PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

By

SAVITHRI T. M.

THESIS SUBMITTED TO THE UNIVERSITY OF CALICUT
FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
UNIVERSITY OF CALICUT
DR. JOHN MATTHAI CENTRE
ARANATTUKARA
THRISSUR - 680 618

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CERTIFICATE

Certified that this written account on "Production, Productivity and Prices – A study on Agricultural Commodities in Kerala" is a bonafide record of research work done by Smt. Savithri. T. M. under my supervision. This thesis has not been submitted earlier for any other degree or diploma.

Place : Thrissur
Date : August 6th 1999

Dr. U. T. Damayanti
Supervising Teacher

V

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DECLARATION

I, Savithri T M, do hereby declare that this written account entitled "Production, Productivity and Prices – A study on Agricultural Commodities in Kerala" is a bonafide record of research work done by mc under the guidance of Dr. U. T. Damayanti, Reader in Economics, University of Calicut.

I also declare that the thesis has not been submitted by me fully or partly for the award of any degree, diploma, title or recognition before.

Savithri T. M.

Place : Thrissur
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ACKNOWLEDGEMENT

It gives me immense pleasure to express my unforgetable feelings of respect, gratitude and love towards my supervising teacher, Dr. U. T. Damayanti, Reader, Department of Economics, University of Calicut. It would have been impossible to me for the timely completion of this work, but for her keen interest, constant encouragement and dynamic supervision. I am also grateful to her valuable suggestions, both as to the style and substance, which contributed much to have the thesis in its present shape.

Dr. P. P. Pillai's (former Head of the Department of Economics) constructive comments and advises have substantially improved the quality of the text. Here I like to express my profound and sincere thanks and indebtedness to him.

I have greatly benefitted from the encouragement and guidance given by Dr. D. P. Nair, Prof. and head of the Department. Equally profound is my gratitude towards Dr. Lakshmy Devi, Dr. B. A. Prakash and Dr. A. C. Kuttikrishnan, professors for their timely help.

Mr. T. M. Balakrishnan, former librarian and Smt. C. V. Usharani, librarian of the Department sincerely helped for literature survey of my research work. I express my thanks towards them. I also wish to put on record my appreciation of the valuable assistance provided by librarians of State Planning Board, Centre for Development Studies (Thiruvananthapuram), Cochin University of Science and Technology (Cochin), College of Co-operation and Banking, College of Horticulture (Mannuthy) etc. for collecting relevant materials.

I deeply remember the Staff of Directorate of Economics and Statistics (Prices) for their kind co-operation and timely help to collect the necessary data. I am also thankful to all Staff members of the Economics Department, University of Calicut for their co-operation and help throughout my study period.

I will be lacking in gratitude if I fail to mention the affectionate consideration and sincerity shown by my friend and colleague, Miss. Vimala. M. and her family members. Also I extend thanks to my friends Susmitha. S, Suresh Kumar. M. S., Shinto M Kuriakose, Bindhu P Verghese etc. for the help and suggestions received from them. I am indebted to all my friends at N. S. S. Hostel, who made my life lively with their fruitful comments.

With all earnestness, sincerity and love I express my deep sense of gratitude towards my parents, brothers and sisters who were keen on the improvement of my academic qualifications.

Amazing as it may seem, I lost my words in trying to adequately express appreciation to my husband Mohan without whose endurance, wholehearted support and inspiration this thesis would not have seen the light of the day.

Place : Thrissur
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SAVITHRI. T. M.

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TO

MY BELOVED PARENTS

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CHAPTER SCHEME

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Chapter 1

1. Introduction

1.1. Need and Significance of the Study

1.2. Objectives of the Study

1.3. Review of Literature

1.4. Plan of the study

1.5. Limitations of the study

INTRODUCTION

Agriculture plays a prominent role in man's day to day life. The role of agriculture in promoting economic growth has been sufficiently underlined in economic literature. Agricultural development is a pre-condition for industrial development. If the agricultural productivity becomes sufficiently high, the nation may enjoy food surplus of such a magnitude so as to permit its export. For example, agricultural development was clearly a contribution to the subsequent economic development of countries like America and Australia.

The Planning Commission of India clearly recognised that substantial development of agriculture is a pre-requisite for industrial development. Our first five-year plan gave greatest priority to the development of agriculture. During the period 1949-50 to 1964-65 foodgrains production had increased at an impressive annual rate of 3.2% (see table 1.1). The major cereals, viz., rice and wheat, recorded high rates of growth (3.5 and 4% respectively), but coarse cereals and pulses recorded relatively lower growth rates. The output growth of non-foodgrains (3.5% per year) was also impressive. This impressive growth rate in agricultural production was due partly to area growth rate and partly to yield growth rate, during this period.

After 1962, the Government introduced biochemical technology with the hope of improving agricultural productivity and through it, agricultural production improved. That the new technology did not really bring about a break through in agricultural production is clear from the fact that except for the production of wheat (5.4%per annum) and potatoes (5.1% per annum), the annual rate of growth in output has been low in almost all other

Table 1.1

Growth in production of principal crops since Independence (All India)

Category	Growth in production (in M. tones)			Compound growth rate	
	1949-50	1964-65	1994-95	1949-50 to 1964-65	1964-65 to 1994-95
1.All foodgrains	55	89	185	3.2	2.5
Rice	24	39	80	3.5	2.4
Wheat	6	12	58	4.0	5.4
Cereals	17	25	32	2.2	0.4
Pulses	8	12	15	1.4	0.4
2.All non-foodgrains	-	-	-	3.5	2.6
Oilseeds(Mt)	5	9	21	3.3	2.9
Sugarcane(Mt)	50	122	245	4.3	2.3
Cotton(m.bales of 170 kg)	3	6	12	4.6	2.3
Potato	2	4	18 ⊗	4.3	5.1
3. All crops	-	-	-	3.1	2.6

"⊗" For the year 1993-94.

Source: 1) GOI, Ministry of Finance, Economic Survey, 1994-95.
2) GOI, Ministry of Agriculture, Annual Report, 1994-95.

crops. The rate of increase in the case of coarse cereals and pulses has been marginal. Certain important conclusions can be drawn from Indian experience, which are cited below.

(a) While area expansion contributed significantly to pre-green revolution growth, gains in agricultural productivity was a major factor for realising output growth in the post 1965 period.

(b) Except for wheat, output growth rate could not be maintained despite the adoption of modern agricultural technology.

(c) Excepting for wheat, growth rates were considerably lower after 1965, when compared with the period 1950-65. Despite the spectacular decline (in the second period), growth rate in foodgrains was maintained at a level of 2.5% per year mainly because of the high growth rate (5.4%) in wheat.

(d) There have been significant shifts in the shares of states in the output of major foodgrains. For instance, the share of the eastern region of the country (composed of West Bengal, Orissa, Bihar, Assam and north-eastern states) in the total output of rice had declined from 38% to 28% between the two periods. On the other hand, the northern region comprising Punjab, Haryana and Uttar Predesh had increased its share in the total output of rice from 10% to 23%. In the case of wheat, the major locational shift has been from the western region to northern region.

(e) With the introduction of modern technology to areas of assured rainfall or with good irrigation facilities, the crops like oil seeds, coarse foodgrains and pulses have been pushed to inferior lands. Hence, these crops have not registered much increase in yield or in total production.

(f) Eventhough there has been substantial growth in agricultural production, this has not been smooth, instead, and there have been continuous fluctuations in crop output from year to year.

As the 1990s began, India was experiencing faster agricultural growth that was becoming more evenly spread across states, including rainfed regions. The poverty reduction potential from agriculture appears far exhausted. Between 1980 and 1996, agricultural growth has accelerated and spread to the eastern regions and rainfed areas and real rural wages improved. The terms of trade – the price of crops relative to goods purchased from the non-agricultural sector - also improved noticeably since 1985-86. In addition, farmers benefited from large public spending for infrastructure, support services and subsidies (for fertiliser, credit, water and power for irrigation pumping) as well as the protection afforded to oilseeds atleast until 1991.

The economy – wide reforms contributed to the acceleration of agricultural growth. Although the 1991 economic reform did not contain an explicit agricultural component, it created a number of favourable conditions for the sector. Of particular importance were exchange rate devaluation and reduction of protection of the manufacturing sector, which virtually eliminated the falling anti-agricultural bias. Accordingly, the agricultural terms of trade improved further by around 4% after deteriorating temporarily in 1992-93. This additional improvement would have been greater but for three factors.

(a) A much-needed realignment of prices began within the agricultural sector. In a closed trade regime for agriculture prior to 1994, changes in domestic supply and demand conditions combined with government price policies for rice, wheat and sugarcane determined their price levels. However, as a result of changes in protection, the price of exportable and disprotected crops (rice and cotton) improved faster than the price of importable and protected crops (oilseeds, sugar and rubber). As a result, price distortions within agriculture narrowed which meant that aggregate agricultural terms of trade did not improve significantly.

(b) The exchange rate devaluation and the trade liberalisation after 1994-95 were not fully reflected in farm gate prices because of high marketing and processing margins.

(c) The world prices of agricultural commodities fell in real terms. Between 1990-91 and 1994 –95, the average real US dollar price of a 13-commodity basket weighted by Indian production fell by an estimated 9%. There was therefore less scope for domestic agricultural prices to increase in real terms.

Thus, the non-agricultural reforms, initiated during the 1980s and accelerated since July 1991, created a favourable environment for the agricultural sector by removing most of the anti-agricultural bias and realigning prices within agriculture by 1994-95.

However, these conclusions may not coincide with Kerala agricultural situations because several features distinguish agriculture of the state from other parts of India. The high density of population results in much smaller holding sizes than the other states. Also Kerala agriculture is characterised by a high value of crop production per unit of area resulting from the preponderance of perennial crops. Intercropping is almost a universal phenomenon in the state, especially in dry land cultivation. The cropping pattern of Kerala differs from that of India in some significant respects. While some of the major all India crops like wheat, barley, bajra, maize, jute, linseed, castor, mesta, indigo etc. are not grown in the state, Kerala cultivates a variety of crops rarely found in other parts of the country. These specialities point out that agricultural position of Kerala is particularly different from that of India.

In table 1.2 we observe that the Government outlay on agriculture and allied services in each plan had increased. The allocation on agriculture was of the order of Rs. 562 lakhs in the first plan but by eighth plan this had increased to Rs. 75125 lakhs. However, the percentage of the outlay on agriculture to total plan outlay was the highest in the annual plans of 1966-69, viz., 25.82% and was between 13.76 to 24.52% in all other plans. Out of the outlay of Rs. 562 lakh during the first plan, a sum of Rs. 244.82 (43.56%) lakhs was spent. This accounted for about 9% of total expenditure. The Percentage of expenditure on agriculture to total plan expenditure was the highest in the annual plans of 1966-69, viz., 26.31% and lowest in the first plan.

Table 1.2

Plan outlays and expenditure on agriculture and allied Activities in Kerala (Rs. in lakhs)

Plans	Year	Outlay		Expenditure		
		On agriculture	% of total outlay	On agriculture	% of total outlay	% of total expenditure
1st	1951-56	562	18.71	244.82	43.56	9.45
2nd	1956-61	1532.48	17.61	1328.11	86.65	16.55
3rd	1961-66	4168.7	24.52	3557.67	85.34	19.51
Annual	1966-69	3680.25	25.82	3798.57	103.21	26.31
4th	1969-74	5458	21.12	4981.1	91.26	14.94
5th	1974-79	10745	18.89	7584.15	70.58	15.41
6th	1980.85	30588	19.73	30524	99.80	19.28
7th	1985.90	31675	15.08	30592.97	96.25	13.27
Annual	1990-91	8921	14.04	8305.61	93.1	13.93
Annual	1991-92	14550	18.02	10877.03	74.76	16.17
8th	1992-97	75125	13.76	NA	NA	NA

Source: Farm Guide, Farm Information Bureau, Thiruvananthapuram.

The primary sector continues to be the single largest sector contributing 31.4% of the State income (during the year 1996-97), the contribution of the other two sectors, secondary and tertiary, being about 24.7% and 43.9% respectively. That the primary sector still dominates the economy of Kerala, in terms of its contribution to net State Domestic Product (SDP) is obvious from table 1.3, though its share has come down from 54.59% in 1960-61 to 29.38% in 1994-95. Share of agriculture to per capita SDP underwent only very little change (increased at a compound growth rate of 0.2%) during the past 35 years.

A comparison of the growth rates of SDP and agriculture and allied activities, given in table 1.3, reveals more about the performance of agriculture sector. SDP and per capita SDP increased at a compound growth rate of 30.8% and 23.4% respectively during 1960-61 to 1994-95. Annual growth rates of agriculture and allied sectors were worst and even negative in

Table 1.3
Share of agriculture to net SDP and per capita SDP and their annual growth rates in Kerala

Year	Share of agriculture to net SDP	Share of agriculture to PC SDP	Annual growth rates of net SDP	Annual growth rates of PC SDP	Annual growth rates of Agriculture
1960-61	54.59	91.07	—	—	—
1965-66	53.39	100.21	16.46	13.80	20.09
1970-71	52.92	111.53	10.73	8.11	11.12
1975-76	41.07	95.92	6.84	4.84	-2.04
1980-81	36.94	93.49	11.09	8.97	5.30
1981-82	38.82	90.48	-3.88	3.83	0.49
1982-83	35.65	93.29	26.26	13.07	16.58
1983-84	38.81	103.43	17.96	15.81	28.40
1984-85	39.02	105.96	13.86	11.74	14.47
1985-86	33.96	93.91	3.56	1.71	-9.85
1986-87	34.58	97.43	12.90	10.79	14.94
1987-88	31.69	89.10	23.60	23.87	13.29
1988-89	31.14	88.44	11.19	10.08	9.26
1989-90	28.92	82.98	16.18	15.00	7.91
1990-91	28.85	83.63	14.32	13.15	14.04
1991-92	34.92	102.61	23.84	22.18	49.90
1992-93	31.68	94.34	13.73	12.22	3.18
1993-94	30.72	92.60	14.52	13.11	11.02
1994-95	29.38	89.85	11.98	10.38	7.10
CGR	-5.70	0.20	30.80	23.40	23.70

Source: Computed from available data.

the years 1971-72, 1975-76, 1977-78 and 1985-86. Growth rate of agriculture was greatest in 1991-92 (49.9%). At the same time, it increased at a compound growth rate of 23.7%.

