
	1970	1985	1970	1985	1970	1985	1970	1985
Tvm.	5	4	24	24	4	5	11	11
Qln...Idi.	21	23	50	40	50	54	35	30
Ekm.Tcr.	24	26	8	8	20	14	17	17
Plgt.	21	23	3	6	2	4	4	4
Mlpm.	11	10	8	7	5	6	9	9
Kz....Kas.	19	17	6	12	20	19	26	32

Source: Government of Kerala, Statistics for Planning (various issues).
Note: For rice gross cropped area is used.

of rice showed sharp fall in the area share under tapioca and coconut. These districts have simultaneously improved their share in the total area under rubber.

Among the crops, rice calls for detailed analysis owing to the specificity of the area under it. Using the *taluk*-wise data available on area under rice, Kannan and Pushpangadan(1990) worked out the rates of fall of area under it over 1975-76 to 1985-86. Their computation showed that 27 *taluks* did not show statistically significant fall in area. Most of these *taluks* were located in the main paddy growing central region of the state. Almost all the *taluks* of Trivandrum district and the districts north of Palghat reported significant fall in area, the exceptions being those *taluks* characterised by the rice lands in the low-lying areas. Similarly, the *taluks* located in the central region and reporting sharp fall in area were mostly in the agro-climatic zones, Highland and High Ranges. There were a few *taluks* falling in the agro-climatic zones I and II which also reported statistically significant fall in the area under rice. Thus, the overall pattern is unmistakable: there is limited scope for area shift away from rice in the main paddy region situated in the low-lying areas of the state.

3. Export- Orientation of Crop Production

The economy of the state is an open one.The exports from Kerala as a percentage of the state domestic product(SDP) ranged between 14 to 20 over 1950-51 to 1986-87. Its imports as a percentage of the SDP increased from 7.5 in the early fifties to over 15 by the mid-eighties. The openness of the economy has a much to do with the nature of agriculture. Almost all the agricultural produce, except rice and tapioca, is exported from the state either in raw form or after various degrees of processing or manufacturing.

Of the output of the numerous crops grown in the state, only rice and tapioca are almost entirely consumed within the state. In fact, the state is chronically deficient in food grains and obtains the bulk of its requirements from outside the state. The share of internal production of rice which was over 50 per cent in the early seventies, has come down to less than 30 per cent. The availability of tapioca, which meets a major share of the total food requirement of the state, which (in rice equivalents)

Table 6

Production and Exports of Certain Important Crops

Crop	Production		Net Exports		Export Ratio %	
	1975-76	1980-81	1975-76	1980-81	1975-76	1980-81
Pepper (tonnes)	24580	28519	30810	44387	125	155
Cardamom "	2050	3244	1684	2441	82	75
Ginger "	28840	32039	8095	11233	28	35
Turmeric "	2608	6141	610	1521	23	25
Tea "	43264	50716	24545	21472	57	42
Coffee "	17528	23540	15298	13723	87	58
Cashew "	122360	81900	104891	58889	91	71
Betalnut(m.nuts)	11387	10805	8555	4644	75	43
Rubber (tonnes)	128769	140333	83310	128236	65	91
Coconut (m.nuts)	3439	3908	1216	1214	35	31

Note:Net Exports = Exports from the State - Import into the State
The reasons for the discrepancy between production and export in the case of pepper is gone into in chapter 2.
Source: Thomas Isaac and Ram Reddy (1992)

was slightly above that of the internal production of rice throughout the seventies and early eighties, has now fallen to a level below the internal production of rice.

All the other crops flow out of the state, the proportion of total production itself varying widely. As is evident from Table 6, the proportion of production exported from the state is below 50 per cent for only coconut,turmeric and ginger. It is very high for pepper, cardamom,coffee,cashew and rubber. It is below two-thirds of production for arecanut and tea.

It may be worth mentioning that Kerala accounted for 95 per cent of the pepper production and nearly the entire exports of the product from India. For cardamom,the proportions are 80 and nearly four-fifths respectively.Around 30 per cent of the ginger production is exported which accounted for 90 per cent of the exports from India. Kerala's share in the exports of turmeric, tea and coffee are comparatively lower.Compared to these minor crops, the major crops of Kerala ,namely rubber, coconut and arecanut,do not enter the foreign exports in any significant manner. They are confined to the larger national market.

4. Conclusion

Given the diversity of physical environment and the preference of crops for specific agro-climatic zones,shifts in the cropping pattern can only take place within narrow bounds. As rice, coconut, tapioca and pepper are grown in a number of agro-climatic zones area can shift from them to a number of crops within the group as well as outside.The restriction, however is that area shift away from rice is confined to fewer areas, is at great investment cost and irreversible. The shift is mostly to coconut with or without inter-crops. The inter-crops with coconut are tapioca, banana, pepper etc. From coconut and its inter-crops there can be shift to rubber. Such shift, however, cannot take place in the low lying areas. In the Highranges and Highlands, the shift is from rice and tapioca to coffee, cardamom and pepper and among the latter from one to another.

On the demand side,the demand for the output of crops originated from diverse sources and from diverse income groups.The bulk of the output of most of the crops produced in the state is exported.The exceptions are rice and tapioca. The production of both these crops are entirely consumed within the state. Consequently, prices are subject to diverse influences and there is limited scope for synchronous movement of any of the prices. The disparate movement of prices opens up the possibility of crop shifts in response to relative price movements, restricted only by the specificity of the agro-climatic zones. Such restrictions can be severe for water-loving crops like rice which are grown in low-lying areas.

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CHAPTER 4

PUBLIC DISTRIBUTION OF RICE IN KERALA AN ANALYSIS OF THE EFFECTS OF UNIVERSAL COVERAGE AND IMPORT DEPENDENCE ON DOMESTIC PRICES

1. Introduction

Large-scale public food distribution programmes in a number of developing countries are intended to ensure minimum levels of food supply at reasonable prices to low income people. Evidence that agricultural growth alone may not lead to adequate `trickle down' mechanisms being established, in order to reach the gains of growth to the poor and that they may inturn be constrained by lack of effective demand, has drawn increasing attention to the food distribution programs in South Asia. Of interest in this context are a whole range of questions. Which groups are reached. To what extent does food distributed through the system represent a net addition to consumption. What is the impact of these programs on food prices and production, transfers of income, and what is the sustainability of such programs in the context of the resource crunch faced by many of the governments.

The public food distribution program in Kerala, which has a long history, now covers nearly all the population in both urban and rural areas. The state is reputed for having one of the best Public Distribution Systems (PDS) in the country [George, 1979 and 1985; United Nations, 1975]. A recent round of National Sample Survey Organisation reports that nearly 95 per cent of persons purchase rice from the PDS in the rural areas of Kerala compared to the all-India percentage of 57. With practically the entire population purchasing edible oil, sugar and kerosene through PDS, the use of PDS in Kerala in respect of all essential commodities is also one of the highest among the states of India[NSSO, 1990]. The operation of the PDS thus supports the consumption of various essential commodities by different segments of the population both through providing the essential commodities at subsidised prices and exerting indirect control over the market prices of these commodities.

It is widely believed that the PDS has been able to increase the purchasing power of various segments of population, especially the poor [George, 1979 and 1985; United Nations, 1975]. Less well understood however is the equity aspect of the system. That is, out of each rupee spent on the PDS, what percentage goes to meet the food requirements of low income people is not known. Nevertheless it is on this factor that the cost-effectiveness of such programmes rests. This aspect becomes highly relevant when the quantity distributed tends to grow over the years, with the concomitant burden on government expenditure, as the experience of Egypt and Sri Lanka in particular has shown [World Bank, 19[illegible]; Tyagi, 1990].

The existing studies on public distribution discuss these issues on a general plane without explicitly incorporating the perspectives of a state like Kerala characterised by a cash crop dominated agriculture and a chronic food deficit. The difference is that in a highly food deficit state like Kerala where PDS is entirely supported by massive imports (from the other states or abroad) the price depressing effects of such imports become all the more dominating compared to the effective demand effect. These, then, have serious implications for production and productivity within the state. Significant price changes of a few food crops can alter relative prices within agriculture, and with or without yield changes can alter relative profitability, setting off massive changes in cropping pattern. The aim of this chapter is to clarify some dimensions of these inter-relationships.

The chapter is organised into five sections in all. Section 2 sets out the broad dimensions of PDS activity in Kerala. Section 3 discusses the beneficiaries of PDS and the effect of PDS on consumption levels. The implications of the PDS for the open market prices within the state are taken up in Section 4.

2. *Some Dimensions of Coverage, Public Distribution, and Procurement in Kerala*

Kerala has a long tradition of providing public services in the areas of health, education, and subsidised food distribution to most of its population. Nearly 100 per cent of the population is covered by subsidised food distribution, the exception being a small percentage of rice producers who are not entitled to draw rice from the PDS[1]. The commodities supplied through the PDS include rice, wheat, edible oil, sugar, kerosene...etc and the allotments are on a weekly basis for the distribution of rice and wheat and on a monthly basis for sugar, kerosene and edible oil. The allotments of foodgrains and sugar are made on a per capita basis and for other commodities on a per card(that is, per household) basis[2]. The number of ration cards, which entitle a household to subsidised supplies of essential commodities, has grown over the years and stood at 49.08 lakhs in 1989 [Table 4.1].

The distribution of foodgrains by the state of Kerala through PDS has shown a phenomenal increase over the last two decades. Off-take of rice and wheat through the PDS which was 12.07 lakh tonnes during 1965 steadily declined over the next five years to reach a level of 8.90 lakh tonnes during 1970-71 (George, 1979:28). From then on it showed a steady increase reaching 17.60 lakh tonnes in 1986 before declining to 14.82 lakh tonnes in 1989 (Table 4.2). Along with such an increase in off-take may also be observed the increasing preference

Table 4.1: Number of Ration Cards Issued in Kerala

Year	Number (lakhs)
1975	36.16
1976	38.73
1977	40.30
1978	40.37
1979	40.47
1980	40.60
1981	41.02
1982	41.09
1983	42.00
1984	42.98
1986	44.47
1987	47.31
1988	48.07
1989	49.08

Source: Government of Kerala, Economic Review (Various Issues).

for rice. The share of wheat in the total off-take which was over 10 per cent during 1965-76, except for 1969-72, declined steadily till 1982 before showing an upward trend in the next five years. The bulk of this preferred staple, namely rice, came from outside the state. The share of imports of rice both on state and private trade account which was below 30 per cent of total availability of foodgrains(including tapioca in rice equivalents) in the early seventies rose steadily after 1975 reaching a level over 40 per cent by the late eighties. Compared to an earlier period the role of imports on state account has become dominant in the post-1975 period.

Tapioca (cassava) had played an important role in the overall food basket of the state, but especially in that of the poorer segments of the population. The massive imports of rice into the state has led to a gradual decline of this crop. The share of tapioca — in rice equivalent terms -- in total foodgrain consumption which was over 40 per cent in the early seventies has shown a steady decline since 1975 reaching close to the 25 per cent mark by the late eighties.

To complete the picture of increasing dependence of the public distribution system on imports of rice it is necessary to indicate the status of procurement of rice within the state. Paddy procurement which was over a lakh tonnes in the

Table 4.2: Availability of Foodgrains in Kerala (Lakh tonnes)

Year	Internal Production	Rice Import on State Account	Import on Private Trade Account	Wheat Import on State Account	Tapioca Availability for Consumption	Total Availability
1969	11.26(31)	7.61(21)	2.00(6)	1.51(4)	13.91(38)	36.29
1970	11.19(28)	7.34(19)	4.00(10)	1.13(3)	15.91(40)	39.57
]971	11.80(29)	7.74(19)	4.50(11)	0.85(2)	15.74(39)	40.63
1972	12.38(27)	8.06(18)	5.00(11)	1.28(3)	18.51(41)	45.23
1973	12.65(31)	6.97(17)	0	2.47(6)	19.23(46)	41.32
1974	10.68(26)	7.44(18)	1.50(4)	2.40(6)	19.12(42)	41.14
1975	12.00(27)	5.12(11)	3.50(8)	5.18(12)	19.00(42)	44.80
1976	11.96(25)	9.02(20)	4.50(10)	2.55(6)	18.21(39)	46.24
1977	11.29(25)	15.03(32)	2.00(4)	0.92(2)	17.32(37)	46.56
1978	11.66(22)	16.20(31)	7.00(13)	0.73(1)	17.28(33)	52.87
1979	11.45(31)	5.32(14)	6.00(16)	0.83(2)	13.66(37)	37.26
1980	11.58(27)	7.72(19)	7.00(17)	1.09(3)	14.27(34)	41.66
1981	11.71(27)	8.83(20)	5.00(12)	0.94(2)	17.20(39)	43.68
1982	12.05(29)	11.70(28)	4.00(10)	1.13(3)	12.65(30)	41.55
1983	11.75(26)	12.97(29)	5.00(11)	2.48(5)	13.00(29)	45.20
1984	11.87(26)	13.36(29)	5.00(11)	2.05(4)	13.96(30)	46.24
1985	11.30(24)	14.60(32)	5.00(11)	2.08(5)	12.60(28)	45.58
1986	10.56(24)	16.03(36)	5.00(11)	1.57(4)	11.17(25)	44.33
1987	10.21	16.60	...	..	8.78	35.59*
1988	9.30	15.50	..	2.35	10.85	38.00*
1989	9.02	12.70	..	2.12	9.55	33.39*

Sources: 1. Government of Kerala, Economic Review (Various Issues)

2. For estimates of import of rice on private trade account see Thomas Isaac, T.M. and Reddy, Ram Manohar. 1992.

Notes: .. indicates figures not available.