Further, within the primary sector, the agricultural crop production remains the most important single activity contributing more than 98% of the SDP in the primary sector. Table 1.4 clearly reveals that agricultural

Table 1.4
Net SDP at factor cost by industry of origin
(at current prices) 1980-81 to 1996-97
(Rs. in lakhs)

Year	Agriculture	Forestry &logging	Fishing	Mining & Quarrying	Primary
1980-81	129384.0 (86.27)	12382.00 (8.26)	7743.00 (5.16)	461.00 (0.31)	149970.00 (100.00)
1990-91	351843.00 (87.83)	8376.00 (2.09)	37193.00 (9.28)	3189.00 (0.80)	400601.00 (100.00)
1991-92	527417.00 (88.78)	12446.00 (2.10)	50685.00 (8.53)	3528.00 (0.59)	594076.00 (100.00)
1992-93	544163.00 (87.94)	14477.00 (2.34)	56049.00 (9.06)	4106.00 (0.66)	618795.00 (100.00)
1993-94	604125.00 (87.50)	23118.00 (3.35)	58494.00 (8.47)	4712.00 (0.68)	690449.00 (100.00)
1994-95	756528.00 (86.49)	34591.00 (3.95)	77968.00 (8.91)	5586.00 (0.64)	874673.00 (100.00)
1995-96⊗	839140.00 (86.53)	40126.00 (4.14)	84011.00 (8.66)	6511.00 (0.67)	969788.00 (100.00)
1996-97⊗⊗	950326.00 (86.80)	46546.00 (4.25)	90521.00 (8.27)	7472.00 (0.68)	1094865.0 (100.00)

"⊗" - Provisional
"⊗⊗" - Quick estimate
Figures in parentheses represent percentages to total.
Source : Economic Review 1997, Government of Kerala, State Planning Board, Thiruvananthapuram.

sector alone contributes more than 85% of net SDP in the primary sector. The agricultural production sector, therefore, deserves special and separate treatment.

1.1. Need and Significance of the Study

Technological development of the last four decades helped us to come up to the level of 199 million tones of total foodgrains production during the year 1996-97, as against just 50.82 million tones in the year 1950-51.

But since the adoption of our first five-year plan in 1951, there has been a sharp rise or fall in agricultural production from time to time. Year to year changes in the production of individual farm commodities was much greater than changes in production of farm commodities in aggregate. This difference is principally due to the fact that expansion in production of some commodities is partially offset by contraction of production of others. Also unplanned changes exert more influence on the production of individual farm commodities than on total agricultural output. For example, good weather conditions in one area may increase production of commodities in that area enough to offset the effects of adverse weather conditions in other areas and leave total production unchanged. Similarly, short-term changes in production of agricultural commodities are quite different from long-term changes because it takes time for variation concerning changes in consumption patterns and prices to reach farmers in order that they can plan changes in production of individual commodities. Thus, a study about individual farm commodities will give a clear-cut idea about the instabilities in production. Also, since production of a crop is much affected by its productivity levels and prices, it is of great interest to study the instabilities of productivity and prices along with instabilities in production.

For proper planning and policy formulation, it is a matter of paramount importance to study the behaviour of farmer's attitudes towards price variations. Generally, variations in agriculture occur through time and overspace. Variations over time comprises long term trend, cyclical, year to year and seasonal variations. Comparison of actual series with trend and cyclical series will give a clear-cut idea about the existing series, which will be useful for future planning purposes. Also, it will be useful to know what type of oscillatory series existed in the production, productivity and prices of agricultural commodities of Kerala during the last 36 years.

Macro economic phenomena (in particular, inflation and monetary policy) affect relative performances of agricultural sector (**Vining and Thomas**, 1976[1]; **Lapp and Smith**, 1992[2] etc.). Do macroeconomic conditions affect the relative variability of the structure of commodity prices within the agricultural sector of Kerala? If they do, any policy to stabilise agricultural prices should include programs that promote the stability of the macro-economy.

We know that direct and indirect government interventions influence general price levels and individual commodity prices of the economy. Union government introduced economic liberalization in July 1991. Privatization and fiscal reforms that accompanied economic reforms of 1991 certainly affect agricultural prices (**Gulati and Sharma**, 1977[3]; **Rao**, 1998[4]; World Bank Study,

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[1] Vining, David J and Thomas C Elwertowski (1976) "The relationship between relative prices and the general price level", American Economic Review, Vol. 66, PP 699-708.
[2] Lapp, John S and Smith, Vincent, H (1992), "Aggregate sources of relative price variability among agricultural commodities", American Journal of Agricultural Economics, Vol. 74, No. 1, February.
[3] Gulati, A and Sharma, A. (1997), ' Freeing trade in agriculture: implications for resource use efficiency and cropping pattern changes", Economic and political weekly, Vol. XXX11, No. 52, December.
[4] Rao, C. H. Hanumantha, (1998), "Agricultural growth, sustainability and poverty alleviation : recent trends and major issues of reform", Economic and political weekly, Vol. XXX111, Nos. 29 and 30, July.

1996[5] etc.). In the present study, an attempt is made to identity and measure changes in price levels and price variances of Kerala's agricultural commodities that accompanied economic reform.

Majority of researchers in agricultural economics has focussed their attention on production economics than on marketing, assuming that the shortages in food supplies can be overcome by improved production technologies and farming systems. Less emphasis has been given to marketing, ignoring the fact that in any free market economy only market forces guide resource allocation. If the markets are imperfect, mere improvement in the production technologies will not serve the purpose. Studies in marketing are either theoretical in nature or case studies with limited scope and purpose. Many studies, particularly on market integration, distribution channels etc. are conducted in a routine manner by adopting out-dated research techniques. In our study we have made an attempt in this direction also, emphasizing agricultural markets in Kerala.

The relation between prices, production and productivity is important and useful because it is the degree of responsiveness of output and productivity to changing prices on which effectiveness of a price policy depends. It is a known fact that price and productivity are two important components, which influence acreage under any crop. Increase in productivity supported by a stable

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[5] World Bank country study, India : Five years of stabilisation and reform and the challenges ahead, Washington, D C., 1996.

price helps in increasing acreage under any crop (**Ahmed and Bhowmick**, 1991[6]). Also growth rates in relative and farm prices of crops were able to explain the shift in area of the crops like rice, coconut, tapioca etc. (**P. K. Sivanandan**, 1985[7]). Here an attempt is made to examine empirically the extent of relation between production, productivity and prices of agricultural commodities in Kerala.

The problem of price rise has been very much widely discussed at the all India level, but very little in the context of any particular state economy and at the inter-regional level. In the past, little attempts had been made to study the inter-relationships of production, productivity and prices of individual agricultural commodities at the country level, not to speak of at a regional level. This research is towards regional analysis. In fact, in a wast country like India, where each region basically differs from ecological, social and economic structural point of view, analysis of any phenomenon at the national level cannot give a realistic picture. Every economic phenomenon is to be studied and analysed in a particular regional framework. Especially, price levels is the net result of the interaction between demand and supply forces which covers directly or indirectly almost all aspects of the economy and differs region-wise. Features of agricultural production, productivity and prices in the past and their interrelationships in the agricultural field can be made useful only when it is

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[6] Ahmed, A.V. and Bhowmick, B. C (1991), " Behaviour of price, productivity and acreage response of some important crops in Assam", Agricultural Situation in India, Vol. XLV1, No. 4, July.

[7] Sivandandan, P. K.(1985), Kerala's agricultural performance: differential trends and determinants of growth, Mphil thesis, Centre for Development Studies, Thiruvananthapuram.

studied and analysed at regional level. Hence, this study is carried out to solve the above problems quantitatively with the following objectives.

1.2. Objectives of the Study

The important objectives of the study are:

(1) To assess the extent of growth and instability in agricultural production, productivity and prices of Kerala after 1960.

(2) To analyse the cyclical phenomenon in agricultural production, productivity and prices and to measure their length.

(3) To analyse the impact of price movements on agricultural production and productivity and to establish their inter-relationships.

(4) To identity aggregate sources of relative price variability of agricultural commodities of Kerala.

(5) To examine the variability of agricultural prices before and after 1991.

(6) To test inter-district price integration of agricultural commodities.

Specifying these objectives, this study also attempts to test the following hypotheses.

(a) Growth rate of prices (both farm and wholesale prices) was greater than that of production and productivity in agriculture.

(b) Moving average type of cyclical series exists in production, productivity and prices of Kerala agriculture.

(c) Macro economic conditions affect the relative price variability of commodity prices within agriculture.

(d) Agricultural price variability increased after 1991.

1.3.Review of Literature

The purpose of this part is to review some of the major contributions in the field of regional and temporal analysis reflecting the features of agricultural production, productivity and prices. Analytical studies of spatial and temporal factors related to this field are numerous but very old. During the recent past, studies have been made both by Government and individual researchers dealing with agricultural production, its components, trend, productivity variations, price movements' etc. For convenience, we classify earlier studies into three groups. Studies related to (a) growth and instability of agriculture, (b) price efficiency and (c) price responses. Important studies from each of these three groups are briefly summarized below.

1.3.1. Studies related to growth and instability of agriculture

Growth and instability of agriculture has been discussed widely. At the international level differences in agricultural productivity among countries have been examined in a number of studies. **Hayami and Rutton** (1971)[8], **Binswanger and Rutton** (1979)[9] and **Evenson and Kinslev** (1975)[10], **Nguyen** (1979)[11] and **Yamada and Rutton** (1980)[12] and **Romesh and Renu** (1986)[13] have done most extensive work.

At the national level, studies have been made by taking examples of states other than Kerala or by comparing different states. Existence of variations in production and productivity across states in India has been investigated in a number of studies. Among the studies of analyzing agricultural growth pattern in the post-green revolution period, the study by **Bhalla and Alagh** (1979)[14] occupies prominence. In their study they have covered all the

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[8] Hayami and Rutton, V. W (1971). Agricultural development: An international perspective, John Hopekins Press.

[9] Binswanger and Rutton, V.W (1979). Induced innovation: Technology, institutions and development, John Hopekins Press.

10 Evenson, R.E and Kislev (1975). Agricultural research and productivity, New Haven, C.T., Yale University Press.

[11] Nyuyen, D (1979). "On the agricultural productivity differences among countries," American Journal of Agricultural Economics, Vol. 61, No.3, PP 565-570.

[12] Yamada, Suburo and Rutton, W. Vernon (1980). " International comparisons of productivity in agriculture." New developments in productivity measurement and analysis, Kendrick and Vaccara (Eds.), Chicago, University press for National Bureau of Economic Research.

[13] Romesh Diwan and Renu Kallianpur (1986). Productivity and technical changes in foodgrains. Tata McGraw-Hill publishing company limited, New Delhi.

[14] Balla, G. S. and Y.K. Alagh (1979), Performance of Indian agriculture: A district-wise study. Sterling Publishers Pvt. Ltd., New Delhi.

districts of the 13 states considering nineteen major crops and have compared performance of the sector in two time periods, 1962-65 and 1970-73. These two periods were taken as pre and post- green revolution period. The study finds that assured irrigation and high rainfall determine high level of productivity. They also found that modern inputs are highly concentrated in the high productivity regions as well as high growth areas and there exists large-scale variations in the level of productivity across the regions.

Mahendradev (1987)[15] studied growth pattern and instability in the foodgrains production for the period 1970-71 to 1984-85. This inter-state analysis covering 17 states emphasizes more on the instability in the foodgrain production. The study found that rainfall and weather explain growth in foodgrains production at all India level and state level and points out that, most of the states, which recorded high growth rates, have shown significant instability in foodgrain production. The study concludes that the states, which recorded low growth with increasing instability, show high incidence of poverty.

Bhalla and Tyagi (1989)[16] analyzed patterns in the development of Indian agriculture in their district-level study, which covered 17 major states and 19 crops. The study period was 1962-65, 1970-73 and 1980-83 which they named as 60's, 70's and 80's respectively. In their study, they also

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[15]Mahendradev, S. (1987), " Growth and instability in foodgrains production: An inter-state analysis", Economic and Political Weekly, Vol. 22, No. 39, September 26.

analyzed state level performance in the growth of production and yield. Their study revealed that large inter-district disparities in productivity level that was already in existence got further accentuated due to the introduction of new technology in 60's.

Dholakia and Dholakia (1993)[17] had undertaken a study on the growth pattern in the agricultural sector with special reference to total factor productivity growth. They have estimated sources of growth of Indian agriculture for three sub-periods during 1950-51 to 1988-89. Total Factor Productivity Growth (TFPG) has contributed significantly to the acceleration of agricultural growth facilitating release of scarce resources from agriculture to other sectors of the economy. To them TFPG in agriculture has been the driving force behind the acceleration of overall growth of the Indian economy during eighties. They found modern inputs like fertilizers, HYV seeds and irrigation to be the major determinants of the TFPG.

Sawant and Achuthan (1995)[18] analyzed agricultural growth across crops and regions. They have taken post green revolution period, 1967-68 to 1992-93 and divided the total period into two sub periods as 1967-68 to 1980-81 and 1981-82 to 1992-93. This study covered 15 states excluding two major states Jammu and Kashmir and Himachal Pradesh, where growth pattern

[16] **Bhalla, G. S. and D. S. Tyagi (1989),** "<u>Spatial pattern of agricultural development in India</u>", **Economic and Political Weekly, Vol. 24, No. 25, June 24, PP. A46-56.**

[17] **Dholakia, R. H. and B.H. Dholakia (1993),** "<u>Growth of total factor productivity in Indian agriculture</u>", Indian Economic Review, Vol. 28, No. 1, January-June.

in the above mentioned period is quite impressive. The study did not cover all the major crops, but only considered the crops, which have significant contributions to the total agricultural production. Methodology of the calculation of growth rates and estimating index number is not properly explained and justified in this study.

Studies relating to individual states forms part of discussions for majority of researches. **Singh** (1981)[19] revealed that contribution of changes in area, yield and cropping pattern were positive towards the growth of aggregate output in Himachal Pradesh during the pre-green revolution period, green revolution period and overall period. However, the interaction effect of first order between yield and cropping pattern and second order interaction between area, yield and cropping pattern was negative in all the periods.

Ashok Parikh (1970)[20] says that contribution of increase in area in explaining output per acre was very high. Chemical fertilizers do not have any importance for the output growth in Madras. Rainfall is a critical variable in the disaggregate analysis and in a region where irrigation facilities are dependent on rain-fed sources, this variable cannot be ignored.

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[18] Sawant, S.D. and C.V.Achutan (1995), " Agricultural growth across crops and regions: Emerging trends and patterns", Economic and Political Weekly, Vol. 30, No. 12, March 25.
[19] Singh, D. V, (1981) "A component analysis and value productivity growth of important crops in Himachal Pradesh." Agricultural Situation in India, Vol. XXXVI, No. 6, September, PP 479-483.
[20] Ashok Parikh (1970). " Cropwise districtwise production functions." Indian Journal of Agricultural Economics, Vol. 25, No.1, January-March.

Shad et. al. (1989)[21] concluded that price structure had a favourable effect on the increase in productivity of ginger under all the five-year plans. The interaction effect of cropping pattern and yield was negative under first, second and fourth five year plans but this effect was favourable under third, fifth, sixth and annual plans and was highest during the sixth plan. It would be seen that individual effect of area to the growth of production of ginger remained favourable under all the five-year plans excepting the sixth plan when the effect of area was negative. Price structure also affected production favourably except in the sixth plan.

Singh (1991)[22] revealed that growth of production and yield of coarse cereals and pulses have not only declined in the post-sixties but have actually become negative. Operation of procurement price led to resource allocation effects on our foodgrain economy. In a situation where there is tremendous pressure on cultivable land, this could have had the effect of shifting area and yield raising investments away from crops which are less attractive now, leading to a fall in the rate of growth of output and yield of crops which have not received such price support from Government on a continuous basis.

Increasing production instability may adversely affect production efficiency and income distribution through wider price fluctuations.

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[21] **Shad, S.K, Sharma, S.L and Bhatti, J. P. (1989). "Disaggregation of trends in production and productivity of ginger under the Plans in Himachal Pradesh." Agricultural Situation in India, Vol. XLIV, No. 3., June, PP 189-194.**

Pal and Sirohi (1989)[23] revealed that growth in area and yield was almost equally important for the increase in production. The interaction between changes in mean area and yield was more important for the increase in cereal production. Changes in area – yield covariance accounted for very small proportion of change in production of all crops. Also it is interesting to note that although production instability decreased, yield instability increased in pulses, while in other crops they moved in the same direction. The study also indicated that there were not only pure effects of area and yield which led to higher production instability, but simultaneous changes in area and yield also destabilized production to a larger extent.

There has been considerable interest in understanding the nature and magnitude of instability in agriculture, causes underlying them and likely measures to reduce it. **Ray** (1983)[24], **Mitra** (1990)[25], **Singh and Byerlee** (1990)[26] etc. were concerned only about instability in agricultural production at regional level. **Jha** (1994)[27] enquires about instability in farmer's agricultural income associated with New Agricultural Technology at disaggregated level. He

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[22] Singh, A. R. (1991). Aspects of price determination in the foodgrain sector of India 1951-89, Mphil thesis, Centre for Development Studies, Thiruvananthapuram.

[23] Pal, Suresh and Sirohi, A. S. (1989), " Sources of growth and instability in Indian crop production – A decomposition analysis." Agricultural Situation in India, Vol. XLIII, No. 11, February, PP 933-6.

[24] Ray, S. K. (1983). "An empirical investigation of the nature and causes for growth and instability in Indian agriculture: 1950-80". Indian Journal of Agricultural Economics, Vol. 31, PP 459-474.

[25] Mitra, A. K. (1990). "Agricultural production in Maharashtra – Growth and instability in the context of new technology". Economic and Political Weekly, Vol. 25, PP A146-A164.

[26] Singh, A. J. and Byerlee, D. (1990). "Relative variability in wheat yields across countries and over time", Journal of Agricultural Economics, Vol. 40, pp. 21-32.

found that instability in gross return and yield largely declined over years (1972-73 to 1990-91). The decline in yield instability in crop viz. paddy and wheat was brought about with increased area under irrigation over years. Nevertheless, Government's consistent price policy also helped in reduction of instability in farm harvest prices. Thus, it can be inferred that with new technology, instability in agricultural income was reduced with adequate irrigation facilities and consistent price policy. However, hypothesis of high instability in agriculture accompanied with high growth rate also was established.

Findings of **Mehra** (1981)[28], **Hazell** (1982,1984)[29], **Walker** (1984)[30] and **Kaushik** (1993)[31] revealed that growth in crop production during the post green revolution period has been accomplished with increased instability and yield fluctuations and it turned out to be a major source of production instability. The instability in agricultural production causes wide fluctuation in agricultural prices and destabilizes farm incomes. The poor consumers who spend a considerable amount of food are also adversely affected by price fluctuation.

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[27] Jha, B. K. (1994). "Growth and instability in agriculture associated with New Agricultural Technology – District level evidence", Agricultural Situation in India, Vol. XLIX, No. 7., October.

[28] Mehra. S. (1981). Instability in Indian agriculture in the context of the New Technology, Research report 25, International Food Policy Research Institute, Washington, D. C., USA.

[29] Hazell, P. B. R. (1982), Instability in Indian Foodgrain production, Research report 30, International Food Policy Research Institute, Washington, D C, USA.

Hazell, P. B. R. (1984), " Sources of increased instability in Indian and US cereal production." American Journal of Agricultural Economics, Vol. 66, No.3, PP 302-31.

[30] Walker, T. S. (1984), High Yielding Varieties and Instability in Sorghum and pearl Millet production in India. Economics Programmes, Progress Report No. 63, International Crop Research Institute for Semi-Arid Tropics, India.

[31] Kaushik, K K. (1993) "Growth and instability of oilseeds production." Indian Journal of Agricultural Economics, Vol. 48, No.3, July-September, PP 334-338.

Narain (1977)[32] decomposed index of productivity on the basis of data pertaining to area and production with the base period triennium ending 1961-62 confined to 32 crops. Results revealed that almost 70% of the increases in productivity in 1952-53 to 1960-61 was produced by changes in the cropping pattern and locational shifts of areas under individual crops and only 30% by pure increases in per hectare yields. The picture underwent a reversal in the 1960-61 to 1972-73 period with pure increases in yields accounting for over 60% of the increase in productivity while cropping pattern changes and locational shifts accounted for under 40% of the increase.

Tripathy and Gowda (1995)[33] examined sources of instability of foodgrains production between 1970-71 to 1979-80 and their identified sources of instability were individual crop variances within districts, inter-crop covariances within districts, inter-district covariances within crops and covariances between crops in different districts.

In Kerala, **Jeromi** (1994)[34] examined growth and instabilities in area, production and productivity of pepper. Results showed that the annual compound growth rate of area under pepper in Kerala from 1950-51 to 1989-90 was 1.25%. Decade wise growth trends showed that during 50's and 60's the

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[32] Narain, Dharm (1977), " Growth of productivity in Indian Agriculture." Indian Journal of Agricultural Economics, Vol. 32, No.1, January-March, PP 1-44.
[33] Tripathy.S and Gowda M.V. (1995) "Sources of variability of foodgrains production in Orissa". Indian Journal of Agricultural Economics, Vol. 50, No.4, October-December.
[34] Jeromi, P. D. (1994), " Growth of pepper economy of Kerala." Agricultural Situation in India, Vol. XLIII, No. 11.

annual compound growth rate of area were 2.13 and 0.84% respectively. However, during 70's the growth rate had turned out to be negative (-1.46%). 80's registered a positive and significant growth rate of 4.95% per annum. However, in comparison with all other sub-periods the instability in growth of area was higher during this period. The compound growth rate of productivity of pepper during 1950-51 to 1989-90 recorded a significant negative growth (-0.47%). It indirectly shows that growth rate of area was the major contributor to production rather than yield.

Pushpangadan (1988)[35] showed that growth rate of output of tapioca in Kerala slowed down during 1963-86. At the same time, mean instability index in production and its components, area and yield had declined. His hypothesis that falling demand constrained growth of output seemed to be empirically valid. To him, market for tapioca followed a divergent cobweb, which results in the loss of income for the cultivators.

Ajit Kumar and Indira Devi (1995)[36] analyzed variability and trends in area, production and productivity of tea in Kerala for the period 1965-66 to 1989-90. The study revealed that variation in area of tea was highest (11.66%) in 1965-70. Overall variability in area was worked out as 4.98% and that of production and productivity was 12.19% and 14.84% respectively. The

[35] Pushpangadan, K. (1988). Agricultural stagnation in Kerala: An econometric study of tapioca. Working Paper No. 226, Centre for Development Studies, Thiruvanthapuram, Kerala.
[36] Ajit Kumar, P. K. and Indiradevi, P (1995). " Variability and trends in area, production and productivity of tea in Kerala," Agricultural Situation in India, Vol. XLXI, No. 11, February.

productivity and production showed highest level of variability during 1980-90. They concluded that production was dependent more on productivity than area under tea.

Why the Technology, which helped to accentuate productivity growth in tapioca and rubber, has failed in the case of rice? **George** (1979)[37] says that it may be due to inadequate utilization of irrigation and other vital inputs in rice cultivation. In contrast we have the experience of plantation crops such as rubber where replantation subsidies and aggressive extension have paid rich dividends and resulted in a more than threefold increase in area and fourfold increase in production during 1952-53 to 1974-75.

According to **Narayana and Nair** (1989)[38] the decline in the yield of coconuts in Kerala can be attributed to the root-wilt disease and the existence of old palms. Other factors such as cultivation practices, input use etc. also affected the yield of coconuts over the years (1960-61 to 1984-85).

Instability of agricultural prices became part of studies for several investigators. Most of the past studies related to agricultural prices concentrated on seasonality aspect of agricultural commodities. These studies were centered on the seasonality behaviour of food crops, rice, wheat,

[37] George, M. V (1979). "Recent trends in production and productivity in Kerala agriculture." M. A Oommen (Ed). Kerala economy since independence. Oxford and IBH publishing Co., New Delhi.

sugarcane, cotton, oilseeds etc. Still few others assessed factors affecting seasonality and its impact on agricultural production.

Ganger and pandy (1985)[39] examined changes in seasonal pattern of prices of unhusked rice of Haryana State at two points of time i.e., 1966-67 and 1982-83. They found that during October, November and December months of 1976-77 to 1982-83, when an effective procurement price policy was in operation, concentration of seasonal indices of rice increased greatly. Also, during other months of the later period (1976-77 to 1982-83), prices were more stable as compared to the earlier period when there was no effective Government intervention in the rice market.

Singh (1965)[40] had shown that lowest prices in cereals exist in harvest and post-harvest months and highest prices exist in the months towards the end of the harvest months. But in non-cereals there may or may not exist seasonal pattern in prices (example jute for existence of seasonal pattern and cotton for non-existence of seasonal pattern). To him, well-organized markets reduce seasonality in prices.

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[38] Narayana, D and Nair, K.N (1989). "Trends in area, production and productivity of coconuts in Kerala." Indian Journal of Agricultural Economics, Vol. 44, No.2, April-June.
[39] Ganger, A. C. and R.N. Pandey (1985) " Price structure of rice and producer's share in consumer's price in Haryana". Indian Journal of Agricultural Economics, Vol. XL, No.3, July-September, PP 358-362.
[40] Singh. S. P. (1965). " A study on the seasonal variations in the food prices following heavy and light harvests in India." Indian Journal of Agricultural Economics, Vol. 20, No.1, January-March, PP 57-60.

While examining seasonal movements of wheat prices, **Venkataramanan and Muralidharan** (1978)[41] adopted a non-linear seasonal regression model of the form:

$P_{jt}-P_t = A_0 + A_1J + A_2J^2 + M_{jt}$. Where,

P_{jt} = wholesale price in a market in period j in year t

P_t = Average wholesale price in a market in year t

M_{jt} = Market arrivals in period j in year t

J = Number of observations within each year.

Analysis indicated upward inter-year seasonal regression in all wheat markets. Inter-year seasonal regression showed year to year variability in the seasonal pattern but confirms the upward seasonal character of price movements in all markets over years.

Report on the marketing of rice in India (1954)[42] states that the extent of fluctuations in prices from month to month varied from market to market depending upon the various factors such as nature of crop, the prospects of the next crop and the prices of the other competitive crops. This report reports that there was a tendency for cheap varieties of grains to show greater fluctuations than the fine ones.

[41] Venkataramanan, L. S. and Muralidharan (1972). " The seasonal price movements, market arrivals and returns to storage in wheat markets". Indian Journal of Agricultural Economics, Vol. 27, No.1, January-March, PP 1-14.
[42] Report on marketing of rice in India (1954), Government of India, New Delhi, PP 99-100.

Bogahawatte (1988)[43] investigates about retail and wholesale prices of rice in Colombo markets, Sri Lanka. Further, he examines the appropriateness of a forecasting procedure based on the Box-Jenkins ARIMA method for the retail and wholesale prices of rice in this market. The seasonal retail (wholesale) price increases were highest in January and December (November and December) respectively. Thus, both retail and wholesale market prices exhibit seasonality in prices. However, this is more prominent in the retail than in wholesale prices. ARIMA results indicated that the forecast values are over-estimates when compared with the actual. Ignoring seasonality, the retail prices showed that the past price history provides no improvements in forecasting future price changes.

Patnaik and Anbumozhi (1991)[44] concluded that slope of increase in prices was much in paddy prices compared to commercial crops. The prices were high during November and December, March and April and July to August (lean seasons). Prices were at their lower level during the months of January to February, May to June and September to October, as these are the harvesting seasons for paddy.

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[43] Bogahawatte, C. (1988). " Seasonal variations in retail and wholesale prices of rice in Colombo markets, Sri Lanka." Indian Journal of Agricultural Economics, Vol. 43, No.2, April-June, PP 139-147.
[44] Patnaik, Uma Sankar, and Anbumozhi, K. (1991). Price behaviour of Indian agricultural commodities. Discovery Publishing House, New Delhi.