Figures in parenthesis are percentages of the total. Tapioca is in rice equivalents after setting apart 25 percent of production for industrial and other uses. One tonne of rice = 2.2 tonnes of raw tapioca.

The Economic Review provides data on a calendar year basis as well and we have used the same here.

* Excluding imports on private trade account.

late sixties and early seventies accounting for about six to seven per cent of the local production has declined steadily since then and has become negligible by the late seventies (Table 4.3). Hence, procurement as a factor in the PDS of the state has simply dropped off. The dependence on imports is complete.

Table 4.3: Procurement of Paddy from Local Production, 1966-67 to 1983-84.

Year	Total Paddy Procurement (000 tonnes)	Procurement as a Percentage of Local Production
1966-67	93.1	5.7
1967-68	118.6	7.0
1968-69	138.0	7.3
1969-70	130.9	7.4
1970-71	114.5	5.9
1971-72	105.0	5.2
1972-73	78.1	3.8
1973-74	80.9	4.3
1974-75	60.3	3.0
1975-76	60.0	3.0
1976-77	35.0	2.1
1977-78	21.0	1.6
1978-79	2.5	0.1
1979-80	0.7	Neg.
1980-81	0.4	Neg.
1981-82	0.3	Neg.
1982-83	0.07	Neg.

Source: Department of Civil Supplies, A Handbook of Statistics (Various Issues).

3. Beneficieries of PDS and the Effect on Consumption Levels

Studies carried out in the seventies pointed to both low income and high income groups benefiting from the PDS in Kerala. As regards rice, a 1974 study showed that ration rice not only contributed more calories per person at the upper end of the population but its share in their total number of calories was also higher. (Table 4.4) (Kumar, 1979). As her sample households represented the bottom 50 to 60 per cent of the population, the upper end referred to the middle deciles of the population. Further, her analysis of consumption across sub-regions showed that, "subregions 2 and 3 have a higher incidence of the lowest income households and also tend to have lower overall consumption of rationed rice" (Kumar, op.cit., p.25)[1]. She was also able to show that ration purchases were subject to wide seasonal fluctuations corresponding largely to the swings of the rural, agriculture based economy" and "the smaller food budgets in March-April and July-September reflect lower agricultural employment and incomes at that time" [Kumar, op.cit., p.23]. Thus, Kumar's study showed that PDS was more beneficial to the population at the upper end of the income scale.

Table 4.4. Overall Dietary Measures by Income Groups

Calories by source (Daily Adult Equivalent)	Monthly Per Capita Total Income (Rs.)					
	Less than 15	15-24	25-34	35-49	50-74	75 or above
Total Calories	1086	1893	2102	2211	2290	1898
Ration Rice Calories	265	376	414	439	569	584
(% to total)	(24)	(20)	(20)	(20)	(25)	(31)
Open Market Rice Calories	155	240	336	538	270	386
Tapioca Calories	1015	898	819	817	729	213
Number of Households	5	7	14	6	6	2

Source: Kumar, 1979: Table 7.

Note: 1. Obviously, the figure 1086 for the total calories for the lowest income class is a mistake.

The study carried out by George (George, 1979) reported the per household purchases of rice from ration shops for a week in 1977 to be marginally higher for the lower income groups compared to the higher income groups [Table 4.5]. Given our understanding of the variation in household size across income classes as per the NSS data - larger size at the lower end and smaller at the upper end - it is possible that per capita purchases from the ration shops are lower for the lower income classes. But they are unlikely to be as low for the lower income classes as reported by Kumar.

The results of the NSS, 42nd Round data on purchases of rice from the ration shops show the validity of George's findings in 1977 for 1986-87 (Table 4.6). The per capita ration purchases show a slight bulge at the middle and dips at both the ends. It may be seen that the purchases by the top two decile groups are not only lower than the overall average but also lower than the quantity purchased by the bottom decile groups (decile groups throughout this chapter refer to the distribution of persons). In fact, the lowest purchases from the

Table 4.5. Household Consumption of Rice, Wheat and Tapioca by Income Group and Source, 1977

Annual Income Group (Rs)	Percentage of Households	Weekly Household Consumption in Kgs. Ration Rice	Own production	Open market purchase	Ration wheat	Tapioca in Rice Equivalents	Total Consumption
Upto 600	20	5.65	..	2.75	0.10	6.45	14.95
601- 1200	23	6.39	..	3.04	1.09	5.14	15.66
1201-2400	30	7.70	1.77	4.00	3.87	7.03	24.37
2401-3600	10	6.67	1.11	6.11	1.44	5.75	21.08
3601-4800	10	4.90	2.00	5.10	0.50	3.05	15.55
More than 4800	7	5.14	5.71	2.57	0.71	1.50	15.63
Total	100	6.35	1.24	3.73	1.89	6.00	19.21

Source: George, 1979, Tables 13 and 14.

Table 4.6. Per Capita Monthly Consumption of Rice by Decile Group and by Source, Kerala (Rural), 1986-87

Decile Group	Average Quantity of consumption (Kg)	Average Quantity of purchase from PDS (Kg)	
	(1)	(2)	(2)/(1)
1	6.938	4.503	65
2	8.273	4.849	59
3	8.660)	4.631	53
4	9.293)		53
5	9.759)	5.046	53
6	9.700)		
7	9.700	4.290	44
8	10.330	4.569	44
9	11.269	3.809	34
10	11.720	2.731	23
Overall	9.540	4.4105	46

Sources: Government of India, Department of Statistics, National Sample Survey Organisation, Sarvekshana, Vol.XIII, No.4, Issue No.43, April - June, 1990.
Sarvekshana, Vol.XII, No.4, Issue No.39, April-June, 1989.

Note: For the four decile groups at the top the percentages of total rice purchases to total rice consumption are taken from George'to arrive at quantity of purchase from PDS to total purchase which excludes the consumption from own production. These are 90,90,83 and 60 respectively for decile groups 7,8,9,10. This procedure had to be adopted because NSS gives only percentage of purchase from PDS to total purchase, which excludes the consumption from own production.

Table 4.7: Distribution of Persons by Source of Purchase of Rice, Kerala(Rural), 1986-87

Decile Group	Distribution of Persons by Source of Purchase (Percentages)		
	PDS only	Other than PDS only	PDS + others
1	17.91	4.11	77.98
2	11.75	4.18	84.07
3,4	6.52	8.12	85.36
5,6	6.49	6.84	86.67
7,8	11.03	12.81	76.11
9	9.54	14.02	76.43
10	11.58	22.84	65.58
Total	9.96	8.75	81.28

Source: Government of India, Department of Statistics, National Sample Survey Organisation, Sarvekshana Vol.13, No.4, Issue No.43, April-June, 1990.

A few interesting findings of the NSS 42nd Round with regard to the utilisation of PDS and the open market for purchases of rice are observed(Table 4.7). Although, for the lowest decile group the percentage of persons wholly dependent on PDS is the highest (17.91) it is fairly high for the highest decile group as well (11.58). It is lower for the decile groups 2 to 6 in comparison with the decile groups 7 to 10. The dependence on sources other than the PDS shows a steady increase from the first decile group. The dependence on PDS and other sources does not show any such systematic variation as in the other two cases. On the whole, across all the decile groups nearly four-fifths purchase rice both from the PDS and the open market. Total dependence on the open market is lowest for the bottom decile groups and highest for the top decile groups. Total dependence on PDS is seen across most decile groups but it was fairly high for the top decile group as well.

Although the three surveys were conducted at three different time points in not strictly comparable locations and with varying sample sizes certain results consistent with the macro data are found to be common to all[4]. Firstly, the increasing dependence on ration rice shown by the aggregate data (Table4.2) gets confirmed by the surveys (Table 4.8). It was roughly 18 percent in 1974 and 32 percent in 1977 and must be around 40 percent in 1986-87. Secondly, although the share of ration rice in total rice consumed is higher for the lower income classes and lower for the higher income classes, the absolute quantity of purchase is higher for the middle deciles. Hence, going by the absolute quantity of purchases from ration shops it cannot be said that PDS is more beneficial to lower income classes. Finally, as the dependence on tapioca is higher for the lower income classes (Kumar, 1974; CRG, 1973 quoted in George, 1988; George, 1988) the bulk of which did not originate in own production, the market dependence (defined as open market purchases of rice, wheat and tapioca as a percentage of total consumption) of lower income classes is significantly higher than that for the upper income classes.

Table 4.8. Share of Ration Rice in Total Consumption, in Rice Consumption and Market Dependence by Decile Groups

Decile Group	Share of Ration Rice in Total Consumption (%) of Rice, Wheat and Tapioca		Share of Ration Rice in Total Rice Consumption(%)		Market Dependence
	Kumar(74)	George(77)	George (77)	NSS, 42	George(77)
1,2	14	38	67	62	56
3,4	30	41	68	52	44
5,6,7	31	32	57	52	38
8	n.a	32	41	44	47
9	n.a	32	41	34	39
10	n.a.	32	38	23	16
Total	..	33	56	51	42
Macro Data	18	32	53	51	..

Sources: Tables 4.2,4.4,4.5 and 4.6 above.

Thus, the distribution of rice through the PDS shows the following pattern. In terms of quantity alloted or price charged the system does not discriminate against any particular income class. And in terms of purchases we do not observe higher purchases by the lower income classes. If at all, in per capita terms the purchases are marginally higher for the middle deciles. Naturally the question arises, how beneficial is the PDS to the poorer segments of the population.

There are two different answers to the question. In terms of open market dependence the poorer segments are at a disadvantage as their market dependence is higher than that for the upper income classes. The upper income classes could draw upon own production of both rice and tapioca. So, the PDS has brought down the market dependence of the higher income classes more than that of the lower income classes. In terms of additions to consumption, George[George, 1979 and George, 1985] estimated the levels that might prevail in the absence of PDS and compared the same with the actual consumption levels under PDS.The procedure adopted by George was the following.He took the expenditure pattern on rice in each income group corresponding to Table 4.5, and determined the quantities corresponding to two levels: the existing open market price level in Kerala and the hypothetical national free market price level. The hypothetical level was obtained by adding transportation cost to the open market price in Andhra Pradesh.In terms of additions to consumption, his estimates showed that at the lower end of the income scale it made a difference of between 14.3 to 18.1 percent to consumption whereas at the upper end the difference was insignificant [Table 4.9]. That is, in the absence of PDS, consumption of rice would have been lower by 14.3 to 18.1 percent for the lower income classes.To that extent the lower income classes benefit more.

Table 4.9: Estimated Consumption Levels of Rice in the Absence of Rationing, 1974-75

Income Group	Actual Weekly Consumption(Kg)	Estimated Weekly Consumption (Kg)	Percentage Decline from Actual Consumption (Rs.)
Upto 600	8.40	6.91	17.7
601 - 1200	9.43	7.72	18.1
1201- 2400	13.47	11.54	14.3
2401- 3600	13.89	13.26	4.3
3601- 4800	12.00	11.74	2.2
More than 4800	13.42	12.09	1.9

Source: George, 1979: p.37.