Pavaskar (1978)[45] compared seasonal price variations with storage costs and concluded that, except for big traders who can store for longer periods, storage of oils and oilseeds does not yield abnormally large returns. This study has not probed into the relative advantage or disadvantage between final products (oil and cake) and raw materials (pods and kernel).

Agricultural prices have a tendency to display wide inter-year and intra-year fluctuations. The rise in agricultural commodity prices will be more than proportionate to the change in production (**Kahlon and Tyagi**, 1983)[46]. **Agarwal** (1986)[47] concludes that there was no significant difference in the rate of increases in wholesale and farm harvest prices. Prices of gram and pulses as a group increased at higher rates compared to cereals. Also, prices of gram and pulses have fluctuated more, resulting in higher uncertainty compared to cereals. According to **Kahlon and Singh** (1968)[48], prices of wheat and gram follow normal seasonal pattern of peak in pre-harvest months and low in post-harvest months. The trend in the prices of groundnut showed a continuous upward movement and irregular fluctuations was uniform for any period.

[45] Pavaskar, Madhoo, (1978). Behaviour of Oilseeds Prices, Tata Economic Consulting Services, Bombay.
[46] Kahlon, A. S. and Tyagi, D. S. (1983). Agricultural price policy in India, Allied Publishers Pvt. Ltd., New Delhi.
[47] Agarwal, N. L. (1986). Agricultural prices and marketing in India, Mittal Publications, New Delhi.
[48] Kahlon, A.S., and Singh, Balwinder. (1968). Marketing of Groundnut in the Punjab, Punjab Agricultural University, Ludhiana.

Selvaraj et.al (1993)[49] observed that there existed seven complete cycles (from trough to trough) in production and nine complete cycles in prices of potato during 1961-62 to 1990-91. The maximum length of cycle was 8 years and 6 years in case of production and price respectively. They also observed that oscillatory series was moving average type for both production and price series.

Narender et. al. (1989)[50] revealed that the growth of crop output in Andhra Pradesh has gone over a full circle of fluctuations over the period 1956 to 1981. It started with 1.55% per annum during 1956-59 to 1962-65, then accelerated to the highest (14.57%) in the subsequent period i.e., 1962-65 to 1966-69. It declined to 4.79% during the period 1966-69 to 1972-75 and slumped further to lowest (1.39%) during 1972-75 to 1978-81. It was 10.40% over the complete period i.e., 1956-59 to 1978-81. For the state as a whole, area contribution towards output growth was negative in all periods except during 1956-59 to 1962-65 where it was of the order of 15.51%.

Other earlier views of instabilities of agriculture were as follows. According to **Singh and George** (1971)[51], there was no visible trend indicating stable market conditions for paddy in Punjab State. Trend in price was

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[49] Selvaraj, K. N, Kailasam C, and Sivakumar, S. D. (1993). "Production and price behaviour of potato in Nilgris district, Tamil Nadu." Agricultural Situation in India, Vol. XLVII, No. 10, January.

[50] Narender, I, Madhava Swamy, G and Parthasarathy, P.B., (1989) "District-wise measurement and decomposition of the growth of agricultural output in Andhra Pradesh." Agricultural Situation in India, Vol. XLIV, No. 1, April, PP 3-8.

[51] Singh, Ranjit and George,M. V. (1971). Marketing of rice in the Punjab. Giani Printing Press, Ludiana, February.

much subdued as compared with the trend of arrivals, which is due to Government's policy of fixing ceiling price on paddy and rice. Results indicated that because of heavy arrivals of paddy, the price index was very low. On the other hand, when paddy arrivals are the lowest, the price indices are the highest in all markets. **Majundar** (1965)[52] supports that producer's share of the consumer rupee was generally low in the marketing period and high in the lean supply period, which was borne out by a study conducted by Ministry of food and Agriculture (1963)[53] in respect of rice in Andhra Pradesh and Madras for the year 1962. According to **Prabha** (1985)[54], relative movement of prices of rice may not be highly positively correlated with movement in the prices of other cereals like cholam, cumbu and ragi. The seasonal price rise of rice from trough to peak was less than 15% in 10 out of 23 years, while it was more than 20% in another 10 years during 1955 to 1977. **Mahanty** (1985)[55] reveals that with the increase in production, there was reduction in geographical price variations. The weather effect was detrimental to price stability – thereby indicating the vulnerability of crop production and prices to abnormal rainfall. According to **Atteri et al.** (1985)[56], the prices of agricultural commodities were determined by supply and demand gaps of the current as well as the previous year. The relative prices of

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[52] Majundar, N. A. (1965). "Some notes on the price policy implications of State Trading in Foodgrains", Indian Journal of Agricultural Economics, Vol. 20, No.1, January-March, PP 53-56.
[53] Ministry of food and agriculture, Report on the Agricultural price policy in India, Government of India, New Delhi, No.114 and 115 February 1963 (mimeo).
[54] Prabha (1985). " Structure and behaviour of cereal prices in Tamil Nadu." Indian Journal of Agricultural Economics, Vol. XL, No.3, July-September , PP 407-408.
[55] Mahanty, B (1985). "Inter-district price instability in agriculture – A case study of Punjab." Agricultural Situation in India, Vol. XXXIX, No. 11 February, PP 837-842.

crops are also influenced by the relative demand and supply situations for the crops. **Buccolo** (1985)[57] revealed that under constant market information, variability of unpredictable price deviations was lower in centralized than in non-centralized markets. To the extent that mean-squared loss is an acceptable weighting criterion, centralized pricing appears more efficient than non-centralized pricing.

1.3.2. Studies related to price efficiency

Empirical studies dealing with price efficiency were very few. Most of them are related to markets outside Kerala. **Jasdanwalla** (1966)[58], **Singh and Arora** (1975)[59], and **Raju and Von Oppen** (1982)[60] studied whether movements in groundnut prices across markets and various product forms are synchronized or divergent. A common conclusion was that they were significantly correlated implying perfect system of price signaling. However, **Singh** (1965)[61] observed dissimilar behaviour in groundnut prices between Bombay, Hyderabad

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[56] Atteri, B.R., Kumar, A and M. A. Muralidharan (1985). " Factors affecting the prices of some important agricultural commodities in India." Agricultural Situation in India, Vol. XL, No. 8 November, PP 683-687.

[57] Buccolo, Steven T (1985). " Pricing efficiency in centralized and non-centralized markets" American Journal of Agricultural Economics, Vol. 67, No.3, August, PP 583-90.

[58] Jasdanwalla, Z.Y. (1966). Marketing Efficiency in Indian Agriculture, Allied Publishers, Bombay.

[59] Singh, Balwinder, and Arora, B. S. (1975). "An Analytical Study on Spatial Differentials in Groundnut In Punjab Markets", Agricultural Marketing, XVIII (3) PP 5-12.

[60] Raju, V. T and Von Oppen,M. (1982). Marketing efficiency for selected crops in Semi-Arid Tropical India. Progress report 32, ICRISAT Economics Program, Patancheru, Andhra Pradesh, India.

[61] Singh, H. S. (1965). "Price Movements and Degree of Market Integration: Study of Groundnut and Jowar Markets paper 68-80", Indian Society of Agricultural Economics, Seminar on Market of Agricultural Commodities Seminar Series 5, Bombay.

and Kanpur markets during 1962-63. Correlation coefficient as a measure of market integration can serve only as an indicator of likelihood, given the many assumptions about market structure and conduct. Generally, some markets play the role of price setters and others take the clue from them, perhaps reflecting the price behaviour with some lag. The above studies have not probed into such aspects.

Von Oppen et al. (1979)[62] studied about the factors affecting pricing efficiency in the markets. They found that factors like distance between markets, size and age of markets, number of traders and commission agents, turnover of traders, density of crop production and population, number of telephones, markets arrivals per unit, size of market yard, etc., significantly influence the degree of marketing efficiency.

Kulkarni (1965)[63], **Kahlon and Singh** (1968)[64], **Singh and Arora** (1975)[65] and **Pavaskar** (1978)[66] studied pricing efficiency by analyzing marketing margins. **Kulkarni** (1965) explained how prices in terminal markets influence price formation in assembling markets. He found it unprofitable to

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[62] Von Oppen, M., Raju, V. T., and Bapna, S. L., (1979). Foodgrain Marketing and Agricultural Development in India, pages 173-92 in Proceedings of the International Workshop on Socio-Economic Constraints to Development of Semi-Arid Tropical Agriculture, ICRISAT, Hyderabad, 19-23 February.

[63] Kulkarni, A. P. (1965). Price Spread for Groundnut in two Regulated Markets, pages 147-55 in Seminar on Marketing of Agricultural Commodities, Indian Society of Agricultural Economics Series 5, Bombay.

[64] Ibid, footnote, no. 49.

[65] Ibid, footnote, no. 59.

[66] Pavaskar, Madhoo, (1978). Behaviour of Oilseeds Prices, Tata Economic Consulting Services, Bombay.

purchase pods in the assembling markets, produce oil and cake, and sells them in Bombay or other local market. This observation was based on only four days price observations. As such further investigation based on comprehensive data might be required to fully endorse his findings.

Kahlon and Singh (1968) and **Singh and Arora** (1975) analyzed inter-market price differentials and found that prices in big markets are higher due to concentration of commission agents and processors. They also found traders making profits by buying product from small markets and selling them in big markets.

Narasimham (1994)[67] studied how groundnut markets were integrated using Koyck's distributed lag model. Results justified the fact that oil price at higher level market influenced the lower level markets. Oil price formed in the lower level markets in turn influenced intra-market oil retail price on the one hand, and pods and kernal prices on the other. He observed that a rupee increase in oil price at higher level markets resulted in an increase of Re.0.12 to 0.34 in the local markets on the same day and a rupee increase in the long run. But to realize 90% of the long-run effect, 5 to 19 days are required. Also to realize 90% of intra-market effects, two to ten days are required.

[67] Narasimham, N. V., (1994). A Model for Commodity Price System Analysis. Himalaya Publishing House, Bombay. 1994.

Kulkarni (1965) examines the price behaviour of food crops recorded in a regulated market. His analysis showed that from 1959-60 through 1961-62, there was a continuous declining trend in paddy prices at Ghoti, Nasik and Bombay. Monthly prices of regulated markets do not show any association with the local supplies and was largely determined by the prices prevailing in other regulated markets. However, the local supply has significant influence on the price paid for the largest consignment marketed in bulk. If the total arrivals are large, the price paid for it is lower than the one paid when the total arrivals are small.

1.3.3. Studies related to price response

Although supply response has been a heavily researched topic, the literature on the response of aggregate output to price changes is rather sparse. The table 1.5 gives the important contributions made in the past by several researchers.

On the basis of tools and techniques used for measuring farmer's response to prices, empirical studies of supply responsiveness can be divided into three groups. The first of studies has used graphic and tabular analysis. The main names to be mentioned here are **Dharm Narain**[68], **Jakhade**

[68] Dharm Narain (1965). Impact of price movements on areas under selected crops in India 1900-1939. Cambridge University Press, London.

Table 1.5
Some Econometric Estimates of Aggregate Agricultural Price Response in Developing Countries

Country/Region	Period	Short-run estimates	long-run estimates	Notes/Sources
Other Countries				
Argentina	1950-74	0.21-0.35	0.42-0.78	Reca(1980)[69]
Ghana	1963-81	0.02	0.34	Bond(1983)[70]
Keyna	1966-80	0.10	0.16	Bond(1983)
Pakistan	1951-88	0.18	0.73	Qureshi & others(1985)[71]
India				
Punjab	1907-46	0.6-0.17	NA	Herdt(1970)[72]
Rajasthan	1956-74	0.24	NA	Bapna(1980)[73]
Semi-Arid Tropical	1955-74	0.09	NA	Bapna&others(1984)[74] Used Panel Data
85 Districts	1961-82	0.13	NA	Binswanger(1989)[75]
All- India	1982-75	0.18	0.30	Krishna(1982)[76]
All- India	1954-78	0.2-0.3	0.2-0.3	Chhiber(1988a)[77]

[69] Reca, Lucio, G (1980). Argentina: Country case study of agricultural prices, taxes and subsidies, World Bank working paper 386, Washington, D C.
[70] Bond, Marian, E (1983). Agricultural responses to prices in Sub-Saharan Africa, International Monetary Fund staff papers 30, No. 4, PP 703-26.
[71] Qureshi, S. K, S J Malick and A N Siddique (1985). Some aspects of agricultural price and taxation policies in Pakistan, Pakistan Institute of Development Economics, Research paper series No. 146, September, Islamabad.
[72] Herdt, Robert W (1970). "A disaggregate approach to aggregate supply", American Journal of Agricultural Economics, Vol. 52, November, PP 512-20.
[73] Bapna, Shanti L (1980). Aggregate supply responses of crops in a developing region, New Delhi, Sultan chand and sons.
[74] Bapna, Shanti L, Binswanger, Hans P and Quizon, Jaime B (1984). " Systems of output supply and factor demand equations for semi-arid tropical India", Indian Journal of Agricultural Economics, Vol. 39, No.2, PP 179-202.
[75] Binswanger, Hans P (1989). The policy response of agriculture, Proceedings of the world bank annual conference on Development Economics, Supplement to the world bank economic review, PP 231-58.
[76] Krishna, Raj (1982). Some aspects of agricultural growth, price policy and equity in Developing countries, Food Research Institute Studies, Vol. 18, No. 3, PP 239-60.
[77] Chhibber, Ajay (1988a). " The aggregate supply response in agriculture : A survey", S. Commander (Ed), Structural adjustment in agriculture : Theory and practice, James Curry Publishers, London.