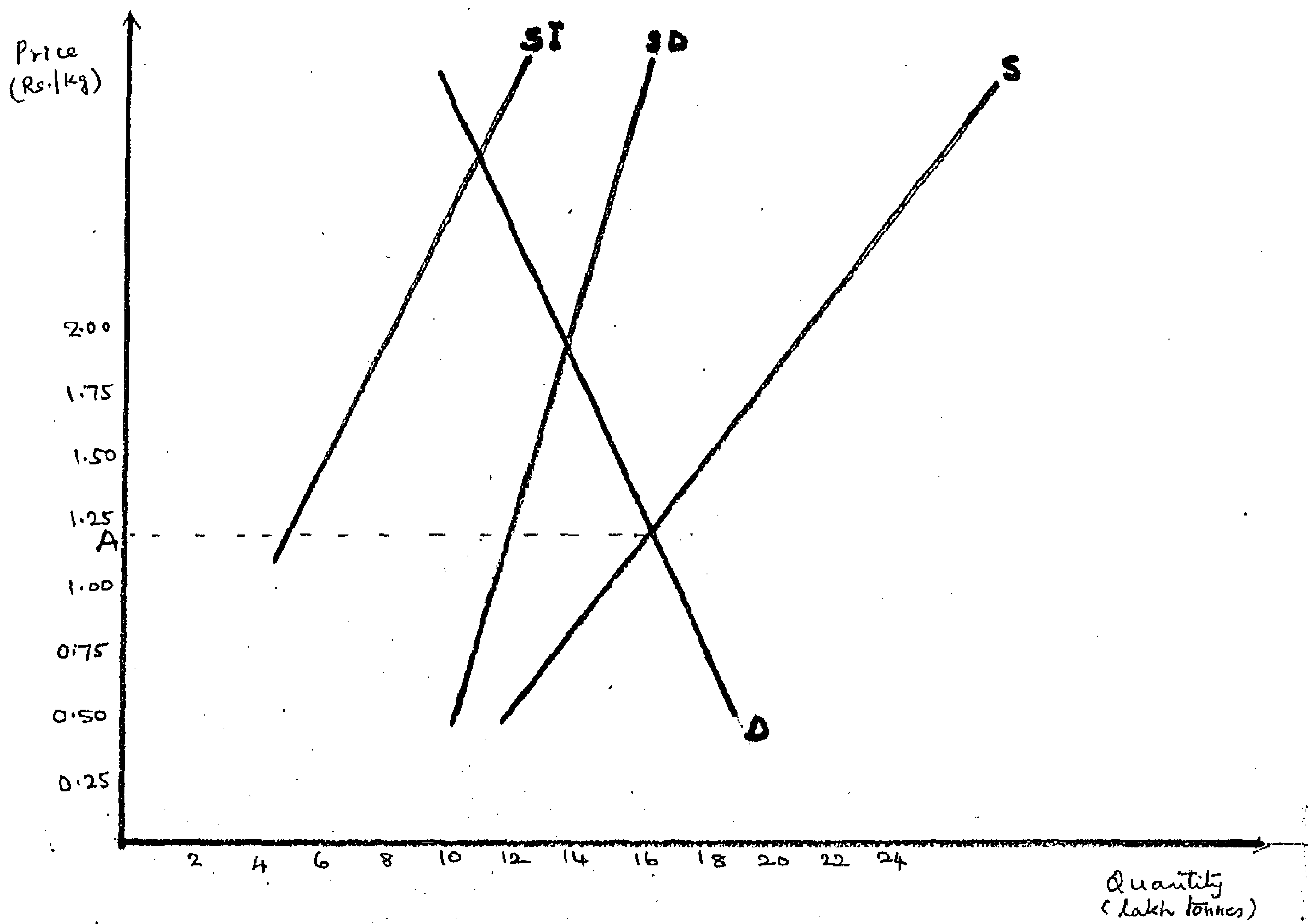
4. Impact of PDS and Import on Private Account on Price

The large-scale import of rice on state account (for distribution through PDS) and private trade account had a depressing effect on prices and production within the state of Kerala. The depressing effect is felt not only by rice but also by its substitute, viz., tapioca leading to a steep fall in its production (Table 4.2). But this is a question we do not go into here; it is taken up in Chapter 6. We confine our discussion to rice.

As the discussion of Section 2 has brought out, import of rice into the state has increased over the last two decades. Imports (on state and private trade accounts) which only kept pace with internal production till the mid seventies doubled in the next ten years. How did such massive imports affect the open market prices?

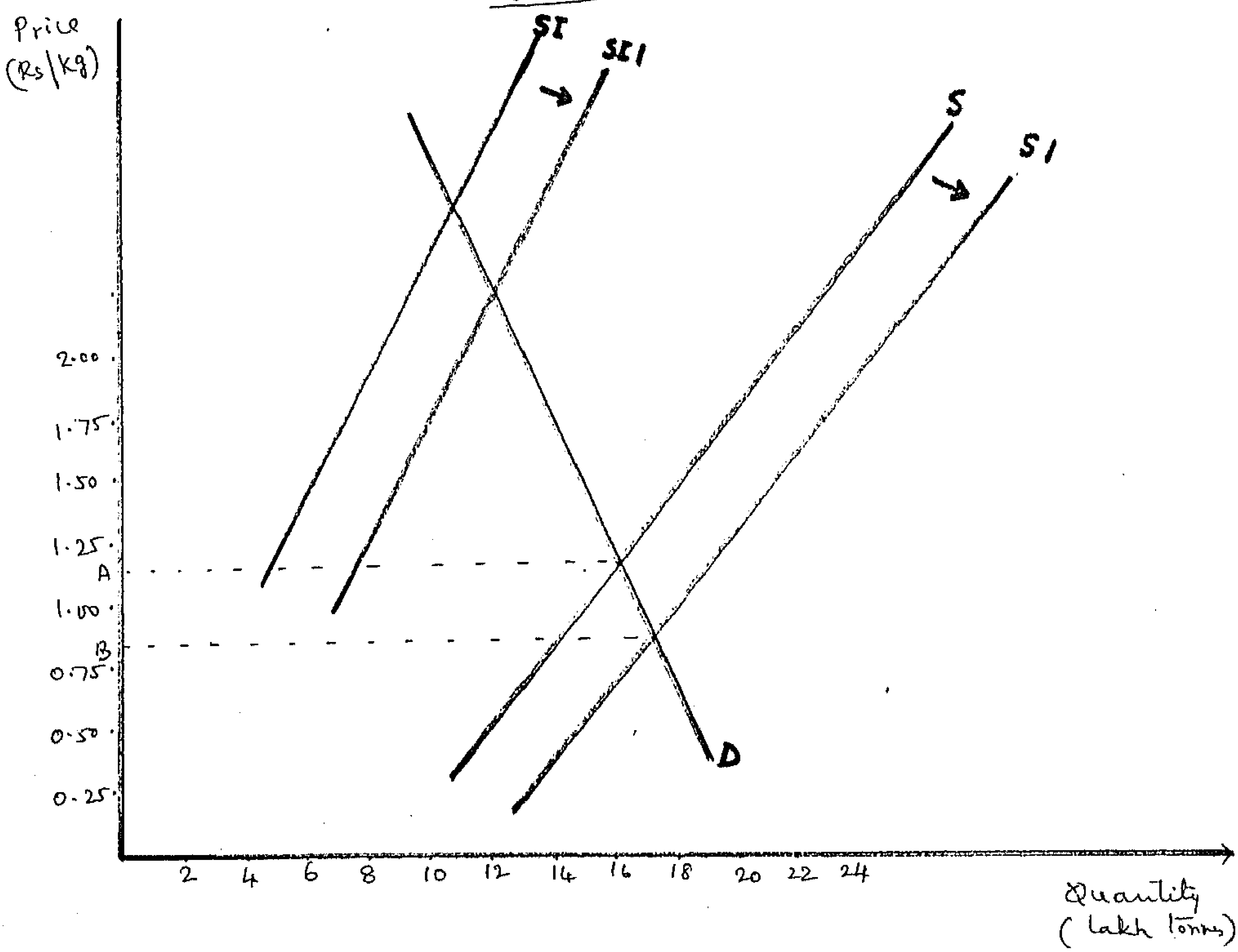
The question can be answered with the help of the following highly simplified diagrams. Let us first of all set out the pre-1975 situation. Imports on state account (PDS) had been around seven lakh tonnes and it tended to be lower in bad years (Table 4.2). With the numerous restrictions on movement of rice, import on private trade account was difficult to come by and had rarely crossed

Figure 4.1



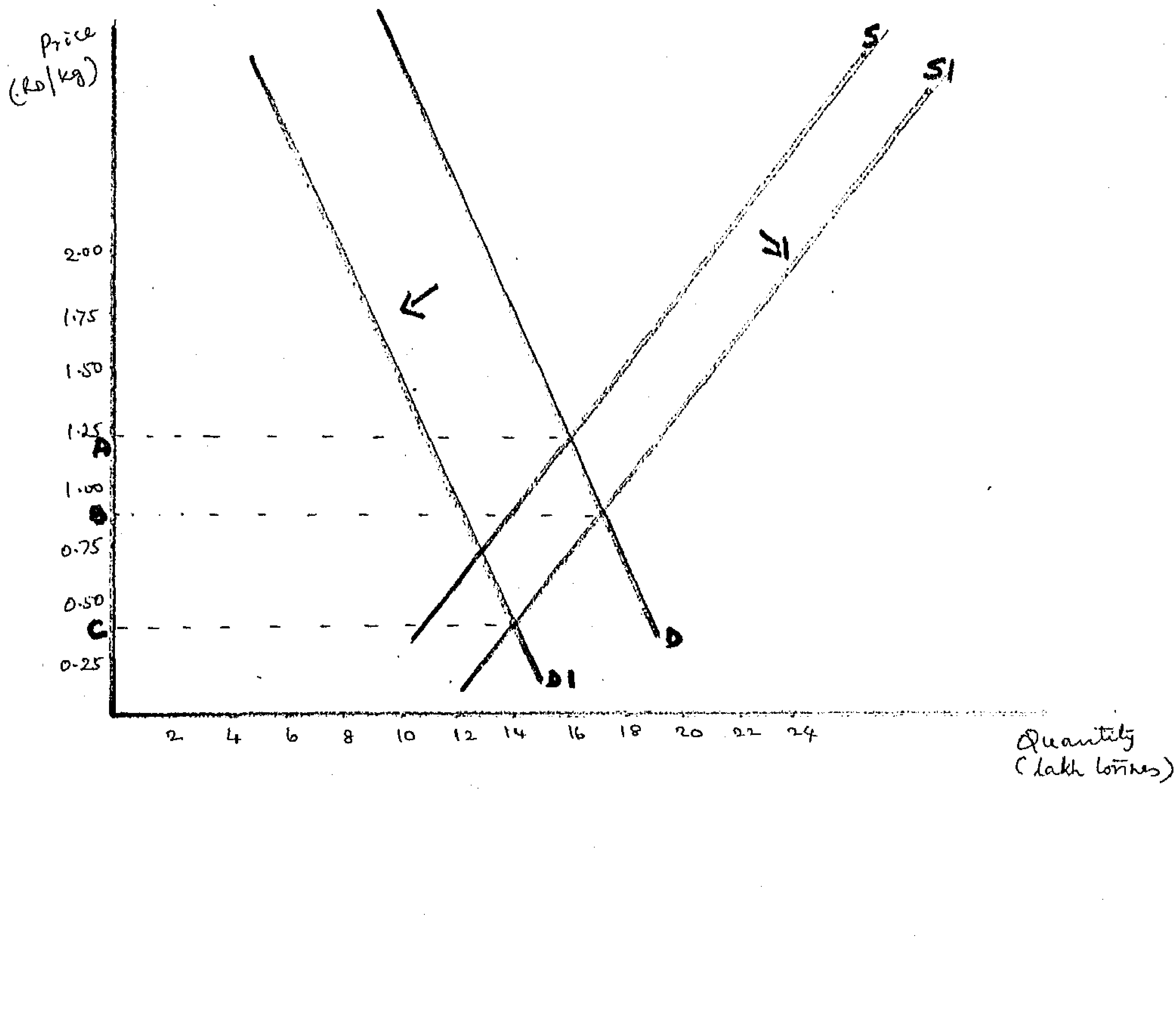
Price
(Rs./kg)
ST
SD
S
D
A
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
2
4
6
8
10
12
14
16
18
20
22
24
Quantity
(lakh tonnes)

Figure 4.2



Price
(Rs/Kg)
SI
SI1
S
S1
D
2.00
1.75
1.50
1.25
A
1.00
B
0.75
0.50
0.25
2
4
6
8
10
12
14
16
18
20
22
24
Quantity
(lakh tonns)

Figure 4.3



Price
(Rs/kg)
2.00
1.75
1.50
1.25
A
1.00
B
0.75
0.50
C
0.25
S
S1
D
D1
2
4
6
8
10
12
14
16
18
20
22
24
Quantity
(lakh tonnes)

the five lakh tonnes limit. Diagrammatically, this situation may be represented as shown in Figure 4.1. The price elasticity of demand is taken here as -0.4. Computations by George (George, 1979) had shown that elasticities varied between -0.8 and -1.0 for the rural and urban areas respectively. The diagram is calibrated taking the 1972 situation and the demand curve shown (D) is the open market demand excluding the PDS purchase. The supply consists of domestic production (SD) and imports on private trade account (SI).

In the post-1975 period, 1977 may be taken as a turning point for rice production at the all-India level as HYV adoption had shown a definite improvement, which had taken place for wheat earlier on. Production of rice had shown a significant increase and there was a fall in the open market price of rice outside the state. Since 1977, restrictions on the movement of levy free rice and paddy have been withdrawn. The technology-induced larger availability of rice on the private trade account at a lower price may be represented as a rightward shift of the supply curve SI to SI1 (shown in Figure 4.2) calibrated taking the 1978 situation. The shift corresponds to roughly three lakh tonnes. It is observed that the larger availability of rice through the private trade account depresses its price from A to B. This in itself need not get reflected as a significant fall in the Kerala price relative to outside price, assuming transport, storage etc, costs to have remained the same. Note that the price elasticity of demand is taken as -0.4 for drawing the demand curve. Instead, if one were to use George's figure of -0.8 for the elasticity then the fall in price corresponding to an import of three lakh tonnes of rice would be smaller.

In the post- 1975 period, PDS supply has also steadily gone up. As the PDS price or the ration price is significantly lower than the open market price of rice (see the data sheet for the figures), households across all income classes purchase rice from the PDS. There would be a corresponding leftward shift of the open market demand curve (shown in Figure 4.3 as D1). In other words, the open market demand curve would shift leftwards by the extent of the additional PDS the five lakh tonnes limit. Diagrammatically, this situation may be represented as shown in Figure 4.1. The price elasticity of demand is taken here as -0.4. Computations by George (George,1979) had shown that elasticities varied between -0.8 and -1.0 for the rural and urban areas respectively. The diagram is calibrated taking the 1972 situation and the demand curve shown (D) is the open market demand excluding the PDS purchase. The supply consists of domestic production (SD) and imports on private trade account (SI).