All- India	1951-88	0.05-0.19	0.09-0.79	Palanivel(1995)[78] Aggregate farm output
All- India	1951-88	0.09-0.23	0.17-0.83	Palanivel(1995) Aggregate crop output
All- India	1951-88	0.07-0.18	0.14-0.72	Palanivel(1995) Gross value added in agriculture

and **Majundar**[79], **M V George**[80], **Gupta and Majid**[81] and lastly **Kamaladevi**[82]. The last followed a method in which the ranks of changes in prices and acreage of different crops during two periods are examined; she made use of not monthly price quotations but averages of 5 years. The second group of studies used regression or correlation coefficient. Names to remember are **Robert M Stern**[83] studying Bengal, Orissa and Bihar, **Subbarao**[84] for Andhra Pradesh, **S M Hussain**[85] for East Pakistan and **P V John**[86] for India. The third group of studies used multiple regression. Names to be recalled in this context are **Rao and Raj**

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[78] Palanivel, T (1995), "Aggregate supply response in Indian agriculture: some empirical evidence and policy implications", The Indian Economic Review, Vol. XXX (2) July-December, PP 251-63.

[79] Jakhade, V. M. and Majumdar, N. A. (1964). Response of agriculture producers to price – A case of jute and rice in India. Indian Journal of Agricultural Economics, Vol. 19.

[80] George, M. V (1979). "Recent trends in production and productivity in Kerala agriculture." M. A Oommen (Ed). Kerala economy since independence. Oxford and IBH publishing Co., New Delhi.

[81] Gupta S. C. and Majid, M. (1965). Producer's response to change in price and marketing policies, Bombay.

[82] Kamaladevi, P. (1964). "Response of acreage to change in price – A study in Madras state." Economic Weekly, September 19.

[83] Robert Stern, M. (1962). " Price responsiveness of primary producers." The review of Economics, Vol. 44.

[84] Subbarao, K. (1969). " Farm supply response – A case study of sugarcane in Andhra Pradesh." Indian Journal of Agricultural Economics, Vol. 24.

[85] Hussain, S. M. (1964). "A note on farmer's response to price in East Pakisthan." The Pakistan Development Review, Vol. 4.

[86] John P.V. (1968). Some aspects of the structure of Indian agricultural economy: 1947-48 to 1961-62. Asia Publishing House, Bombay.

Krishna[87], **Satyanarayana**[88], **W. Herdt**[89], **D. Romesh**[90] and **Raj Krishna**[91].

Dharm Narain (1965) in his analysis of the impact of price movements on acreage, observed oscillatory movements of cyclical character in both acreage and relative price of sugarcane. "Durations of cycles are not uniform but the tendency for both area and price to trace cycles of approximately four to six year's duration persists through out." He argues that "price cycles are, in the main, supply cycles and area cycles are, in the main, price inspired."

Expounding the cobweb hypothesis, **Ezekiel** (1938)[92] had enunciated three conditions which must be fulfilled, viz., (a) production is entirely determined by producer's response to price under conditions of pure competition, (b) atleast one full period is required before production can be changed, and (c) the price is set by available supply. It is quite clear that while the first two may be

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[87] Rao, M. S. and Raj Krishna. (1965). " Price expectations and acreage response for wheat in Uttar Pradesh." Indian Journal of Agricultural Economics, Vol. 20.
[88] Satyanarayana, Y. (1970). " Factors affecting acreage under sugarcane in India." Indian Journal of Agricultural Economics, Vol. 52.
[89] Ibid, footnote No. 71
[90] Romesh, D. (1965). " Long and short-term elasticities of acreage under crops." Agricultural Situation in India, Vol. XX.
[91] Ibid, footnote No. 75.
[92] Ezikiel. M. (1938), "The cobweb theorem", Quarterly Journal of Economics, Vol. LII, No., 1 February, PP 272.
[93] Waugh. F V., (1964) "cobweb models", Journal of Farm Economics, Vol. 46, No.4, November.
[94] Jha D. and C C Maji. (1971), " Cobweb phenomenon and fluctuations in sugarcane acreage in north Bihar." Indian Journal of Agricultural Economics, Vol. 26, No.4, October-December.
[95] Mukherjee, S. K., (1983). " Trends in cereal prices" Agricultural Situation in India, Vol. XXXVIII, No. 5, August, PP 301-303.
[96] Naidu, M. R. (1984) " Impact of area, rainfall and prices on production of groundnut in Andhra Pradesh." Agricultural Situation in India, Vol. XXXIX, No. 6, September, PP 419-420.
[97] Naik, D and Patnaik, S.C. (1984) " Impact of price changes on area, output and productivity of potato in Orissa." Agricultural Situation in India, Vol. XXXIX, No. 6, September, PP 425-429.
[98] Stanislaus, Sebastian S. J. M. (1985). Farmer's response to price changes in a developing economy. Ashish Publishing House, New Delhi.

considered feasible, the third may not. Government intervention has been, perhaps, most pronounced in sugarcane pricing than for any other agricultural commodity. This would seem to violate the cobweb assumptions but **Waugh** (1964)[93] has demonstrated that in spite of price interference's, the oscillatory movements characterising the cobweb may persist, though in a modified form. **Jha and Maji** (1971)[94] examined whether this cobweb theorem can be applied to explain fluctuations in sugarcane acreage in North Bihar, over the period 1934-35 to 1964-65. Results showed that both static and dynamic type of fluctuations exists and it is of a convergent type. Assuming static demand there exists cycles of 4-5 year's duration.

Mukherjee (1983)[95] revealed that rise or fall in cereal production leads to variations in the prices of cereals, whenever production declined, the prices of cereals increased. This increase in price was reflected more in rice. Also, trend in prices of cereals was very much influenced by the trend in production of cereals. Thus ratio of prices between cereals was quite an important factor for indicating its production position and also for determining movement of cereals prices over the years. **Naidu** (1984)[96] found that area as well as previous year's price of groundnut influences current year's production. **Naik and Patnaik** (1984)[97] concluded that price has more explanatory significance in a study of price impact on area and output. Correlation between harvest price with pre-sowing price and average wholesale price was highly significant. Also, output and area under potato were dependent upon its harvest price lagged by one year. Further, while there was very close association between harvest price and area and output of potato, there was, however, no significant relationship between price and productivity. **Stanislaus** (1985)[98] conclusively shows that price is but one of the several factors determining farmer's production decisions.

Thus, the review of available literature reveals that studies related to the present topic were relatively few and outdated. Further, most of these studies were concentrated on the northern states of India. No one, so far, has made any attempt to study the characteristics of individual agricultural commodities of Kerala. Here the present study makes an earnest attempt to fill this research gap in the field of agriculture.

1.4. Plan of the study

This study consists of 8 chapters. In the first chapter a general introduction, need and significance of the study, objectives and a review of earlier studies are given. The database and variables, period of study, commodities selected and the conceptual framework are described in the second chapter. A brief discussion of the important analytical and post-analytical tools is also included here. Growth and instability of agriculture in Kerala from 1960-61 to 1995-96 and its components of growth, share of districts in total production, district-wise growth of production and productivity etc. are examined in the 3rd chapter. The cyclical phenomenon of agriculture is empirically assessed in the 4^{th} chapter. The following chapter analyses impact of price movements on agricultural production and productivity and their inter-relationships in agriculture. In the next chapter, relative price variability is estimated using divisia price index and the important aggregate sources of relative price variability of agricultural commodities are identified. This chapter also investigates nature of changes in price levels and variability after economic reforms using ARCH model. In chapter 7, spatial price efficiency of agricultural prices is examined using integration techniques. A summary of the main findings of the study and their implications for policy is given in the last chapter.

1.5. Limitations of the study

The study is based on time series data available from different publications and therefore the results depend upon their availability and reliability. Limitations of these data often pose problems for the study. Since the analysis was done in a quantitative way, the actual experience may deviate slightly. Also, the study is restricted to Kerala state and therefore the findings and suggestions may or may not have general application.

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PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

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August 1999

Chapter 2

2. Data and methodology

2.1. Database and Variables

2.2. Period of study

2.3. Commodities under study

2.4. Data Sources

2.5. Conceptual Framework

2.6. Analytical Approach

DATA AND METHODOLOGY

In this chapter we introduce our database, period of study, conceptual framework and analytical tools used in the present study. Each of them is briefly discussed in the following sections.

2.1. Database and Variables

This study is based upon time series data on production, productivity and prices of important agricultural commodities of Kerala. Both farm and wholesale prices are included in our analysis. The impact of economic reform is examined by taking dummy variables (both pre and post reform dummies), trend and seasonal factors and lagged values of prices. To identify the aggregate sources of relative price variability, variables like average rate of change of agricultural commodity prices, consumer price indices (with 1960-61 base), unemployment rate, real GNP growth rate, money supply, exchange rate etc. are used.

The study mainly uses yearly data, but for analysing the impact of liberalisation and price integration monthly data is also made use of. Since data on wholesale prices of all the 14 districts were not available we have taken the available district markets for different commodities. Eventhough our main analytical part deals with aspects of state as a whole a district-wise analysis also is attempted.

2.2. Period of study

The study covers a period of 36 years extending from 1960-61 to 1995-96. This period includes the pre and post green revolution period as well as the period before and after the introduction of structural adjustment programme of the country. For convenience, to examine the impact of economic reforms and price efficiency we have included only 10 calendar years i.e., from 1987 to 1996.

2.3. Commodities under study.

The study analyses 12 crops under 2 categories: foodgrains and non-foodgrains. Under foodgrains category cereals – rice has been selected. Non-foodgrains have been divided into the following 5 categories.

(1) Oil seeds –Coconut
(2) Plantation crops – Tea and rubber
(3) Spices and condiments – Pepper, ginger, turmeric and arecanut
(4) Fruits and vegetables – Banana, cashewnut and tapioca
(5) Miscellaneous crops – Sugarcane.

The selection of commodities under each category was made by taking into account its importance to the state economy. Due to the non-availability of comparable data we have taken wholesale prices of 9 commodities like tapioca, coconut, pepper, ginger, arecanut, banana, turmeric, rubber and tea and farm prices of 9 commodities like rice, tapioca, coconut, pepper, ginger, arecanut, cashewnut, banana and sugarcane.

2.4. Data Sources

The present study is based on both published and unpublished data collected from various sources. Data on area and production of crops cultivated in the state are collected by the Bureau of Economics and Statistics, Government of Kerala. We have collected these data from their annual publications such as Statistics for Planning, Economic Review etc. Another important source of data is Directorate of Economics and Statistics (DES). We used their publications like Season and Crop reports of Kerala, Agricultural Statistics of Kerala, Land utilisation statistics etc. Apart from this, substantial volume of materials (especially wholesale and farm prices of agricultural commodities) has been drawn from the unpublished records kept by DES. Also relevant data has been taken from various issues of Monthly Abstract of Statistics, Department of Statistics, Central Statistical Organisation, New Delhi.

2.5. Conceptual Framework

Some of the basic concepts used in this study like agricultural production, agricultural productivity, agricultural prices, cropping pattern, seasonality etc. are explained below.

2.5.1. Agricultural Production

Agricultural production function relates agricultural output as a function of agricultural inputs such as area used, irrigation, rainfall, seeds, fertilisers etc. This is the same as a general production function except the name of variables. In theory, a production possibility set is a set X in the n+1 dimensional space such that each point X_1, X_2, X_3, ………, X_{n+1} in that set represents a possible combination of inputs X_1, X_2, X_3, ………, X_n and the resultant output X_{n+1} gives a certain state of technological knowledge.

Consider a subset X^M of X such that the typical point X^m belonging to X^M is a combination of inputs X_1, X_2, X_3, ………, X_n and the maximal output $X^m{}_{n+1}$ possible by the transformation of the inputs X_1, X_2, X_3, ………, X_n. The subset X^m is defined as the production function. All points belonging to X that do not belong to X^m represent "inefficient" combinations of input and output – an output less than the maximum possible by transforming the same combination of inputs, given the state of technological knowledge.

The methods used for fitting production functions – the least squares method, the method of maximum likelihood etc. – are such that the underlying model obviously is $+e_{xn+1} = f(X_1, X_2, X_3, \ldots\ldots\ldots, X_n) + c$ ------ (1) or more commonly $X_{n+1} = f(X_1, X_2, X_3, \ldots\ldots\ldots, X_n)h$ where 'e' is an additive error-term and 'h' a multiplicative one. In other words, the production function $f(X_1, X_2, X_3, \ldots\ldots\ldots, X_n)$ is conceived of as the expected value of output, given the inputs $X_1, X_2, X_3, \ldots\ldots\ldots, X_n$) and not the maximal value.

Index of agricultural production for the individual crops are calculated as a chain base method so as to account for the changes in concept/coverage in crop estimation. For subgroup and groups of crops the index number of production is calculated by using the following formula:

$$\text{i.e. } IP = \frac{\Sigma \, Pij \times Pio}{\Sigma \, Pio \times Pio} \times 100 \qquad \text{where,}$$

IP = Index of production.
Pij X Pio = value of current year's production of i^{th} crop with base year price.
Pio X Pio = value of base year's production of i^{th} crop.

2.5.2. Agricultural Productivity

Productivity is used to express the power of agriculture in a particular region to produce crops without regard to whether that power is due to the bounty of nature or to the efforts of man. Agricultural productivity may be defined as a ratio of the index of total agricultural output to the index of any input used in farm production. It is, therefore, a measure of the efficiency with which inputs are utilised in production, other things being equal. According to Dewett, " productivity expresses the varying relationship between agricultural output and one of the major inputs like land or labour or capital, other complementary factors remaining the same....................". It may be borne in mind, that productivity is physical rather than a value concept.[99] The connotation of agricultural productivity engaged the attention of many an economist at the 23rd annual conference of the Indian Society of Agricultural Statistics.[100] After a thorough discussion, it was generally agreed that the yield per acre may be considered to represent the agricultural productivity in a particular region and that other factors of production be considered as the possible causes for the variation while comparing it with the other regions.

Productivity based on agricultural output per hectare may be accounted due to certain advantages, because land is the most permanent and

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[99] Ganguli, B N (1938), Trends of agriculture and population in the Ganges valley, London, PP. 93.

[100] Kendall, M G (1939) "The geographical distribution of crop producitivity in England", Journal of Royal Statistical Society, PP 162.

fixed among other factors for evaluating productivity. Recently, it has assumed a special attention due to population explosion and the relative returns from it. Therefore, to evaluate productivity indices, state level harvest prices for the corresponding years have been incorporated. This gives the agricultural output per hectare (in Rs.). These indices were finally added up and divided by the total crop area to get the value of output per hectare (in Rs.).