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Instead of importing such large quantities through the PDS, suppose the quantity was restricted to meet the needs of the bottom 60 per cent of the population. Then private trade would have become more active and the price fall would not have been so sharp because after the initial shift of the supply curve from S to S1 there would only be a movement along the supply curve S1. To illustrate, when the PDS supply is 12 lakh tonnes the open market price is C. Restricting the PDS supply by 5 lakh tonnes, or keeping it at the pre-1975 level and redistributing it among the bottom 60 per cent of the population - so that consumption is not affected to any significant extent- would raise the price from C to B.

What has happened in Kerala is that the PDS import had shown a sharp increase in 1977 and 1978, a fall in the succeding three years and a rise later. Beyond 1983, the PDS supply has increased at a rate above the rate of growth of population and stood at 18 lakh tonnes in 1992. Import on private trade account, on the other hand, has not shown any significant increase. The large scale import of rice on the PDS account has depressed the rice prices in Kerala. The extent of the fall may be gauged by the figures provided in Table 4.10.

Farm price of paddy (unhusked rice) in Kerala which was 60 to 90 percent higher than in Tamilnadu, Andhra Pradesh and Karnataka from the mid-sixties to the mid-seventies showed a significant change in the period after the mid-seventies. The relative price came down over the next fifteen year period after the mid-seventies.As is evident from Table 4.10, by 1982 the difference had come down to 32 to 42 per cent. Since then the differentials have been maintained. This has come about by the interaction of two opposite forces. While the PDS supply has steadily increased the area under rice within the state has steadily come down. While the former may be represented as a leftward shift of the open market demand curve the latter being an area shift may be represented as a leftward shift of the domestic supply curve.

Table 4.10. Relative Farm Price of Rice in Kerala (Percentage)

Years	Farm Price of Rice in Kerala Relative to Farm Prices in Karnataka	Tamilnadu	Andhra Pradesh
1966-67 to 1970-71	157.25	163.78	197.97
1971-72 to 1975-76	162.47	190.64	183.09
1976-77 to 1980-81	132.41	137.91	142.39
1981-82 to 1985-86	133.12	144.31	155.69
1986-87 to 1988-89	129.00	142.67	147.67

Source: Government of India, (Dte.of) Economics and Statistics, Farm Prices of Principal Crops in India (Various Issues)

The depressing price of paddy had played a significant role in the decline in production (-.9 percent per annum) that has taken place in kerala since 1975-76[5]. A sharp reduction in area under paddy (-2.1 percent per annum) and low increases in yield (1.2 per cent per annum), are held responsible for this decline. *But one of the major causative factors (other than the technological* one) was the depressed price. The connection of the depressed price of rice with the reduction in area under this crop has already been discussed in Chaper 3; its effect on the adoption of HYVs is taken up in the next Chapter. The main finding here is in agreement with Elminiawy's observation regarding the Egyptian rice economy that "the distribution of subsidised rice adversely affects rice production by depressing the free market price" [Elminiawy, 1989:67].

The chronic deficiency of rice in the state has obliged the state government to set apart a lion's share of it's resources for improved rice production. In this connection the findings of an earlier study are pertinent,

> "Agricultural development plans of the state had attached a high priority for improved rice production. During the Fifth Plan period, when there was explicit financial allocation according to individual crops, of the total state sector outlay of Rs.2335.7 lakhs for all crops, 1576.50 lakhs was alloted for rice. Ambitious production targets were specified for rice in each plan, but in every case the achievements lagged behind the targets.....in fact between the fifth and sixth plan periods there had been absolutely no increase in actual production" [George and Mukherjee, 1986:68]

This has come about because on the one hand the Central Government has been spending vast amounts to distribute rice through the PDS; on the other hand the state government has been spending vast amounts to boost rice production which has not materialised as expected. The key economic link between the two is the depressed price.

6. Conclusions

The dependence of Kerala state on PDS for its requirements of cereals and cereal substitutes has increased from about 25 per cent in the early seventies to over 35 per cent in the late eighties. Although PDS has universal coverage in Kerala and the share of ration rice in total rice consumption is fairly high for the lower income classes, it has in no way reduced their market dependence as tapioca, a cereal substitute consumed by them, is outside the domain of the PDS. Hence one of the main objectives of the PDS, namely protection of the poor against the vagaries of the market is met only to a limited extent; the PDS has helped all the classes and not necessarily the poor.

The impact of the massive State intervention through the PDS has depressed the price of rice and has seriously affected the agricultural employment and income within the Kerala. The declining production and prices have called for further governmental measures in the form of production support. In brief, given the structure of procurement and public distribution, the more that is spent on PDS the more would be the need for expenditure on alternate support measures. So, if the strategy to be pursued is to put more in the hands of the poor "through employment and faster growth in poorer and agriculturally stagnant areas" a major restructuring of the PDS is required.

NOTES

1. Such households are entitled to draw commodities other than rice like sugar, kerosene, palm oil....etc.

2. The per capita allotments do take into account the adults and children through a system of units. Adults are considered as two units whereas children are taken as one unit.

3. "Sub-regions 1 to 3 means moving progressively inland, with rapidly declining area under rice cultivation, fewer employment opportunities and poorer all round infrastructure (Kumar, op.cit).

4. Kumar's survey was confined to three sub-regions in Trivandrum district and George's sample size was only 100 whereas NSS covered the whole state.

5. In explanations of different hues [George and Mukherjee, 1986 and Kannan and Pushpangadan, 1990] price had an important role to play.

6. The growth rates are from Kannan and Pushpangadan, 1990.

Data Annexe

The Data

The data base of the Kerala economy has been gone into in some detail in Chapter 2. Here a few clarifications on the data used and the question of statistical methodology are sought to be provided..

In the computation of the ratio of the price of paddy to straw in Chapter 5, the price of paddy used is the state average farm price as the district-wise farm price of paddy are not available for the entire period considered. In Chapter 7, the rubber replanting model uses the total area new planted before 1938 as the total area under rubber as of 1937. In as much as this figure is set against a cumulative total of the area replanted between 1937 and 1957 to arrive at area due for replanting as of 1957, the lack of information on the distribution of area by age as of 1937 is not a major problem.

The Methodology

The statistical methodology used in the study is guided by the following considerations. Referring to the possibility of representing a trend by a polynomial in the time-variable, Yule and Kendall (1911) An Introduction to the Theory of Statistics, had the following to say,

> "This method of trend determination has some serious drawbacks when as in Table 26:1 the polynomial required to obtain a good fit is of high order. The arithmetic becomes troublesome; the higher order terms of the polynomial tend, ..., to "wag the tail" of the curve; and if at some stage we add further terms to the series (as frequently happens when new data arise by the passage of time) the work of fitting has to begin afresh".

A few illustrations of the drawbacks shall be provided later.

This study uses dummy variable regressions extensively. About dummy variables, one of the basic texts by Damodar N. Gujarati (1988) Basic Econometrics, has the following to say,

> ". . . . . dummy variables, makes the linear regression model an extremely flexible tool that is capable of handling many interesting problems encountered in empirical studies" (p.431).

Later referring to deseasonalization, he says there are several methods one of which is the method of dummy variables. He illustrated it as follows:

> "A look at these data reveals an interesting pattern. Both profits and sales are higher *in the second quarter* than in either the first quarter or the third quarter of each year. Perhaps the second quarter exhibits some seasonal effect ..... Note that we are assuming that the variable "season" has four classes, the four quarters of a year, thereby requiring the use of three dummy variables. Thus, if there is a seasonal pattern present in various quarters, the estimated differential intercepts, ... if statistically significant, will reflect it" (pp.452-3).

Regarding quarterly data, Robert Bacon (1988) A First Course in Econometric Theory, has the following to say,

> "With quarterly data, we might expect that, for example, the intercept would be different in every quarter. This could be modelled by a constant term normalised to (say) the first quarter and three dummy variables ..." (pp.140-1).

(emphasis in all the passages are ours).

Thus, testing structural change is only one of the uses of dummy variable regressions. There are other uses wherein one begins by "looking at the data", "assuming", "*might expect*" and then sets up models. This is the method followed here.

Illustrations

The first illustration here has reference in Chapter 6. The movement of the yield of tapioca over 1971-72 and 1989-90 is sought to be analysed. A cubic equation with time as the explanatory variable was run. It was seen that the coefficient of the cubic term was not significant. The estimated quadratic equation is shown below.

$$Y = 18.64 - 0.635\ TIME + 0.36\ TIME2$$

$$(-4.76^{*}) \qquad (5.034^{*})$$

[0.61, 0.57, 1.54, 12.74]

Y is the yield per hectare in tonnes. It is evident that yield had been falling from 1971-72 and the turning point was 1980-81. A careful scrutiny of the data - "looking at the data" - revealed that 1979-80 was the turning point. A dummy variable regression of the following type was tried.

Y = a + b DTIME + C DTIME1, where DTIME was defined as -8, -7 .... upto 1978-79 and zero beyond. DTIME1 was defined as zero upto 1979-80 and 1, 2, 3 ... beyond. The estimated equation is,

$$Y = 15.27 - 0.40 \text{ DTIME} + 0.31 \text{ DTIME1}$$

$$(-4.39^{*}) \qquad (4.44^{*})$$

$$[0.60,\ 0.56,\ 1.60,\ 12.23]$$

Going by adj. R^2, DW or F, there is hardly any difference between the two regressions. But the advantage with the dummy variable regression is the ease of interpretation. The intercept corresponds to the lowest level of yield reached in 1979-80; the coefficient of DTIME is the rate at which yield has been falling between 1971-72 and 1979-80; and the coefficient of DTIME1 is the rate at which yield has been rising beyond 1979-80. How the dummy variable regression helps further analysis is discussed in Chapter 6.

This second illustration has reference in Chapter 8. The problem is to characterise the movement of rubber production over 1948 to 1974. Polynomials of various degrees in time are fitted to the logarithm of production. Adj. R^2 are uniformly high (above 0.94) and DW are uniformly low (below 0.5) (hence not shown)

$$\text{LPROD} = 9.43 + 0.085^{*} \text{ TIME};\ F = 438.26$$

$$\text{LPROD} = 9.70 + 0.0209^{*} \text{ TIME} + 0.0025^{*} \text{ TIME2};\ F = 762.24$$

$$\text{LPROD} = 9.73 + 0.009 \text{ TIME} + 0.003^{***}\text{TIME2}$$
$$- 2.97 \times 10^{-5} \text{ TIME 3};\ F = 495.35$$

$$\text{LPORD} = 9.59 + 0.132^{*} \text{ TIME} - 0.0185^{*} \text{ TIME2}$$
$$+ 0.0013^{*}\text{TIME3} - 2.58 \times 10^{-5*}\text{TIME4};\ F = 848.31$$

$$\text{LPORD} = 9.60 + 0.124^{**}\text{TIME} - 0.016 \text{ TIME2} + 0.001 \text{ TIME3}$$
$$- 1.616 \times 10^{-5} \text{ TIME4} - 1.48 \times 10^{-7} \text{ TIME5};$$
$$F = 649.11$$

$$LPROD = 9.66 - 0.039TIME + 0.053^{*} TIME2 - 0.01^{*}TIME3$$

$$+ 0.0008^{*} TIME4 - 2.81 \times 10^{-5*}TIME5$$

$$+ 3.59 \times 10^{-7*} TIME6; F = 1064.29.$$

The above is a clear case of the higher order terms "wagging the tail" of the curve. The way the coefficients behave one does not get a stopping rule. What is to be done?

A dummy variable regression (elaborated in Chapter 8) was run after "looking at the data" and taking 1962 as the year for dividing the whole period into sub-periods. The estimated equation was,

$$LPROD = 9.673 + 0.047^{*}DUM1 + 0.062^{*}DUM2; F == 1850.04.$$

Going by any of the criteria of goodness of fit, the dummy variable regression is better than a polynomial of any degree in the above case.

The specificity of the problem taken up for discussion in the study called for the application some unconventional statistical methods. That is the justification for using the "extremely flexible tool" of dummy variable regressions.