Productivity index means the calculation of an index of total output and an index of all the factor inputs.

i.e. $$INP = \frac{IP}{INAS} X100$$ where,

INP = Index of productivity per hectare of net area sown
IP = Index number of production of all crops
INAS = Index number of net area sown.

2.5.3. Agricultural Prices

Price is the most important determinant of profit or loss in farm enterprise. When market price is favourable in relation to cost it leads to profit and provides incentive to producers to grow more. In farm enterprise, time factor is quite important. This long gestation period exercises significant influence on price determination. We make use of wholesale and farm prices of agricultural commodities.

Farm prices

Farm price is the price which is offered to the producer-seller in villages of his own produce or is prevailing in the village irrespective of the fact whether any transaction has or has not taken place. The report submitted by Thapar Committee laid down the uniform definition of farm (harvest) price as "the farm price may be defined as the average wholesale price at which the commodity is disposed off by the producer at the village site during the specified harvesting period.

Wholesale prices

Wholesale price is the price received by the producer-seller for his agricultural produce which is brought in the assembling market from the villages or village hats by him or by his agent. Accordingly, assembling market may have a number of primary wholesale prices, i.e., the prices received by the producers from different shops in a market. Hence it is thought convenient to record the model wholesale price. The model rate is the price at which most of the transactions in a particular wholesale market during the specified time actually take place during the peak marketing hours.

/ There are several types of fluctuations in agricultural prices. They are briefly explained below.

Long term movements :- Long term movements in prices are caused by factors, which continue to operate for a considerable period after they appear. These factors bring about a basic change in supply or demand conditions. The change caused by these factors is generally of a permanent nature and generally no attempt should be made to suppress their impact on prices. However, attempts should be made to dilute their impact if the changes caused by them are sudden.

Cyclic fluctuations :- Though a trend (long term fluctuations) does not show sudden and sharp turns, the cyclic fluctuations do reveal some sort of regular up and down movements around the trend. We often come across changes of a cyclic nature in live stock production, particularly pigs and poultry and a cyclic of production in case of some vegetables, fruit etc. The length of a cycle in production is governed by the biological characteristics of the product.

Seasonal fluctuations :- The seasonal fluctuations too, affect the ultimate fluctuations in prices as these appear in the agricultural sector. Agriculture is a seasonal industry in the sense that a crop is sown only in a particular season of the year and one has to wait for a year to have a similar crop again. This interval obviously means that conditions of supply of a crop are not uniform throughout the year. There may be excessive supply of the crop immediately after harvesting and it may taper off as the time passes. As demand conditions for quite a number of crops e.g., the food crops are likely to remain stable throughout the year(other things being the same), the changed supply conditions will obviously affect the prices and income of the farmers during the course of the year.

Annual fluctuations :- Annual fluctuations refer to the variations in production (and the consequent changes in prices) of certain products which take place rather in a regular manner. Such fluctuations are generally experienced in case of tree products. It is of common knowledge that, other things being the same, power of a tree to bear fruit in a particular year, is determined by the size of production in the preceding year.

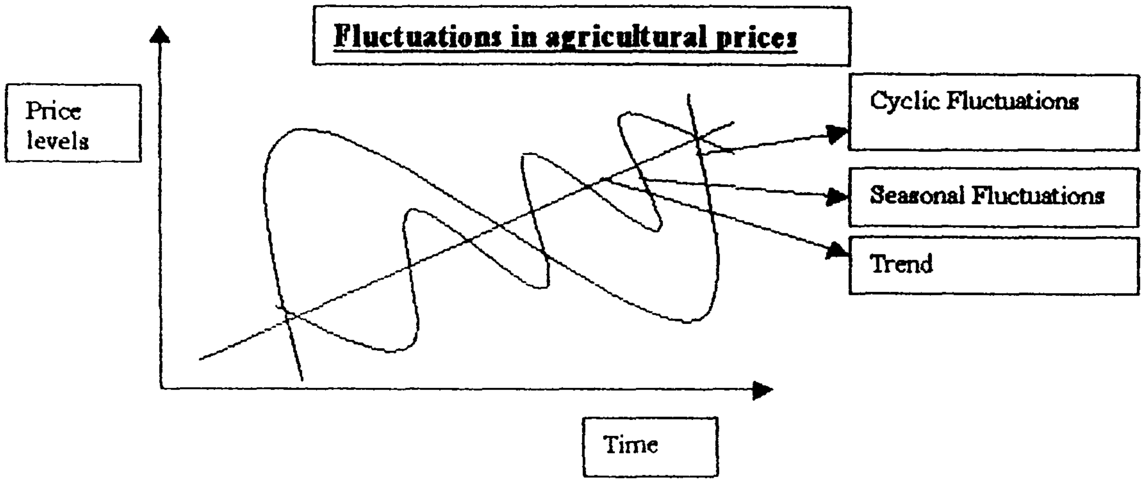
Irregular fluctuations :- These fluctuations have no system about them. They appear in the agricultural sector because of irregular changes in the supply or demand for the agricultural products. The factors responsible for such fluctuations are e.g., drought, floods, pests and diseases, speculation in agricultural products etc.

Fluctuations due to the operation of cobweb theorem:-

Operation of cobweb theorem, in fact, explains another type of cyclical fluctuations in prices and output of certain products in agriculture. According to this theorem, some cycles are caused by the tendency of producers to base tomorrow's production plans on the profits of current or recently past

Figure 2.1

Fluctuations in agricultural prices



operations. Figure 2.1 shows some of the fluctuations described above. With figure 2.1, we can recognise that one cycle generally covers a much smaller period than a long-term fluctuation. A seasonal fluctuation is a regular fluctuation like a cyclic fluctuation but occurs many times within a period covered by a full cycle.

We can see other types of fluctuations too. But the final fluctuations as observed in agriculture are the combined result of the operation of various factors causing these fluctuations.

Spatial price efficiency

In a competitive market with free flow of information, spatial price differences will be equal to or less than transportation costs between the two markets. These costs are often high in relation to the farm value of agricultural commodities. Hence, farm prices differ by region depending on, whether the production area is near or far from the principal market areas. The market is said to perform efficiently if price differentials for a particular commodity arising from place, time and form differences would correspond closely to the costs incurred in providing the respective transportation, storage and processing facilities.

Thus, it is clear that a change in volume of flow from one region to another and its-price relationships between regions may occur if either any regional demand or regional supply curve shifts, or transfer costs change. When more than two regions are involved, complicated mathematical and geometrical analysis would be needed to determine the pattern of flow or the structure of prices.

2.6. Analytical Approach

The methodology adopted for the study is both descriptive and analytical. Analytical part of this study is classified into 6 sections, each of which relies upon entirely different methods and procedures. Here we are giving a very brief idea about these methods and procedures and their detailed explanation will be given at the relevant part of this study.

Assessment of growth of agriculture (aggregate, period-wise and crop-wise) is done using log-lin model for the period 1960-61 to 1995-96 taking all observations in the series. These growth rates are decomposed into growth rate of area, productivity and cropping pattern using the methodology of **Ashok Parikh** (1966)[101]. Cadde Ville Index explains instability of agriculture. Seasonal variation of prices is analysed by calculating monthly seasonal indices.

Cyclical trend of production, productivity and farm and wholesale prices are separated using second-degree polynomial function. Then cropwise cyclical behaviour of agricultural commodities is analysed using harmonic analysis. Calculating Fourier coefficients, we estimated cyclical length and significance of these lengths is tested using F-test. Actual series is separated as series generated by moving average method, autoregressive method and harmonic series using sample autocorrelation function. Significance of these autocorrelation coefficients is tested using Barlett test and Ljung-Box statistic.

Interrelationships between production, productivity and farm and wholesale prices are tested applying 9 models. They are simple and multiple regression models and are given in the relevant chapter. We estimated these models by the usual OLS method and their goodness of fit by R^2.

Relative price variability is calculated by constructing divisia price index for prices received by farmers. This relative price variability is treated

[101] Ashok Parikh (1966), "Analysis of growth components and method of constructing the index number of agricultural production under constant cropping pattern", Indian Journal of Agricultural

as dependent variable and aggregate factors influencing this is taken as explanatory variables in the regression model. Changes in mean price levels and variability of each agricultural commodity before and after 1991 is analysed by Autoregressive Conditionally Heteroskedastic (ARCH) approach. Using monthly wholesale prices, first, we tested whether ARCH effects are present or not by White's criteria and error model. These ARCH models are estimated by Ordinary Least Squares method and statistical significance of estimated coefficients are tested using Student's t test.

Monthly wholesale prices of different markets at district level for the period 1987 to 1996 are used to test price efficiency of agricultural commodities. Depending upon the availability of data Thiruvananthapuram or Ernakulam market is treated as central market and others as local markets. Single lagged and actual local price is taken as independent variable to see the dependency of central market on local markets. Regression of local price on central market price and lagged price is estimated to classify markets having market segmentation, short-run or long-run market integration. Student's t-test is used to test significance of estimates and R^2 for overall goodness of fit.

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Chapter 3

3. Growth and Instability of Kerala Agriculture

3.1. Growth of Agricultural Production

3.2. Decomposition of Growth of Agricultural Production

3.3. District-wise growth of Agricultural Production

3.4. District-wise growth of Agricultural Productivity

3.5. Growth of Prices

3.6. Instability in Agriculture

GROWTH AND INSTABILITY OF KERALA AGRICULTURE

In this chapter we analyse the growth and instability of agricultural production, productivity and prices. Along with overall analysis, a crop-wise analysis also is attempted. First, we estimate growth rates of production for the whole period and for periods 1 (i.e., from 1960-61 to 1969-70), 11 (i.e., from 1970-71 to 1979-80), 111 (i.e., from 1980-81 to 1989-90) and 1V (i.e., from 1990-91 to 1995-96). Then these growth rates are decomposed into several components using index numbers. District-wise share and growth rates of production and productivity are compared for the period 1985-86 to 1994-95, because we have comparable data for all the 14 districts only after 1984-85. Instability of agriculture was estimated using Cadde Ville Index. At the end of this chapter, we discuss seasonal variation in agricultural prices.

3.1.Growth of Agricultural Production

Agricultural production showed an increasing trend during the selected period (1960-61 to 1995-96). Index number of agricultural production was steadily increasing during sixties and early seventies (see appendix 1). But it was decreasing during mid seventies, lowest during 1983 and then onwards progressive trend. Total agricultural production increased at a rate of 1.5 percentage (see table 3.1) during this period.

Production of cereals was declining at a compound growth rate of 0.7%. It increased slightly during early seventies and eighties but after mid eighties decrease in production were lower than that of sixties. Between mid seventies to mid eighties, production of coconut showed declining trend but before and after these periods an increasing trend was visible. It was worst during 1983. Overall analysis revealed that coconut production increased at a rate of 2.1%. Production of plantation crops was increasing after 1960s. Eventhough production of tea declined in some years, that of rubber was continuously increasing. Increase in tea at a compound growth rate of 3.3% and in rubber at 19.3% was visible.

Spices and condiments also showed an increasing production trend. Pepper production was less than that of 1960s during 1962-63 to 1978-79 and 1982-83 to 1984-85, but between 1960-61 to 1995-96 its increment was at a rate of 5.4%. Ginger production continuously increased at 12.5%. Arecanut production was greater in the later years than 1960s but its increment was only 3.8%.

Growth of fruits and vegetables was very low, even negative for some of the crops. Banana production was very low during mid seventies and cashewnut production was low in early eighties. Tapioca production was high during mid sixties to early eighties but after that it also was declining. On the whole, banana (1.4%) and tapioca (0.01%) production had an increasing and

Table 3.1

Compound Growth rates of Agricultural Production

Crops	1960-61 to 1995-96	1960-61 to 1969-70	1970-71 to 1979-80	1980-81 to 1989-90	1990-91 to 1994-95
Rice	-0.7	4.8	-1.1	-7.1	-6.9
Coconut	2.1	5.2	-8.2	10.1	14.4
Tea	3.3	2.7	6.4	4.1	2.9
Rubber	19.3	37.1	14.7	18.7	22.1
Pepper	5.4	-1.4	0.9	15	9.1
Ginger	12.5	1.1	12.1	10.9	-6.5
Arecanut	3.8	7.4	-1.6	5.4	15.2
Banana	1.4	-0.8	-37.5	9.9	-8.5
Cashewnut	-0.6	8	-10.8	7.7	-4.4
Tapioca	0.01	35.1	-6.9	-7.8	-6.4
Sugarcane	1.11	8.7	1.4	-5	-9.1
Total	1.5	7.7	-12.5	4.1	9.1

Source : Estimated by the researcher.

cashewnut (-0.6%) had a decreasing trend. Sugarcane was zigzag during seventies but average growth rate was positive (1.11%).

3.1.1. Trend during 60s

Total production showed an increasing trend during 1960-61 to 1969-70. It increased at a rate of 7.7%. Eventhough the overall trend of cereal production had been decreasing, it was increasing during this period. Its growth was impressive and at a compound growth rate of 4.8%. Increment in coconut production was relatively greater during 1960s compared to the later years. The growth rate of coconut production over the period was worked out as 5.2%. Rubber production increased at a rate of 37.1% during 1960-69. Compared to this, growth rate of tea was very small (only 2.7%). Some commodities in the category of spices and condiments showed declining and others an increasing trend during sixties. Pepper and ginger output lowered and that of arecanut increased. Compound growth rate of arecanut was 7.4% but that of pepper was -1.4%. Growth of fruits and vegetables was impressive but some of them depicted negative growth. While growth rate of tapioca (35.1%) and cashewnut (8%) was impressive, that of banana was negative (-0.8%). Sugarcane production increased at 8.7%. Thus during 60s production of most of the commodities was impressive.