Area Under Crops in Kerala (000 hectares)

Year	Rice (Total Cropped)	Coconut	Pepper	Areca	Tapioca
1957-58	767	463	91	50	214
1958-59	768	476	91	50	224
1959-60	769	493	92	53	225
1960-61	779	501	100	54	242
1961-62	753	505	100	57	237
1962-63	803	539	99	55	222
1963-64	805	545	99	57	210
1964-65	801	559	100	60	209
1965-66	802	586	100	64	230
1966-67	799	610	100	71	225
1967-68	810	639	100	76	218
1968-69	874	686	100	81	297
1969-70	874	708	118	84	296
1970-71	875	719	118	86	294
1971-72	875	730	118	87	303
1972-73	874	745	118	87	305
1973-74	874	745	118	91	306
1974-75	881	748	118	93	318
1975-76	876	693	108	77	327
1976-77	854	695	109	68	323
1977-78	840	673	101	62	290
1978-79	799	661	107	62	273
1079-80	793	663	106	61	244
1980-81	802	651	108	61	245
1981-82	806	667	108	61	248
1982-83	778	674	107	61	228
1983-84	740	682	106	60	233
1984-85	730	687	106	57	217
1985-86	678	687	106	57	203
1986-87	664	706	129	58	193
1987-88	604	776	146	61	173
1988-89	578	867	165	63	169

Source: Government of Kerala, Statistics for Planning (Various Issues

Production of Crops

Year	Rice (Kerala) (Lakh tonnes)	Tapioca (Kerala) (Lakh tonnes)	Arecanut (All India) (tonnes)	Cardamom (All India) (tonnes)
1960-61	10.68	-	-	-
1961-62	10.04	-	-	-
1962-63	10.93	-	-	-
1963-64	11.28	25.24	-	-
1964-65	11.21	27.63	-	2200
1965-66	9.98	30.96	-	2000
1966-67	10.84	34.1	130	2700
1967-68	11.24	41.98	135	2400
1968-69	12.31	40.81	140	2100
1969-70	12.51	46.66	140	2300
1970-71	12.98	46.17	141	3170
1971-72	13.52	54.29	147	3785
1972-73	13.76	56.92	148	2670
1973-74	12.57	56.59	167	2780
1974-75	13.34	56.25	165	2900
1975-76	13.29	53.9	160	3000
1976-77	12.54	52.24	165	2400
1977-78	12.95	41.89	175	3900
1978-79	12.72	40.44	181	4000
1979-80	13	40.89	190	4500
1980-81	12.72	40.61	196	4400
1981-82	13.39	37.45	194	4100
1982-83	13.06	38.49	202	2900
1983-84	12.08	39.03	190	1600
1984-85	12.56	36.94	219	3900
1985-86	11.73	32.77	216	4700
1986-87	11.34	32.92	219	3800
1987-88	10.33	32.36	-	2875
1988-89	10.13	31.65	-	-
1989-90	11.41	30.54	-	-

Source: Government of Kerala, Statistics for Planning (Various iss
Government of India, Cardamom Statistics (Various issues)
Government of India, Bulletin on Commercial Crop Statisti
(Various issues).

Note: Production of Cardamom are reported for the Calendar year

Wage and Price

Year	Money Wage Rate of Paddy Field Labour (Male)(Rs.)	Retail Price of Rice (Rs/kg)	Farm Price of of Paddy (Rs/kg)	Farm Price of Tapioca (Rs/kg)	Whole sale Price Index all Commodities (1952-53=100)	PDS Issue Price of Rice (Rs/Kg)	Fertiliser Price (Nitrogenous) (Rs./kg)
1960-61	1.7	0.6	0.41	0.09	124	-	-
1961-62	1.96	0.44	0.44	0.08	126	-	-
1962-63	2.34	0.45	0.41	0.1	129	-	-
1963-64	2.47	0.67	0.44	0.1	134	-	-
1964-65	2.64	0.91	0.68	0.09	150	-	-
1965-66	3.02	1.33	0.85	0.18	163	-	-
1966-67	3.43	1.61	1.02	0.17	174	-	-
1967-68	4.07	2.18	1.36	0.18	198	-	-
1968-69	4.62	1.98	1.08	0.23	209	-	
1969-70	4.85	1.66	1.02	0.19	209	1.5	-
1970-71	4.95	1.55	0.8	0.21	245	1.5	-
1971-72	5.23	1.52	1	0.21	222	1.5	2.01
1972-73	5.64	1.77	1.19	0.25	218	1.5	2.06
1973-74	6.13	2.4	1.87	0.35	285	1.6	2.2
1974-75	7.43	3.51	2.38	0.37	373	1.72	4.35
1975-76	8.43	3.78	1.82	0.4	350	1.72	3.91
1976-77	8.45	2.69	1.42	0.36	371	1.72	3.59
1977-78	8.58	2.38	1.3	0.29	410	1.72	3.46
1978-79	8.81	2.19	1.26	0.32	435	1.72	3.28
1979-80	9.2	2.25	1.33	0.4	430	1.72	3.15
1980-81	10.24	2.4	1.52	0.42	497	1.92/2.02	4.35
1981-82	12.06	3.24	1.79	0.49	513	2.02	5.11
1982-83	13.1	3.24	2.08	0.62	507	2.15	5.11
1983-84	13.95	4.14	2.52	0.7	656	2.15	4.67
1984-85	20.18	3.84	2.01	0.57	918	2.35	4.67
1985-86	24.86	3.9	2.37	0.71	722	2.24/2.58	5.11
1986-87	27.35	4.13	2.4	0.95	800	2.58	5.11
1987-88	29.34	4.43	2.49	1.05	933	2.58	5.11
1988-89	31.28	4.98	2.77	0.97	963	2.58	5.11
1989-90	32.38	5.39	3.03	1.18	904	2.58	5.11

Source: Government of Kerala, Economic Review (Various Issues).

Note: Retail price of rice is for the ordinary medium variety.
PDS issue price is for the super fine variety. Wholesale Price Index is Calendar year-wise.

State Average Farm Harvest Price of Paddy (Rs / Quintal)

Year	Kerala	Karnataka	Tamil Nadu	Andhra Pradesh
1966-67	101.03	69.11	45	48.03
1967-68	134.83	74.15	45	55.88
1968-69	107.56	74.09	45	58.58
1969-70	100.31	59.16	57.49	51.49
1970-71	90.25	62.91	58.82	56.48
1971-72	99.48	71.08	61.68	66.94
1972-73	119.36	77.76	61.82	82.05
1973-74	187.5	119.44	82	86.42
1974-75	246.23	130.43	128.52	110.61
1975-76	182.98	106.07	98.53	86.21
1976-77	142.74	105.56	93.27	92.62
1977-78	130.69	97.35	89.51	90.04
1978-79	125.76	94.81	93.24	84.79
1979-80	133.24	100.92	111.72	97.29
1980-81	152.06	120.49	133.56	113.8
1981-82	178.78	137.33	141.9	125.01
1982-83	208.16	138.91	145.74	135.98
1983-84	251.62	176.62	157.61	148.76
1984-85	200.76	162.32	159.41	138.36
1985-86	237.25	193.42	166.82	152.4
1986-87	238.42	179.56	169.03	160.71
1987-88	261.22	198.79	186.99	175.1
1988-89	289.7	235.72	197.71	197.77

Source: Government of India (Directorate of Economics and Statistics) Farm Harvest Prices of Principal Crops in India (Various Issues).

Annual Average Price of Paddy Straw (Rs./10kg)

Year	Trivandru	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode
1973	1.82	1.9	2.37	1.87	2.14	3.23	2.67	4.39
1974	2	2.22	2.44	2.6	3	3.83	2.48	3.41
1975	3.9	3.78	3	3.42	3	3.88	2.59	4.11
1976	3.6	4	3.6	3.2	3.8	4	3	4.2
1977	4.1	4.1	3.8	3.6	3	4.3	3.1	4.6
1978	4	4	3.4	3.8	3.2	4.9	4.4	4.2
1979	3.1	4.7	3.5	4.1	8.1	5.7	4.4	5
1980	3.3	7.3	4	4.8	6.3	5.5	5	6.4
1981	6.5	8.2	5.8	7.1	10.6	4.9	5.6	6.6
1982	11.5	9.6	6.4	7.6	8.6	8	5.8	6.7
1983	14.9	10.6	6	7.3	9.5	7.2	5.9	7.5
1984	15.5	10.7	7.2	8	9.2	6.7	7.2	7.2
1985	17.3	11.8	8.3	8.8	9.7	6.1	8	7.8
1986	18.8	12.8	10.2	10.3	10.8	7.8	8.1	8
1987	21	14.4	8.3	9.6	12.9	7.6	9.6	14.9
1988	21	15	10.8	8.8	14.3	7.2	9.8	13.3

Source: Government of Kerala, Bulletin of Animal Husbandry Statistics (Various issues).

Year	Proportion of Area Under HYV to Total Area Under Rice(%)			Proportion of HYV Yield to total yield (%)			Yield of Rice(Tonnes per hect.)	Yield of Tapioca (Tonnes per hect.)
	Virippu	Mundakan	Punja	Virippu	Mundakan	Punja	Total	
1969-70	10.12	13.03	47.31	117	116	122	1.43	15.78
1970-71	14.7	12.6	54.07	120	105	120	1.48	15.73
1971-72	17.34	8.34	68.89	150	115	115	1.54	17.9
1972-73	24.06	14.4	60.3	105	128	111	1.58	18.68
1973-74	31.9	14.96	65.31	118	100	106	1.44	18.47
1974-75	19.62	13.25	38.45	114	105	106	1.51	17.69
1975-76	24.8	16.2	66.71	122	104	111	1.52	16.49
1976-77	31.8	19.6	67.4	120	119	116	1.47	16.16
1977-78	38.92	24.15	59	134	123	114	1.54	14.46
1978-79	41.78	22.53	52.88	128	113	122	1.59	13.95
1979-80	42.01	24.73	52.07	138	129	117	1.64	16.77
1980-81	39	26	52	131	123	115	1.59	16.58
1981-82	40	21	45	129	116	109	1.66	15.1
1982-83	33	15	38	133	129	111	1.68	16.91
1983-84	31	19	55	123	127	115	1.63	16.75
1984-85	35	19	52	120	116	112	1.72	17.04
1985-86	30	13	46	114	122	122	1.73	16.15
1986-87	27.94	15.01	51.46	105	124	117	1.71	17.07
1987-88	22.77	11.49	44.89	111	123	118	1.71	18.72
1988-89	26.74	13.85	52.24	105	117	116	1.75	18.68

Source: Government of Kerala, Report on Crop Cutting Experiments (Various issues).

Proportion of Area Under HYVs (%)

Virippu

Year	Trivandrum	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode	Cannanore	Malappuram
1973	12.8	29.1	47.2	49.8	32.4	40.5	42	9.13	7.31	23.6
1974	4.29	16.16	25.21	23.52	24.3	25.56	27.78	10.84	10	14.29
1975	12.68	21.7	40.18	30.77	44.04	11.36	31.25	15.56	12	19.44
1976	12.78	9.6	60.02	69.67	52.04	27.59	38.05	9.44	9.3	17.47
1977	9.31	16.4	42.14	63.9	57.26	26.22	68.57	19.63	15.74	16.01
1978	13.38	24.79	45.6	74.95	52.9	27.03	67.47	13.36	18.49	27.21
1979	13.17	44.44	39.04	62.87	46.43	17.02	74.41	7.84	14.81	20.88
1980	11.03	51.18	48.64	85.71	30.39	18	69.28	18.04	14.81	5.35
1981	7.34	46.57	50.25	81.21	41.67	15.72	64.49	13.14	13.32	18.58
1982	7	60.86	29.22	55.28	39.32	8.45	54.78	8.85	13.01	9.94
1983	9.86	59.97	41.22	82.88	30.01	18.22	42.59	12.98	9.13	6.5
1984	22.62	49.92	57.52	88.25	52.44	8.83	34.77	23.31	23.33	9.66
1985	22.6	63.5	30.7	58	38.2	17.4	30.9	16.6	28.6	12.4
1986	11.9	75.6	38.1	72	29.7	18.3	17.2	18.5	40	15.4
1987	15.38	74.02	32.94	68.79	27.67	7.75	10.43	28.98	33.06	16.56

Mundakan

Year	Trivandrum	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode	Cannanore	Malappuram
1974	10.3	4.8	25	51.1	12.3	20.8	10.9	5.5	7.5	19.1
1975	11.43	1.96	13.98	32.53	13.54	12.2	4.88	16.18	15	24.64
1976	10	6.54	10.58	56.45	8.14	24.32	11.69	16.18	16.82	21.74
1977	13.92	3.33	30.77	41.57	4.67	16.07	16.81	7.92	10.47	7.92
1978	8.11	7.43	22.47	54.17	15.43	11.28	29.5	16.07	13.51	17.89
1979	6.59	5.95	19.35	78.2	6.97	12.99	47.45	6.55	6.79	20.84
1980	4.54	8.28	10.79	44.11	10.66	17.48	57.4	7.98	10.71	20.05
1981	4.9	4.64	19.73	90.74	10.27	15.82	62.66	7.63	7.31	9.79
1982	2.01	4.74	13.64	79.79	5.5	19.66	40.15	10.03	12.83	11.05
1983	1.66	6.57	7.72	53.81	3.98	7.74	31.83	3.53	16.5	5.66
1984	5.01	6.53	37.79	81.53	3.55	12.73	30	5.51	11.43	7.98
1985	10.93	9.89	10.15	83.81	8.9	14.46	22.93	15.48	12.58	5.89
1986	10.8	10.8	22.7	66	11.6	12.5	6.5	7.7	17.9	4.6
1987	11.2	2.5	28.6	75	14.4	10.1	5.4	8.8	12.1	8.5
1988	9.14	2.55	21.32	43.63	8.45	11.04	5.2	5.14	31.63	7