3.1.2. Trend during 70s

During this period growth rate of agricultural production steadily declined. The growth rate was –12.5%, the worst among the selected 4 sub-periods (see table 3.1). This may be due to decrease in the production of rice, coconut, arecanut, banana, cashewnut and tapioca. Decrease in production was severe in banana production (37.5%), followed by cashewnut (10.8%), coconut (8.2%), tapioca (6.9%), arecanut (1.6%) and rice (1.1%). Positive growth rate was visible for tea (6.4), rubber (14.7%), pepper (0.9%), ginger (12.1%) and sugarcane (1.4%). Thus, seventies were a better period for plantation crops and sugarcane and a worse period for cereals, oilseeds and fruits and vegetables.

3.1.3. Trend during 80s

Compared to seventies, eighties were a better period for agricultural production. It increased at a rate of 4.1%. This increase was highest in the production of rubber (18.7%), followed by pepper (15.0%), ginger (10.9%), coconut (10.1%), banana (9.9%), cashewnut (7.7%), arecanut (5.4%) and tea (4.1%). But performance in the production of rice (7.1%), tapioca (7.8%) and sugarcane (5.0%) was still bad.

3.1.4. Trend during 90s

During early nineties, agricultural production increased at a rate of 9.1%, better than sixties, seventies and eighties. Production of individual crops, however, showed either decreasing or increasing trend. Growth of rubber (22.1%) was the highest followed by arecanut (15.2%), coconut (14.4%), pepper (9.1%) and tea (2.9%). Lowest growth was for sugarcane (-9.1%), followed by banana (-8.5%), rice (-6.9%), ginger (-6.5%), tapioca (-6.4%), cashewnut (-4.4%) etc. Thus, eventhough total production was increasing; some individual crop production had been decreasing during early nineties.

Thus, on the whole agricultural production increased during 60s, 80s and early 90s, but it decreased during 70s. Growth of cereals was highest in 60s but negative during later periods. Seventies was a bad period for coconut and its growth rate was highest during early 90s, followed by 80s and 60s. Production of plantation crops was positive in all sub-periods. Greatest growth rate of tea was visible in 70s, then in 80s, 90s and was the lowest during 60s. But growth rate of rubber was highest in 60s, followed by early 90s, 80s and 70s.

Performance of spices and condiments was not in a uniform manner. 60s were worst for pepper production, early 90s were worst for ginger and 70s were worst for arecanut. Pepper production was highest during 80s followed by early 90s, and 70s. Ginger production was highest in 70s, then in 80s and 60s. Highest growth rate of arecanut production was during early 90s followed by 60s and 80s.

In case of fruits and vegetables, growth rate of banana was positive only during 80s, cashewnut production was positive in 60s and 80s and that of tapioca was positive only during 60s. Banana and cashewnut production was worst during 70s and tapioca production was worst during 80s. Thus performance was not uniform in sub-periods. Sugarcane production was continuously decreasing. Its growth rate declined from 8.7% (in 60s) to 1.4% (in 70s) to –5.0 (in 80s) to –9.15% (in 90s).

With these observations on the trend of production of agricultural commodities, now, we can analyze causes behind these trends by looking into the components of growth rate. Growth rate of production can be decomposed into several components and the method followed to decompose these growth rates is explained in the following section.

3.2. Decomposition of Growth of Agricultural Production

Decomposition of growth of production is done by constructing index numbers (by the method followed by **Ashok Parikh**, 1966[102]) and then calculating compound growth rates for these separated index numbers.

From the raw data of agricultural production and area, first we constructed weighted index numbers with base year as 1960-61 and contribution of value product of each crop to total value product as weights. This index number of agricultural production is known as the agricultural production under prevailing cropping pattern, composite of changes in productivity acreage and changes in cropping pattern (see appendix 1).

Now, let the index of area under a particular crop is denoted by Ait at time t and index of total area be denoted as At. Ait/At is known as index of proportion of area under crop i at time t. Let the total area index at time t+1 be At+1. Under the constant cropping pattern, the index of proportion of area under a particular crop is to be held constant. The allocation of At+1 should be made exactly in the same proportions. This means that Ait/At should be multiplied by the index of area under all crops at time t+1, i.e., Ait/At X At+1. This will be the index of area under crop i at time t+1 under constant cropping pattern (see appendix 2).

Let the index of agricultural production be Pt, which is a weighted average of indices of production under different crops (Pit). Using new index of area under each crop of year t+1, we can compute the index of production under each crop on the basis of constant cropping pattern for year t+1. The formula will be

$$\frac{Ait\ / At\ X\ At+1}{Ait+1}\ X\ Pit+1$$

Adding weights to the index of various crops, the above formula changes to

$$\sum_{i=1}^{n} Wi\ \left[\ \frac{(Ait/At)\ X\ At+1\ X}{Ait+1}\ Pit+1\right].$$

This index is known as the index of agricultural production under constant cropping pattern at time t+1 (see appendix 3). The term constant cropping pattern implies that if proportions of area under each crop to total cropped area are held constant, what will be the production under each crop under changes in productivity per acre from time to time.

Deflation of index number of agricultural production under prevailing crop pattern by the index number of agricultural production under constant crop pattern yields the contribution of changes in crop pattern in the absence of productivity and area changes (see appendix 4). Both these index numbers (the first two) have the element of productivity and area changes and deflation will eliminate this common factor.

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[102] Ibid, footnote number 101.

Deflation of the composite index of productivity and area changes by the index number of area yields the index number of contribution of productivity to total agricultural production (see appendix 5). Thus index number of agricultural production under prevailing cropping pattern (IAM) can be decomposed into index number of agricultural production under constant cropping pattern (IAP) and index number of contribution of changes in cropping pattern (IAC).

IAM = IAP X IAC.

Index number of agricultural production under constant cropping pattern (IAP) can be again decomposed into index number of area (IaA) and index number of productivity changes net of area (IAPr). i. e .,

IAM = IaA X IAPr X IAC.

Calculating compound growth rates for these separated index numbers gives growth rate of agricultural production (GaM) as the sum of growth rate of area changes (GaA), growth rate of productivity changes (GaPr) and growth rate of changes in cropping pattern (GaC). That is,

GaM = GaA + GaPr + GaC.

Here sum of GaA and GaPr is known as growth rate or production under constant cropping pattern (GaP). These estimated growth components of agricultural production are discussed below.

3.2.1. Components of Growth rates of Production (1960-61 to 1995-96)

Growth components of agricultural production are explained with the help of table 3.2. We know that (from table 3.1) agricultural production increased at a rate of 1.5% during 1960-61 to 1995-96. Out of this, contribution of productivity was 3.7%. But area (-0.3%), cropping pattern changes (-1.8%) and interactions of these three components (-0.1%) lowered production growth rate to the level of 1.5%. Thus, eventhough agricultural productivity improved after 1960s, decrease in cropped area and cropping pattern changes pulled down growth rate of agricultural production to a lower level.

In the case of cereals also productivity changes were high (3.0%) but decrement in area cultivated (-3.4%) and interactions (-0.3%) lowered its total growth rate to a level of –0.7%. Effect of cropping pattern changes was very small but negative. Thus area cultivated and cropping pattern changes were not favourable to rice production.

Coconut production increased at a compound growth rate of 2.1% due to the favourable effect of area cultivated (3.1%), cropping pattern changes (0.2%) and interaction effects (0.1%). But its productivity decreased (-1.3%). Production of plantation crops increased during this period. Out of the production growth rate of 3.3% of tea, productivity growth rate (GaPr) was 4.2%; cropping pattern growth rate was 0.2% and interaction effect was positive but very small. Thus productivity and cropping pattern changes were favourable and area changes (-1.1%) were unfavourable to tea production. But in the case of rubber, changes in area (9.1%), productivity (9.1%), cropping pattern (0.2%) and interaction effect (0.9%) were favourable and therefore there was a tremendous growth rate of 19.3 % after 1960s.

Growth rates of spices and condiments were high due to their increase in productivity. In the case of pepper, area (4.0%), productivity (0.8%) and cropping pattern changes (0.6%) were favourable. Cropping pattern changes (-0.1%) was unfavourable to ginger production, but high growth rates of area cultivated (1.6%) and productivity improvement (10.9%) increased total production. Cultivated area of arecanut decreased (-0.3%) but high compound growth rate of productivity (4.3%) and cropping pattern (0.1%) increased production at 3.8% growth level.

In the case of fruits and vegetables, productivity of banana (-1.8%) and cashewnut (-3.6%) decreased and that of tapioca (5.3%) increased. Area and cropping pattern changes were favourable to banana cultivation. Eventhough area cultivated increased at a rate of 3.5%; decline in productivity (-3.6%) and unfavourable cropping pattern (-0.5%) decreased total cashewnut production. Similarly, decline in cultivated area (-4.7%) and unfavourable cropping pattern (-0.5%) decreased the total effect of tapioca to 0.01%.

Table 3.2

Components of growth rates of Agricultural Production (1960-61 to 1995-96)

Category	Crops	GaM	GaA	GaPr	GaP (=GaA+ GaPr)	GaC	Interaction growth Rates
Cereals	Rice	-0.7	-3.4	3.0	-0.4	(-)0.0	-0.3
Oilseeds	Coconut	2.1	3.1	-1.3	1.8	0.2	0.1
Plantation crops	Tea	3.3	-1.1	4.2	3.1	0.2	0.0
	Rubber	19.3	9.1	9.1	18.2	0.2	0.9
Spices & condiments	Pepper	5.4	4.0	0.8	4.8	0.6	0.0
	Ginger	12.5	1.6	10.9	12.5	-0.1	0.1
	Arecanut	3.8	-0.3	4.0	3.7	0.1	0.0
Fruits& Vegetables	Banana	1.4	2.8	-1.8	1.0	0.5	-0.1
	Cashewnut	-0.6	3.5	-3.6	-0.1	-0.5	0.0
	Tapioca	0.01	-4.7	5.3	0.6	-0.5	-0.09
Miscellaneous	Sugarcane	1.1	-2.3	3.5	1.2	-0.01	-0.09
Total		1.5	-0.3	3.7	3.4	-1.8	-0.1

Notes : `0.00' and '(-)0.00' denotes very small values

Source : Same as in table 3.1

Eventhough productivity improved (3.5%), decline in cultivated area (-2.3%) and unfavourable cropping pattern (-0.01%) decreased production of sugarcane. Thus, in nutshell, cultivated area of coconut, rubber, pepper, ginger, banana and cashewnut increased and that of rice, tea, arecanut, tapioca and sugarcane decreased. Productivity of rice, tea, rubber, pepper, ginger, arecanut, tapioca and sugarcane improved. Cropping pattern changes were favourable to coconut, tea, rubber, pepper, arecanut and banana and unfavourable to rice, ginger, cashewnut, tapioca and sugarcane.

3.2.1.2. Sub-period 1

Growth components of agricultural production during 1960-61 to 1969-70 are presented in table 3.3. We have seen (from table 3.1) that compound growth rate of production during this period was 7.7%. Out of this, area changes contributed 5.9%, productivity improvement was 2.0% and interaction effect was 0.1%. But unfavourable cropping pattern lowered production by 0.3%. Thus, during 60s cultivated area and productivity increased production level. This fact was applicable to the production of cereals and plantation crops. In the case of coconut, cultivated area (9.5%) increased and cropping pattern (0.3%) was favourable but high rate of decline in productivity (-4.5%) decreased production level. This is same in the case of arecanut also. 6.3% decrease in productivity lowered production growth rate of 14% to 7.4%. Pepper production was negative due to its poor productivity (-7.5%) and

Table 3.3

Components of growth rates of Agricultural Production (1960-61 to 1969-70)

Category	Crops	GaM	GaA	GaPr	GaP (=GaA+ GaPr)	GaC	Interaction growth Rates
Cereals	Rice	4.8	3.5	1.4	4.9	-0.2	0.1
Oilseeds	Coconut	5.2	9.5	-4.5	5.0	0.3	-0.1
Plantation crops	Tea	2.7	0.3	4.2	4.5	-1.9	0.1
	Rubber	37.1	8.6	27.0	35.6	-0.6	2.1
Spices & condiments	Pepper	-1.4	6.0	-7.5	-1.5	(-)0.00	0.1
	Ginger	1.1	-0.9	2.4	1.5	-0.6	0.2
	Arecanut	7.4	13.1	-6.3	6.8	0.9	-0.3
Fruits& Vegetables	Banana	-0.8	5.8	-7.4	-1.6	0.7	0.1
	Cashewnut	8.0	15.6	-4.1	11.5	-2.8	-0.7
	Tapioca	35.1	7.9	22.9	30.8	1.9	2.4
Miscellaneous	Sugarcane	8.7	-4.1	15.5	11.4	-2.1	-0.6
Total		7.7	5.9	2.0	7.9	-0.3	0.1

Notes : `0.00' and '(-)0.00' denotes very small values

Source : Same as in table 3.1

unfavourable cropping pattern. But in the case of ginger, eventhough area cultivated declined (-0.9%) and cropping pattern was unfavourable (-0.6%), high rate of productivity growth (2.4%) caused production to increase at 1.1%. Changes in banana were just opposite to this. Area (5.8%) and cropping pattern (0.7%) were favourable and productivity rate (-7.4 %) was unfavourable to banana. Area (7.9%), productivity (22.9%), cropping pattern (1.9%) and their interactions increased production of tapioca during sixties. Table also reveals that sugarcane productivity was high (15.5%) but lowering of cultivated area (-4.1%) and negative cropping pattern (-2.1%) decreased production to 8.7%.

Thus, during sixties, cultivated area of all crops (except that of ginger and sugarcane) increased, productivity of rice, tea, rubber, ginger, tapioca and sugarcane improved and cropping pattern was favourable for coconut, arecanut, banana and tapioca.