Punja

Year	Trivandrum	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode	Cannanore	Malappuram
1974	77.37	9.12	82.6	66.1	27.3	53.3	54.38	62.69	39.2	63.79
1975	66.69	4.93	36	26.27	32.95	48.68	50.7	65.22	43.96	53.03
1976	82.86	12.12	84.31	56.45	30.1	70.27	55.42	65.22	38.68	55.88
1977	68.83	39.53	55.56	60.34	44.23	50.5	48.6	59.55	33.76	55.1
1978	74.65	45.71	70.19	66.67	46	40.43	55.56	55.06	32.52	45.78
1979	57.16	20.95	84.52	86.77	22.18	26.7	58.05	59.93	14.72	56.24
1980	60	40.53	69.05	86.19	19.88	45.71	62.65	58.58	20.94	66.25
1981	41.46	11.42	85.87	59.56	25.74	48.48	61.46	60.83	18.88	34.12
1982	67.84	22.34	59.4	56.61	20.08	48.35	32.88	70	34.84	53.75
1983	70.34	37.01	35.8	52.11	9.48	51.87	38.71	55.98	22.89	59.82
1984	69.84	56.34	79.79	94.16	10.82	45.72	32.65	49.04	17.8	58.27
1985	54.91	2.5	63.68	72.56	24.85	55.26	26.39	72.68	11.96	47.27
1986	18.1	1.5	64.4	76.6	13.1	33.8	22.4	62.1	18.5	49.8
1987	26.4	9.6	79.5	71.8	18.1	37.5	21.5	60.7	12.5	60
1988	18.3	19.64	46.14	94.74	15.89	47.32	15.89	51.51	27.49	62.72

Ratio of HYV Yield to TV Yield

Virippu

	Trivandrum	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode	Cannanore	Malappuram
1973	1.13	1.1	1.85	1.1	1.01	0.96	1.32	1.19	1.98	1.48
1974	1.21	1.19	1.03	1.13	1.59	1.11	1.26	1.25	0.97	1.3
1975	1.09	1.42	1.48	1.76	1.29	1.19	1.14	1.25	1.6	1.26
1976	1.1	0.93	1.07	1.55	1.39	1.21	1.19	1.32	1.26	1.42
1977	1.21	1.55	1.37	1.33	1.51	1.45	1.6	1.3	1.19	1.51
1978	1.12	1.3	1.16	1.21	1.07	1.36	2.1	1.19	1.28	1.54
1979	1.12	1.54	1.73	1.41	1.27	1.3	3.72	1.15	1.27	1.6
1980	1.08	1.56	1.37	1.61	1.23	1.29	1.75	1.23	1.21	1.53
1981	1.17	1.56	1.63	1.36	1.14	1.04	1.48	1.54	1.24	1.3
1982	0.93	1.56	1	1.06	1.2	1.29	1.55	1.23	1.28	1.44
1983	1.17	1.59	1.26	1.41	1.39	1.2	1.11	1.09	1.48	1.02
1984	1.19	1.6	1.46	1.36	1.09	1.14	1.22	1.88	1.3	1.27
1985	1.11	1.56	1.1	1.53	1.05	1.26	1.11	1.68	1.34	1.33
1986	1.16	1.48	1.2	1.08	1.03	1.15	1.29	1.3	1.41	1.23
1987	1.25	1.45	0.98	1.02	1.15	1.29	1.01	0.8	1.36	1.37

Mundakan

Year	Trivandrum	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode	Cannanore	Malappuram
1974	1	1.01	1.19	0.92	0.95	0.92	0.93	1.44	1.37	1.47
1975	1.03	0.75	1.15	1.06	1.24	1.37	0.94	1.04	1.06	1.4
1976	0.94	0.84	1.64	1.21	0.88	1.2	1.11	1.06	1.2	0.93
1977	0.88	0.93	1.51	1.03	0.67	1.18	0.99	1.17	1.23	1.1
1978	1.05	1	1.78	1.22	0.98	0.95	1.16	1.43	1.36	0.91
1979	0.95	1	1.91	0.74	0.81	1.15	1.13	0.58	1.09	1.1
1980	1.33	1	1.72	1.23	1.19	1.12	1.39	1.29	1.47	1.04
1981	1.24	0.95	1.57	0.82	1.06	1.16	1.17	0.96	1.17	1.18
1982	1.14	0.84	1.57	1.33	1.11	1.44	0.99	1.63	1.39	1.17
1983	0.91	1.01	1.32	1.16	1.25	1.27	1.28	1.29	1.41	0.82
1984	1.24	1.18	2.04	1.15	1.41	1.09	1.13	2.02	1.49	1.07
1985	0.99	0.99	1.5	1.01	0.95	1.08	1.19	1.42	1.26	1.18
1986	1.19	0.97	1.84	1.42	1.22	1.38	1.07	1.71	1.39	1.13
1987	0.95	1.3	1.23	1.09	1.15	0.8	0.98	1.47	1.48	1.36
1988	1.15	1.14	1.36	1.03	1.03	1.31	1.15	1.43	1.25	1.28

Punja

	Trivandrum	Quilon	Alleppey	Kottayam	Ernakulam	Trichur	Palghat	Kozhikode	Cannanore	Malappuram
1974	1.55	0.92	0.8	1.77	0.65	1.32	1.48	1.73	1.22	1.17
1975	1.13	1.18	1.09	0.99	1	1.67	2.03	5.95	1	1.03
1976	1.52	1.27	1.54	1.32	1.14	2.34	1.86	0.89	0.95	1.14
1977	1.33	0.91	1.32	1.41	0.92	1.13	1.74	1.14	1.24	1.65
1978	0.97	0.87	1.39	1.54	0.79	1.11	2.33	1.85	1.07	1.26
1979	0.88	2.45	1.36	1.17	1.08	1.14	1.7	1.57	0.84	1.25
1980	0.83	1.35	0.89	1.21	1.04	1.31	1.44	1.01	1.21	1.67
1981	1.04	1.95	1.03	1.1	1.02	1.22	1.37	2.02	1.34	1.25
1982	1.08	1.04	1.25	0.94	1.1	1.46	1.26	1.32	1.13	1.31
1983	1.31	2.06	1	1.08	0.48	1.42	1.51	3.37	1.23	1.37
1984	0.7	1.42	1.18	0.79	1.06	1.48	1.33	1.8	1.22	1.17
1985	0.73	0.49	1.19	0.89	1.04	1.26	1.21	1.95	1.1	1.39
1986	0.76	2.16	1.48	1.07	1.08	1.09	1.63	1.33	1.16	1.37
1987	1.85	1.38	1.17	0.96	1.08	1.34	1.07	1.54	1.42	1.28
1988	1.38	5.48	1.12	1.11	1.02	1.45	0.88	1.68	1.48	1.18

Source: Government of Kerala, Report on Crop Cutting Experiments (various Issues)

Area, Production, Consumption and Price of Rubber in India

Year	Total Area (000 ha.)	Area New Planted (ha.)	Area Replanted (ha.)	Wholesale Price (Rs/kg)	Yield (kg/ha)	Production (MT)	Consumption (MT)
1957-58	111	14278	1394	3.28	345	24534	32273
1958-59	123	12605	1874	3.33	344	24169	35312
1959-60	132	9963	1641	3.31	346	24173	39282
1960-61	144	12104	1385	3.51	345	25697	45941
1961-62	158	14485	2446	3.22	370	27446	48319
1962-63	171	13222	2499	3.1	384	32239	60209
1963-64	177	6551	2309	3.08	393	37487	51776
1964-65	182	5800	2692	3.13	420	45616	60076
1965-66	187	4749	4163	3.47	448	50530	64676
1966-67	192	5886	4039	5.5	483	54818	66693
1967-68	199	6614	2905	3.47	548	64468	72516
1968-69	204	6079	1905	4.66	576	71054	84206
1969-70	211	6709	1920	5.01	616	81953	86692
1970-71	217	6655	2089	4.64	653	92171	86469
1971-72	220	3044	1473	4.21	678	101210	93125
1972-73	224	3775	1704	4.59	725	112364	101100
1973-74	227	3975	1576	5.15	756	125153	123298
1974-75	231	4310	2200	8.49	762	130143	133538
1975-76	236	4561	3099	7.44	772	137750	129138
1976-77	261	4882	3172	5.96	806	147758	133494
1977-78	245	4770	3645	6.32	770	151609	142763
1978-79	253	8450	4050	9.53	711	132991	158168
1979-80	265	12300	4065	10.16	771	147200	167675
1980-81	284	19308	5476	12.12	788	155380	170800
1981-82	302	18100	4188	14.31	779	150655	181915
1982-83	322	19884	4963	14.09	830	165920	197035
1983-84	340	18805	5641	17.08	857	160025	205395
1984-85	362	22365	5217	15.87	886	183925	212540
1985-86	383	21222	5759	16.61	898	198375	232540
1986-87	402	19856	5563	15.92	926	218985	253695
1987-88	422	19535	6517	17.26	944	227397	277635
1988-89	441	19471	6998	17.45	974	254805	311105
1989-90	460	20175	6854	20.57	1000	288592	333185

Source: Government of India, Indian Rubber Statistics (Various Issues).

Note: Price of ungraded natural rubber in Kottayam Market. Consumption is inclusive of imported rubber adjusted for stocks.

Area New Planted, Replanted and Yield

of Rubber in India, 1938-1957

Year	Area New planted (ha.)	Area Replanted (ha.)	Yiled (Kg/ha.)
Before 1938	27843	772	NA
1938-39	331	322	NA
1939-40	1160	384	NA
1940-41	1166	364	NA
1941-42	202	508	NA
1942-43	724	882	NA
1943-44	2808	124	NA
1944-45	2267	378	NA
1945-46	2340	65	NA
1946-47	1373	164	NA
1947-48	1575	198	NA
1948-49	1077	268	320
1949-50	629	127	318
1950-51	721	444	284
1951-52	374	270	298
1952-53	961	364	318
1953-54	1601	314	326
1954-55	3910	435	326
1955-56	8399	687	353
1956-57	11689	680	333

Source: *Government of India, Rubber in India (Various issues).*

Note: Adding up the new planted area upto 1957-58 does not tally with the total area under rubber given for the year 1957-58.

CHAPTER 6

IMPORT OF RICE, AREA EXPANSION UNDER RUBBER AND THE DECLINE OF TAPIOCA

1. Introduction

Tapioca is a staple food crop cultivated in several developing countries. In India the crop is mainly cultivated in the chronically food deficit state of Kerala and is an important constituent of the consumption basket. It has played an especially important role in sustaining the calorie intake of lower income groups in times of low availability or high prices of rice.

Tapioca, which had shown fairly high rates of growth in production during the sixties and the early seventies, showed a rapid decline since the mid-seventies. Both supply and demand side factors contributed to the decline in the production of tapioca. The rapid increase in the price of rubber relative to that of tapioca and the shift of area away from tapioca was an important supply side factor. The larger availability of rice through the public distribution system (PDS) and its relatively lower open market price had an important bearing on the demand for tapioca. This chapter attempts to investigate the interplay of these forces in shaping the fortunes of tapioca in Kerala.

The chapter is set out in six sections, including the introduction. Section 2 reviews the studies and sets out the issues in a clear perspective. Section 3 takes up the question of the area shift away from tapioca to rubber. Section 4 brings together the findings of the preceding two sections and attempts at measuring the determinants of the price of tapioca. Section 5 goes into the determinants of the yield of tapioca. Section 6 is the conclusion.

2. A Review of the Literature and the Key Issues

In Kerala the cultivation of tapioca, which accounted for roughly seven per cent of the total cropped area, was concentrated in the southern districts comprising the Travancore region. These four southern districts, namely Trivandrum, Quilon, Alleppey and Kottayam, accounted for almost 65 per cent of the total area and production of tapioca in the state. Tapioca, like coconut, is basically a small-holder crop with over 56 per cent of its area in holdings of less than one hectare (Ninan, 1986, p. 30.). For such small holders it is one of the most important crops occupying 45 to 60 percent of their total cropped area (Ninan, ibid., p. 100); but the proportion of area under tapioca grown as a pure crop is relatively low for them. Ninan's study reported that, "..........in the lowest size group (below 0.5 acres) only 8.7 per cent of the tapioca area is grown as a pure crop while in the highest size group (above 15 acres) this proportion is as high as 95 per cent" (ibid., p.105). Further, it was reported that for holdings above 2.5 acres almost all households sold their tapioca produce and the output sold was above 65 per cent. From these trends it may be inferred that tapioca was a commercial crop for the medium and large farmers but a subsistence crop for the small and marginal farmers:

> "........... marginal and small farmers grow tapioca primarily for self-consumption. But medium and large farmers grow tapioca primarily for the market". (Ninan, ibid., p.202).

A fairly high rate of growth in output of tapioca was reported during 1963-64 and 1974-75 - the rate being 8.51 per cent per annum - contributed in almost equal measure by area and yield. Although increase in yield was reported by almost all the districts of the state, area expansion was confined to the northern districts of Trichur, Palghat and Cannanore and the southern districts of Quilon and Trivandrum (Pushpangadan, 1988, p.9). Since 1974-75 there has been an equally sharp fall in output, at the rate of 9.78 per cent per annum, largely accounted for by the steep fall in area under the crop, at the rate of 7.07 per cent per annum. The decline in area was widespread; all the districts of the state, except Palghat and Cannanore, reported steep fall in area under the crop during the period. The decline in yield was confined to fewer districts during this period (Pushpangadan, op.cit., p.9).

The sharp increase in the output of tapioca till 1974-75 has been attributed to a significant growth in its price and yield (Ninan, op.cit., p. 35). The sharper decline in the output since 1974-75 has been explained by the increase in the price of rubber relative to tapioca and the consequent shift in area (Pushpangadan, op.cit., p.25). Given that tapioca is grown as a commercial crop by the medium and large farmers such an explanation is consistent. But to clinch the argument it is necessary to show that the shift in area from tapioca has in fact gone in favour of rubber.

In line with the concentration of production, the per capita consumption of tapioca is high in the southern districts. The per capita daily consumption in these districts in 1971 was high, ranging between 0.23 and 0.33 kilograms, in the districts of Trivandrum, Quilon and Alleppey and was low, ranging between 0.03 and 0.10 kilograms in the districts of Kottayam, Ernakulam, Trichur and Palghat; the other districts reported figures of around 0.15 kilograms (Government of Kerala, 1972). The consumer surveys conducted in the seventies reported fairly high levels of consumption of tapioca among the lower income groups; the levels were distinctly lower for the higher income groups. But the various rounds of NSS did not report such differences among expenditure classes. The NSS rounds reported sharp increase in the consumption of tapioca upto a certain expenditure group starting from the lowest and little change beyond. The expenditure elasticities for tapioca obtained from three rounds of NSS data quantify the same. The expenditure elasticities (rural) were 0.289, 0.145, and

0.253 for 1970-71, 1977-78 and 1983 respectively. The elasticity was negative for the urban areas. The expenditure elasticities for the different expenditure groups showed the following tendencies:

> "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......." (George, 1986, p.27).

When consumption of tapioca across size class of holdings was related with the production and sale characteristics, it was reported that the smaller holdings were heavily dependent on purchases. Ninan's study reported that,

> "In the case of tapioca almost 95 percent of households with holdings upto 0.5 acres depend on the market to meet the larger part of their tapioca requirements while in the next size class (0.51 - 1.0 acre) 62 percent of the households depend on the market. Thereafter the proportion of households depending on the market for tapioca are not many" (Ninan, op.cit., p. 271).

Thus, consumption of tapioca is characterised by its regional concentration and by the high market dependence of the lower size class of holdings.

As regards data on consumption of tapioca, the two surveys -Operations Research Group (ORG) and Shubh Kumar (SK) - give estimates for a point of time each. For inter-temporal comparisons, one may use NSS estimates or estimates of food availability following the CDS food balance sheets. If SK is ignored for its narrow coverage - three locations within a single district - then it may be said that

> "There is not much variation in the estimates of rice consumption between the three sets of estimates, being around 1000 calories per capita per day. But in regard to tapioca consumption the CDS estimates differ greatly from the other two. On the average during the sixties according to the CDS data, around 628 calories per capita per day were derived from tapioca consumption. The NSS and ORG estimates of tapioca consumption for rural Kerala were around 300 calories". (Ninan, ibid., p. 46).

But the variations in the estimates of consumption of tapioca from the different sources do not come in the way of inter-temporal comparisons because although the figures themselves are different, the trends are broadly the same as has been argued below.

The data on the consumption of rice and tapioca are presented in Table 6.1. In the case of rice, the availability figures are arrived at by estimating the total imports and combining the production within the state, setting aside 10 per cent for seed and other wastage. In the case of tapioca 75 per cent of the production is taken as the availability for consumption. As is evident from the Table, estimates of the consumption of rice do not vary between

Table 6.1

Monthly Consumption of Rice and Tapioca per Head

(kilograms)

Year	Consumption (NSS)						Availability	
	Rural		Urban		Total			
	Rice	Tapioca	Rice	Tapioca	Rice	Tapioca	Rice	Tapioca
1961-62	9.83	5.16	9.83	1.40	9.83	4.41(100)	9.08	8.41
1973-74	7.33	6.99	7.23	3.64	7.31	6.32(143)	7.41	15.80
1977-78	9.92	5.55	8.47	2.50	9.60	4.90(111)	9.67	13.40
1983							9.33	9.25
1986-87	9.54	1.83	8.57	0.96	9.35	1.66(38)	9.70	7.50

Source: Sunny, 1988, Table 3.

Note: Availability of tapioca is computed setting apart 25 per cent of production for industrial and other uses as in Chapter 4, Table 4.2.

the two sources, in contrast to those of tapioca. But the trend is unmistakable in both. Consumption of rice showed a sharp decline betweeen 1961-62 and 1973-74. Simultaneously there was a sharp increase in the consumption of wheat and tapioca (see Chapter 4, section 2). Obviously, wheat and tapioca were being substituted for rice during the period. With the larger availability of rice in 1977-78, consumption of rice rose to reach the 1961-62 level and consumption of wheat came down, but consumption of tapioca did not come down sharply. In terms of NSS estimates, the fall in the consumption of tapioca was 23 per cent and in terms of availability, the fall was 15 per cent. Beyond 1977-78 neither did the availability of rice nor did its consumption show any increase, but the consumption of tapioca showed a sharp decline reaching 30 per cent and 50 per cent of the 1973-74 levels in terms of NSS and availability estimates respectively. This decline has been attributed to the demand constraint by Ninan (op.cit., p.50) and to the easy availability of rice by George.

> "........... in recent years easy availability of rice in Kerala has resulted in a fall in the demand for cassava for human consumption ......" (George, op.cit., p. 31).

The sharp fall in the ratio of retail price of rice to that of tapioca is then taken as facilitating this shift in demand.

The problem with the above argument is that if the demand for tapioca has fallen mainly on account of a shift to rice, then, the quantity of rice consumed should have shown a commensurate increase. As is seen from Table.6.1, the quantity of rice consumed has not shown any secular increase since 1977-78 but the quantity of tapioca consumed has shown a secular decline. The causation seems to be the following. As shown in Chapter 4, the price of rice declined beyond the 1975 levels mainly because of the supply of the larger quantity of rice through the PDS. This in itself has not improved the per capita availability of rice in the state. However, for altogether different reasons, the price of rubber relative to tapioca had shown a sharp increase during this period. As the area under tapioca can be substituted by rubber, the rising relative profitability of rubber resulted in a shift of area away from tapioca to rubber. The area shift and the consequent sharp fall in the production of tapioca led to an increase in its price and a decline in the price ratio between rice and tapioca. The area shift away from tapioca to rubber becomes the crucial link which is taken up in the next section.

3. Changes in Area under Tapioca

Given the data base of area under crops in Kerala, it is fairly difficult to arrive at any precise conclusion regarding the area shift. This is owing to the use of two concepts of area. As elaborated in Chapter 2, the area concept used is that of gross area. Net area is not reported for any crop, except probably for the plantation crops. The only net area reported is that of the net area sown in the aggregate. The second difficulty arises because area reported for many tree crops is arrived at by dividing the estimated plant population by a norm. Hence, reported area changes between two time points are the combined effect of net area change and area change arising out of the changes in intensity of cropping. Keeping these limitations of the data in mind an analysis of the area changes of crops is attempted in this section.

Data on area under crops are presented for four time points in Table 6.2. As the cropping pattern is dominated by perennials, year to year fluctuations are not a major problem and hence averages over trienniums need not be computed. The contrast between the two sub-periods is striking. The first period from 1957-58 to 1974-75 showed both a sharp increase in the net area sown and intensity of cropping whereas the second period from 1975-76 to 1986-87 showed negligible increase in the net area sown and a mild decline in the intensity of cropping. The intensity of cropping, that is the total cropped area divided by the net area sown, increased from 120 per cent to 137 per cent in the first period and fell to 130 per cent by the end of the second period. The more striking feature is that of the trends in the intensity of cropping of the area under rice. During the first period with practically no increase in the net area under rice, its total cropped area increased by 114000 hectares accounting for about 14 per cent of the increase in the total cropped area in the aggregate. This would indicate that the intensity of cropping of not only rice but all other crops showed an increase. In the second period, net area

Table 6.2: Area Under Crops in Kerala

Crops	1957-58	1974-75	Absolute change	1975-76	1986-87	Absolute change
	Area under crops (000 hectares)					
Net Area Sown	1839	2208	369	2189	2207	+18
Total Cropped area	2211	3028	817	2981	2870	-111
Rice (net)*	395	395	0	396	297	-99
Rice (total)	767	881	114	885	664	-221
Pepper	91	118	27	108	129	+21
Cardamom	28	47	19	54	63	+9
Arecanut	50	93	43	77	58	-19
Cashew	44	105	61	109	134	+25
Tapioca	214	318	104	327	193	-134
Coconut	463	748	285	693	706	+13
Coffee	17	37	20	42	66	+24
Rubber	100	202	102	207	348	+141
Tea	40	38	-2	38	35	-3
Total Fresh Fruits	98	180	82	180	178	-2

Source: Government of Kerala, Statistics for Planning (Various Issues)
* Maximum of the three seasons is taken as the net area sown.

under rice fell by 99000 hectares and the total area under it by 221000 hectares, which is proportionate to the intensity of rice cultivation. But the fall in the total cropped area under all crops was only 111000 hectares indicating that the intensity of cropping in the non-rice areas must have increased. It is within this overall setting of an increasing intensity of cropping that the changes in area under tapioca need to be viewed.

To begin with the first period. Taking the largely pure cropped areas under rubber, tea, coffee, cardamom and arecanut, it may be seen that they accounted for an increase of 184000 hectares, out of the increase in the net area sown of 369000 hectares. The increase in the net area sown for the other crops was then 185000 hectares. But the increase in the areas under cashew, tapioca, coconut and fresh fruits alone is 532000 hectares clearly indicating that these have come about largely owing to the increase in the intensity of cropping.

During the second period the increase in the net area sown is just 18000 hectares. Consequently, area gains of crops falling under largely pure cropped plots must be at the expense of other crops. The increase in the largely pure cropped areas under rubber, coffee, and cardamon - areas under tea and arecanut have fallen - is 174000 hectares. The fall in the net area under rice is 99000 hectares and the gross area under tapioca is 134000 hectares. There is very limited scope for shifts in area under rice to rubber, coffee, or cardamon. However, area under tapioca can move over to these crops. Even if it is assumed that the entire area loss of tapioca is in the net, which is very unlikely, it does not entirely explain the increase of area under rubber, coffee and cardamon. Further, the sharp drop in the area under rice remains unaccounted for. In order to explain this more fully, the analysis must be carried out at the level of the district.

Table 6.3
Changes in Area under Crops between 1975-76 and 1986-87
(000 hectares)

Districts	Changes in Area						
	Rice	Pepper	Coconut	Tapioca	Rubber	Coffee	Cashew
Trivandrum	-7.66	0.85	1.45	-22.62	9.33	-.08	0.77
Quilon, Pathanamthitta, Alleppey, Kottayam	-8.91	2.41	-34.06	-73.14	68.06	-.78	2.11
Idukki	-5.58	18.75	4.72	-1.02	11.37	1.92	0.04
Ernakulam, Trichur	-25.40	2.09	19.03	-15.02	22.22	1.07	0.97
Palghat	-17.89	0.66	8.09	3.09	9.42	-0.57	0.24
Malappuram, Kozhikode Wynad, Cannanore Kasaragod	-59.58	0.74	13.34	-26.33	20.73	23.32	20.40
Total	-99	21	13	-134	141	24	25

Source: Government of Kerala, Statistics for Planning (various issues)

Note: 1. Districts have to be grouped because new districts have come into existence during the period.

2. Change in area under rice in the subregions will not add upto the state total because the season recording the maximum for the districts need not be the same as that for the state total.

As is evident from Table 6.3, rice and tapioca showed a loss in area and rubber a gain in every sub-region. While area under pepper went up mainly in Idukki, the area under coffee increased in Wynad, while the increase in area under cashew was confined to Cannanore and Kasaragod. These crops are largely confined to specific agro-climatic zones. That leaves the four crops, rice, tapioca, coconut and rubber with relevance for entire Kerala. The first thing to be noted is that except in one subregion, the area under rice is shifting over to coconut. In Palghat, it also shifts over to tapioca. Furthermore, in the region south of Ernakulam the sole gain is marked by rubber, with area under coconut also being reduced in favour of rubber[1] . Even if the entire area under coconut lost is assumed to have been brought under rubber, the bulk of the increase in area under rubber can only be explained as conversion of area under tapioca. In all the other regions too, since coconut is also gaining area that cannot be a source of increased area under rubber. That leaves the loss of area under tapioca as the major source for conversion into rubber. Thus, the loss of this area has been a major source for the increasing area under rubber in Kerala in the post-1975 period.

One of the major forces making for the crop shift away from tapioca is relative profitability. As has been argued in Chapter 3, when the price of rubber relative to rice was increasing sharply its profitability relative to tapioca was increasing. It may be pertinent here to recall Ninan's finding that the large holders producing mainly for the market are also pure croppers of tapioca. Put together with the empirical finding presented above, it may be concluded that the fall in area under tapioca was largely because of the emergence of rubber as a competing crop since the late seventies.

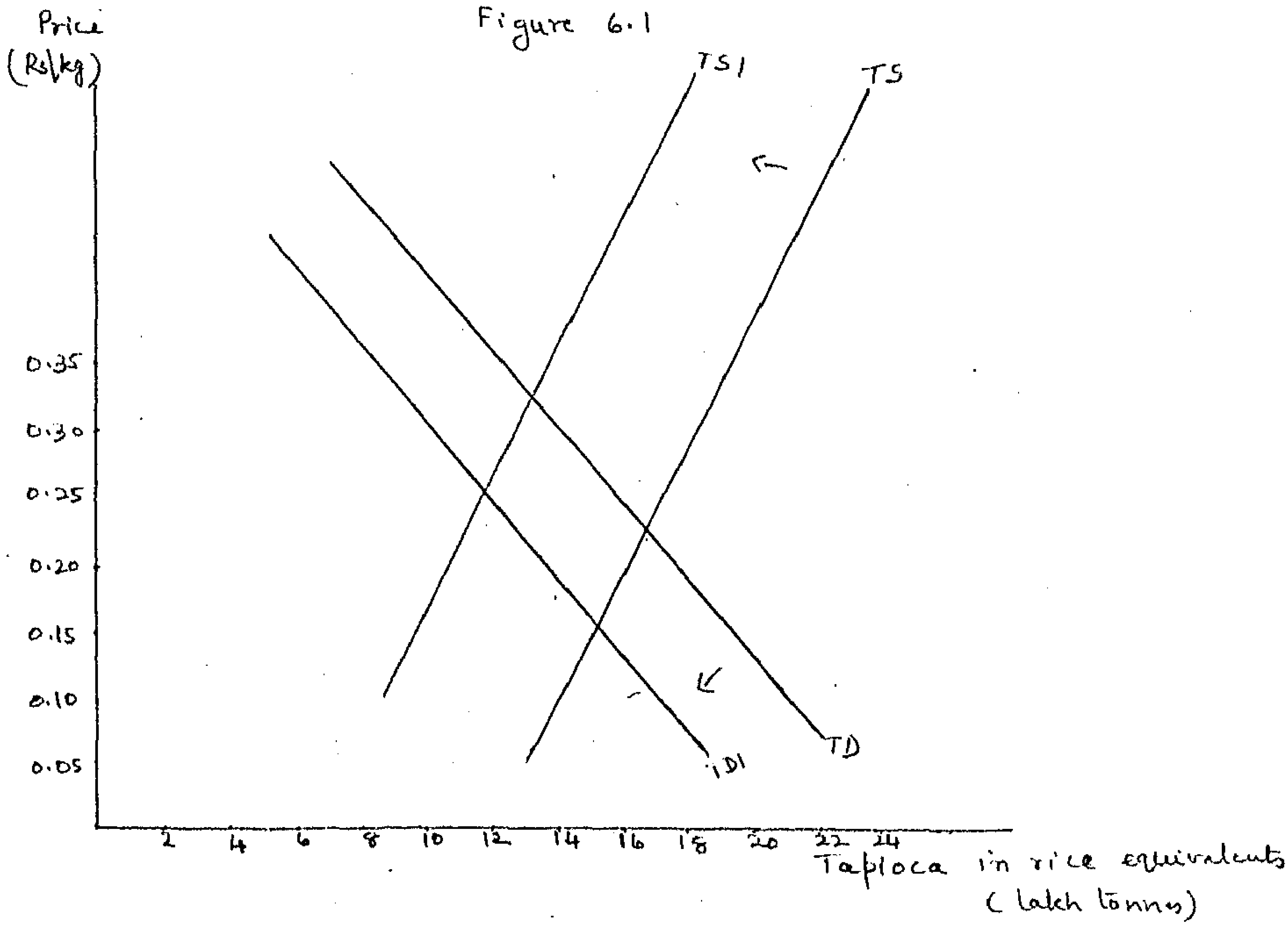
4. Price Determination of Tapioca

Having taken up consumption, and area questions in Sections 2 and 3 respectively, the question of the price of tapioca is taken up in this section.

As was argued in Chapter 4, the larger availability of rice through the public distribution system after the mid-seventies brought down its open market price. As tapioca is an almost perfect substitute of rice (Ninan, op. cit.) , the fall in the price of rice would result in a corresponding fall in the demand for tapioca. The open market price of rice in real terms (open market price divided by the wholesale price index) has come down by about 40 per cent between 1970-72 and 1977-79. This would have resulted in a leftward shift of the demand curve for tapioca (shown in the diagram as a shift from TD to TD1) bringing down its price. As tapioca is an almost perfect substitute of rice, the fall in its price would be proportionate to the fall in the price of rice leaving the ratio of the two prices unaltered.

The above argument would hold if the supply had not shifted. As argued in Section 3 above, the rise in the price of rubber in the late seventies had resulted in the area expansion under the crop and one of the major sources of area had been that under tapioca. The area shift away from tapioca may be represented as a shift of the supply curve leftwards (shown in the diagram as a shift from TS to TS1). This would raise the price of tapioca. Now, the fall in the price of rice had been sharp between 1970-72 and 1977-79. But beyond 1979, it did not show a fall, only fluctuations around the level reached by then. Thus, the demand curve does not shift leftwards from TD1. But the area shift continued throughout the eighties. In terms of the diagram, this would mean a steady leftward shift of the supply curve S1. Such a shift would lead to a steady increase in its price and a fall in the ratio of the price of rice to tapioca. The price ratio which has been between five and six till the mid-seventies had steadily come down to between two and three by the late- eighties (Table 6.4).

Figure 6.1



Price (Rs/kg)
TS1
TS
TD
D1
0.35
0.30
0.25
0.20
0.15
0.10
0.05
2
4
6
8
10
12
14
16
18
20
22
24
Tapioca in rice equivalents (lakh tonnes)

Table 6.4

Price Ratios of Rice and Fertiliser to Tapioca

Year	Ratio of the Price of Rice to Tapioca	Ratio of the Price of Fertiliser to Tapioca
1966-67 to 1970-71	5.58	-
1971-72 to 1975-76	5.17	9.14
1976-77 to 1980-81	3.86	10.08
1981-82 to 1985-86	3.94	8.15
1986-87 to 1989-90	2.58	4.96

Source: Government of Kerala, Economic Review (Various Issues).

5. Yield Response to Prices

It is evident from the discussion so far that profitability is one of the main considerations in the cultivation of tapioca, especially among the medium and large holders who sell the bulk of the output in the market. If this is so, then the same profitability consideration should also govern their decisions regarding the level of application of chemical fertilisers and manure, which would in turn determine the yield level.

Ninan's study showed that among the medium and large cultivators a fairly high proportion applied fertilisers and the quantity of fertilisers and manure used showed a strong positive relationship with the size of holding. This was not the case with the man-days applied per unit of land. His yield response functions showed no statistically significant coefficients for labour though the coefficient of fertiliser was positive and significant. He went on to conclude that,

> ".......when all holdings above one acre were pooled the fertiliser coefficient was positive and significant in both linear and log linear functios. Fertilisers,......seems to be emerging as a significant contributor to enhancing tapioca productivity" (Ninan, op.cit.,p.126).

The cost of cultivation studies also reported application of fairly high doses of fertilisers and manure for tapioca. The share of these two inputs in the total cost was roughly 25 per cent and the amount spent per hectare was comparable to that spent on the coconut gardens.

The yield response function of tapioca may be put down in the following form:

$Y = K + A e^{-BX}$; where Y is the yield, X is the quantity of fertiliser applied and K, A and B are constants.

It may be noted that $\frac{dy}{dx} = - B(Y-K)$.

If tapioca cultivators are profit maximisers, then they would apply fertilisers to the point where profit is maximised. That is, profit = Y.P - X.C , where P is the price of tapioca and C is the price of fertiliser. And at the point of profit maximisation, d(profit)/dx = 0. Taking the expression for dy/dx this may be written as, Y = K - (1/B)(C/P). If the tapioca cultivators seek to maximise profit, then there should be a relationship of the above type between the yield of tapioca and the ratio of the price of fertiliser to tapioca.

In order to test the above hypothesis, the data taken was from 1971-72 to 1989-90[1] . Before testing the hypothesis, the movement of the yield of tapioca and the ratio of the price of fertiliser to tapioca was sought to be analysed. When a cubic equation wuth time as the explanatory variable and yield per hectare (in tonnes) as the dependent variable was run, it was seen that the coefficient of the cubic term was not significant. The estimated quadratic equation is shown below:

$$Y = 18.64 - 0.635 \text{ time} + 0.036 \text{ time2}$$
$$(-4.76^*) \qquad (5.034^*)$$
$$[\ 0.61,\ 0.57,\ 1.54,\ 12,74\ ]$$

It is evident that tapioca yield had been falling from 1971-72 and the turnaround came in 1980-81. A careful scrutiny of the data, however, suggested a turnaround in 1979-80. A dummy variable regression of the following type was tried,

Y = a + b Dtime + c Dtime1 , where Dtime was defined as -8, -7, ...upto 1978-79 and zero beyond. Dtime1 was defined as zero upto 1979-80 and 1, 2, 3, ...beyond. The estimated equation was,

$$Y = 15.27 - 0.40 \text{ Dtime} + 0.31 \text{ Dtime1}$$
$$(-4.39^*) \qquad (4.44^*)$$
$$[\ 0.60,\ 0.56,\ 1.60,\ 12.23\ ]$$

Going by adj. R^2, DW, or F, there is hardly any difference between the quadratic and the dummy variable regression. But the advantage with the latter is the ease of interpretation. The intercept corresponds to the lowest yield level reached in 1979-80; the coefficint of Dtime is the rate at which yield has been falling between 1971-72 and 1979-80; and the coefficient of Dtime1 is the rate at which yield has been rising beyond 1979-80. Interestingly, the rate of fall and rise in the two sub-periods are not the same.

The above finding led one to a careful scrutiny of the ratio of the price of fertiliser (nitrogenous per kg.) to tapioca (per kg.). It showed fluctuations around a certain level till 1979-80 and a falling tendency beyond. When a dummy variable regression of the type indicated above was run the following result was obtained:

$$(C_t/P_t) = 10.447 + 0.207 \text{ Dtime} + 0.625 \text{ Dtime1}$$
$$(1.40) \qquad (-5.45^*)$$
$$[0.69,\ 0.65,\ 2.33,\ 17.49\ ]$$

As the coefficient of Dtime is not significant, the ratio is fluctuating around 10.45 till 1979-80, beyond which it has been falling at a rate of 0.625. This finding together with the earlier observation regarding the different rates of change of yield in two sub-periods led one to set up the yield response to fertiliser application as follows:

$Y_t = a + b\ (C_{t-1}/P_{t-1}) + c\ (C_{t-1}/P_{t-1})\ D$; where D takes values zero upto 1979-80 and one beyond. Lagged values of the prices are used, the assumption being that the cultivators are guided by the prices actually paid out for fertilisers at the time of planting and received for tapioca harvested a few months earlier. Here it may be noted that tapioca crop takes ten months, the main crop being planted in April- May and harvested in January - February. The estimated equation is given below.

$$LY_t = 5.34 - \underset{(3.52*)}{0.024}\ (C_{t-1}/P_{t-1}) - \underset{(-0.83)}{0.003}\ (C_{t-1}/P_{t-1})*D$$

[0.45, 0.38, 1.22, 6.20]

[LY stands for log of yield in quintals].

Although the coefficient of $(C_{t-1}/P_{t-1})*D$ is of the expected sign, it is not statistically significant. This term was dropped and the equation was rerun; the estimated equation is,

$$LY_t = 5.32 \underset{(-3.45*)}{-0.023}\ (C_{t-1}/P_{t-1})$$

[0.43, 0.39, 1.13, 11.95]

As is evident, the data fits the equation well with the F value being statistically significant. The coefficient of the price ratio is also significant clearly bringing out the fact that the quantity of fertiliser applied is governed by the relative prices and that it is the quantity of fertiliser applied which determines the yield level.

A question may arise at this stage as to the effect of rainfall, its quantum and distribution, on yield. Tapioca being a crop of approximately ten months' duration, is mostly planted with the first rains in April-May; the effect of rainfall was tested by taking the quantum of rainfall during April- May, June-August, September- October, and November- December separately and together as the independent variable. None of the equations were significant. Hence, it could be concluded that rainfall did not play much of a role in influencing the yield of tapioca.

6. Conclusion

Tapioca is substitutable on the consumption plane by rice and on the production plane by rubber. Consequently, the prices of rice and rubber enter the price of tapioca. How it affected the profitability of tapioca relative to rubber has been gone into in Chapter 3. The consequence of such a movement of profitability has been the shift of area under tapioca to rubber. This chapter provided the evidence of such area shift. The area shift steadily raised the price of tapioca relative to rice. The rising price of tapioca made for a falling ratio of the price of fertiliser to tapioca which through the variation in the quantity of fertiliser applied showed up as a turnaround in the yield of tapioca from 1979-80. The interaction of price and technology which was evident in the adoption of HYV rice (Chapter 5) is evident here in the application of fertiliser and its resultant yield.

Notes

1. The districts south of Trichur report increasing incidence of root (wilt) disease. And in some districts this has lead to a sharp drop in productivity leading to the conversion of area under coconut into other crops.

2. Alonger period could not be taken because data on fertiliser prices were available only from 1971-72.