3.2.1.3. Sub-period 11

Seventies was a period of depression for agricultural production. Total production decreased (-12.5%) due to decrease in area (-1.9%), productivity (-0.8%) and cropping pattern (-21.8%) (see table 3.4). In the case of rice and arecanut, there was a positive growth in productivity. But high negative growth of area and cropping pattern caused total production to decline. Negative growth of area cultivated, productivity and cropping pattern caused

Table 3.4

Components of growth rates of Agricultural Production (1970-71 to 1979-80)

Category	Crops	GaM	GaA	GaPr	GaP (=GaA+ GaPr)	GaC	Interaction growth Rates
Cereals	Rice	-1.1	-2.5	1.5	-1.0	-0.1	0.0
Oilseeds	Coconut	-8.2	-3.1	-4.7	-7.8	-0.2	-0.2
Plantation crops	Tea	6.4	-1.4	7.2	5.8	0.7	-0.1
	Rubber	14.7	5.9	7.8	13.7	0.4	0.6
Spices & condiments	Pepper	0.9	-2.3	0.0	-2.3	3.2	0.0
	Ginger	12.1	1.6	8.2	9.8	1.8	0.5
	Arecanut	-1.6	-12.3	12.2	-0.1	-1.6	0.1
Fruits& Vegetables	Banana	-37.5	-7.9	-28.3	-36.2	0.7	-2.0
	Cashewnut	-10.8	-2.2	-10.9	-13.1	2.3	0.0
	Tapioca	-6.9	-1.4	-4.3	-5.7	-1.0	-0.2
Miscellaneous	Sugarcane	1.4	-4.0	5.2	1.2	0.3	-0.1
Total		-12.5	-1.9	-0.8	-2.7	-21.8	12.0

Notes : `0.00' and '(-)0.00' denotes very small values

Source : Same as in table 3.1

decrease in the production of coconut and tapioca. In the case of tea, pepper and sugarcane decline in area lowered production but improvement in productivity and favourable cropping pattern placed production to have a positive value. Area cultivated, productivity and cropping pattern were favourable to rubber and ginger and therefore their growth rate of production were high during 70s. Eventhough cropping pattern was favourable, decrease in productivity and area caused production of banana and cashewnut to have a high negative growth.

3.2.1.4. Sub-period 111

Growth components of agricultural production during 1980-81 to 1989-90 was estimated and presented in table 3.5. The Table reveals that growth rate of 4.1% of total production was the contribution of area growth rate of –2.8%, productivity of 7.4%, cropping pattern of -0.3% and their interaction effect of –0.2%. Thus during 80s, only the productivity was favourable and others were unfavourable to total production. This effect was same for rice, cashewnut and tapioca production but total effect of rice and tapioca became negative whereas that of cashewnut was still positive which imply its stronger effect of productivity. Area, productivity and cropping pattern changes of coconut and arecanut favoured their production. Eventhough total effect was positive, area effect of tea, productivity effect of pepper and cropping pattern effect of rubber and ginger were unfavourable. Banana production declined from 12.3% to 9.9% due to its

Table 3.5

Components of growth rates of Agricultural Production (1980-81 to 1989-90)

Category	Crops	GaM	GaA	GaPr	GaP (=GaA+ GaPr)	GaC	Interaction growth Rates
Cereals	Rice	-7.1	-9.6	3.5	-6.1	-1.0	0.0
Oilseeds	Coconut	10.1	6.9	1.9	8.8	1.0	0.3
Plantation crops	Tea	4.1	-0.9	4.7	3.8	0.2	0.1
	Rubber	18.7	11.4	7.1	18.5	-0.4	0.6
Spices & condiments	Pepper	15.0	14.0	-2.3	11.7	3.2	0.1
	Ginger	10.9	2.9	9.5	12.4	-1.6	0.1
	Arecanut	5.4	0.5	3.8	4.3	1.2	-0.1
Fruits& Vegetables	Banana	9.9	5.5	6.7	12.2	-2.4	0.1
	Cashewnut	7.7	-4.2	13.2	9.0	-0.8	-0.5
	Tapioca	-7.8	-12.1	5.0	-7.1	-1.0	0.3
Miscellaneous	Sugarcane	-5.0	0.3	-5.8	-5.5	0.4	0.1
Total		4.1	-2.8	7.4	4.6	-0.3	-0.2

Notes : `0.00' and '(-)0.00' denotes very small values

Source : Same as in table 3.1

unfavourable cropping pattern (-2.4%). Sugarcane production had negative growth because of its decline in productivity.

Thus, during 80s area cultivated of coconut, rubber, pepper, ginger, arecanut, banana and sugarcane, productivity of all crops except pepper and sugarcane increased. Cropping pattern was favourable to coconut, tea, pepper, arecanut and sugarcane.

3.2.1.5. Sub- period 1V

The growth components of agricultural production for the period 1990-91 to 1995-96 are presented in table 3.6. Table reveals that production growth rate of 9.1% was due to the strong effect of productivity. Eventhough area cultivated decreased and cropping pattern became unfavourable, productivity growth rate of 10.3% suppressed their negative effect and so total production increased at a rate of 9.1%. But for individual crops the situation is different.

In the case of cereals area cultivated was negative, cropping pattern was unfavourable and these negative values were greater than the positive growth rate of productivity and therefore total effect was negative. Coconut and arecanut production was increasing at a positive rate due to their favourable effect of area, productivity and cropping pattern. Cropping pattern was

Table 3.6

Components of growth rates of Agricultural Production (1990-91 to 1995-96)

Category	Crops	GaM	GaA	GaPr	GaP (=GaA+ GaPr)	GaC	Interaction growth Rates
Cereals	Rice	-6.9	-7.7	2.8	-4.9	-2.0	0.0
Oilseeds	Coconut	14.4	5.9	6.9	12.8	1.0	0.6
Plantation crops	Tea	2.9	0.5	3.3	3.8	-0.7	-0.2
	Rubber	22.1	4.6	21.2	25.8	-3.7	0.0
Spices & condiments	Pepper	9.1	6.8	4.9	11.7	-2.6	0.0
	Ginger	-6.5	-10.4	14.9	4.5	-10.9	-0.1
	Arecanut	15.2	8.7	4.0	12.7	1.8	0.7
Fruits& Vegetables	Banana	-8.5	6.8	-15.0	-8.2	-0.7	0.4
	Cashewnut	-4.4	-2.0	-7.4	-9.4	4.8	0.2
	Tapioca	-6.4	-12.2	4.2	-8.0	1.2	0.4
Miscellaneous	Sugarcane	-9.1	-22.2	9.4	-12.8	2.5	1.2
Total		9.1	-0.5	10.3	9.8	-0.6	-0.1

Notes : `0.00' and '(-)0.00' denotes very small values

Source : Same as in table 3.1

unfavourable to tea, rubber and pepper but their production growth rate was still positive due to increase in area cultivated and productivity. Strong negative area and cropping pattern effect caused total effect of ginger to be negative (-6.5%), strong negative productivity and cropping pattern effect lowered banana production to be at –8.5% and strong negative area and productivity effect decreased production of cashewnut (-4.4%). Area cultivated of tapioca and sugarcane declined at a rate of 12.2 and 22.2% respectively. Thus, eventhough productivity and cropping pattern was favourable, total effect became negative.

In nutshell during early 90s, area of rice, ginger, cashewnut, tapioca and sugarcane declined. Productivity of all crops (except banana and cashewnut) increased. But cropping pattern became unfavourable to rice, tea, rubber, pepper, ginger and banana.

3.3. District-wise growth of Agricultural Production

In this part along with comparison of growth rates of production we will look into the share of each districts to total production. Below we can discuss these matters for each crop. Here we have taken only 10 crops, which are common to all the 14 districts. The empirical results are briefly discussed below.

3.3.1. Rice Production

District-wise growth rate of rice production (presented in table 3.7) showed that major share of rice production was contributed by Palakkad district (26.28% in 1985-86 to 32.39% in 1994-95) and least share by Idukki (1.41% in 1985-86 to 1.01% in 1994-95). All other districts come in between them. Another feature of rice production was that the proportion of area cultivated increased during this period only in Palakkad.

At the state level rice production decreased by 2.6% during 1985-86 to 1994-95. District-wise growth rates showed that growth rate was greater in Kollam (20.6%) followed by Palakkad (3.8%) and Pathanamthitta (1.0%). In all other districts growth rates were negative. Highest decrease in rice production was in Kozhikode (-19.4%) followed by Kannur (-11.0%), Idukki (-10.9%), Thiruvananthapuram (-10.3%), Kasaragod (-9.6%), Ernakulam (-8.0%), Thrissur (-7.2%), Malappuram (-6.1%), Kottayam (-2.7%), Alappuzha (-2.6%) and Wayanad (-0.6%). Rate of decline in rice production was greater than state level in most districts.

3.3.2. Coconut Production

Table 3.8 revealed that coconut production was greater in Kozhikode. Its share in total production ranged from 8.76% to 17.91% during

Table 3.7

Share and growth rates of districts to state rice production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	4.03	4.02	3.52	3.52	3.42	3.52	3.12	3.22	3.13	3.03	3.45	-10.30
QLN	5.14	0.50	5.14	4.53	5.13	5.34	4.33	5.03	4.94	4.84	4.49	20.60
PTA	2.32	2.21	3.22	2.92	2.72	3.02	2.82	3.12	2.93	2.52	2.78	1.00
ALP	9.57	10.87	11.98	12.27	12.78	12.19	10.98	11.36	11.00	10.19	11.32	-2.60
KTM	4.93	6.24	6.34	6.04	6.24	5.74	5.24	5.63	5.95	5.75	5.81	-2.70
IDK	1.41	1.31	1.01	1.11	1.01	1.01	1.01	0.80	1.11	1.01	1.08	-10.90
EKM	12.19	12.07	11.68	11.77	10.56	9.47	10.37	10.55	10.09	10.39	10.91	-8.00
TCR	12.99	13.28	12.69	12.17	10.97	11.88	11.48	11.06	10.90	11.71	11.91	-7.20
PGT	26.28	26.96	25.88	27.16	28.97	30.11	32.73	31.06	31.69	32.39	29.32	3.80
MPM	7.96	8.85	7.65	7.34	7.65	7.45	7.55	7.54	7.06	7.27	7.63	-6.10
KDE	1.91	1.81	1.51	1.51	1.41	1.31	1.21	1.11	1.21	1.01	1.40	-19.40
WYD	4.63	5.33	3.52	3.92	3.72	3.83	4.03	4.62	4.64	5.15	4.34	-0.60
CNR	3.63	3.52	3.22	3.02	3.02	2.92	2.92	2.61	2.83	2.62	3.03	-11.00
KSD	3.02	3.02	2.62	2.72	2.41	2.22	2.22	2.31	2.52	2.12	2.52	-9.60
State	100	100	100	100	100	100	100	100	100	100	100	-2.60

Source : Same as in table 3.1

Table 3.8

Share and growth rates of districts to state coconut production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	10.06	10.88	9.96	11.77	12.29	11.58	11.29	10.08	11.36	9.86	10.91	14.90
QLN	8.05	10.78	9.15	9.36	8.76	9.26	7.36	7.76	7.64	8.05	8.62	8.80
PTA	4.73	4.13	3.62	3.32	2.92	3.63	2.92	2.72	2.61	2.31	3.29	-1.80
ALP	8.25	7.96	7.24	6.54	7.05	7.55	6.55	5.95	5.73	6.54	6.94	6.70
KTM	6.44	6.34	5.43	5.03	4.83	4.93	4.64	3.93	3.92	3.22	4.87	-2.10
IDK	2.11	1.31	1.81	1.51	1.61	1.61	1.51	1.61	1.51	1.31	1.59	8.80
EKM	10.06	9.77	10.06	10.46	9.67	8.76	7.96	8.47	7.94	7.24	9.04	5.40
TCR	10.97	9.87	11.27	12.27	12.19	11.88	11.79	12.40	11.36	11.57	11.56	17.90
PGT	3.12	1.71	2.21	2.31	2.52	3.32	2.92	3.13	3.52	3.12	2.79	28.00
MPM	7.55	7.85	8.85	9.66	9.57	11.58	10.79	11.39	11.56	10.87	9.97	28.00
KDE	17.91	16.72	16.40	15.19	15.11	8.76	16.23	17.84	15.68	17.61	15.74	14.00
WYD	0.10	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.20	0.20	0.11	50.30
CNR	8.35	8.06	9.05	8.25	8.86	11.08	10.79	9.78	11.36	11.87	9.74	26.70
KSD	2.31	4.63	4.83	4.23	4.53	5.94	5.14	4.84	5.63	6.24	4.83	34.30
State	100	100	100	100	100	100	100	100	100	100	100	14.90

Source : Same as in table 3.1

1985-86 to 1994-95. Share of Wayanad was the least. Other districts come in between them.

Growth of production of coconut was 14.9% at state level. Growth rates were greater than the state level in the districts like Thrissur (17.9%), Palakkad (28.0%), Malappuram (28.0%), Wayanad (50.3%), Kannur (26.7%) and Kasaragod (34.3%), whereas growth rates were lower than it in Kollam (8.8%), Alappuzha (6.7%), Idukki (8.8%), Ernakulam (5.4%) and Kozhikode (14.0%). In districts like Pathanamthitta (1.8%) and Kottayam (2.1%) growth rates of production were negative. Thus eventhough Kozhikode district contributed major part of total production; its growth rate was less than that of state average.

3.3.3. Pepper Production

Share of Idukki in total pepper production increased from 14.69% in 1985-86 to 24.87% in 1994-95 and that of Wayanad from 19.72% to 31.75% (table 3.9) during this decennial period. That was the least in Alappuzha (1.91% in 1985-86 to 0.3% in 1994-95).

Table also revealed that pepper production increased at a rate of 13.9% at state level. Idukki (25.8%), Ernakulam (35.5%) and Wayanad (24.8%) showed greater rates of growth than that of state level. Rates of growth

Table 3.9

Share and growth rates of districts to state pepper production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	4.73	3.42	2.11	2.41	2.12	2.32	1.81	1.92	2.31	1.92	2.51	-4.00
QLN	8.95	4.93	6.34	5.62	6.67	6.25	4.74	5.05	5.63	3.64	5.78	0.60
PTA	4.63	3.92	4.33	3.31	3.94	3.33	3.33	3.63	3.02	2.33	3.58	0.30
ALP	1.91	3.42	1.81	1.20	1.21	0.50	0.40	0.40	0.30	0.30	1.15	-65.10
KTM	3.22	5.13	3.02	2.61	3.13	4.23	3.43	3.13	3.42	1.42	3.27	0.50
IDK	14.69	16.40	28.57	38.86	35.25	30.34	28.83	28.76	26.76	24.87	27.33	25.80
EKM	3.22	2.82	3.72	2.41	2.02	2.72	2.52	2.72	2.41	16.48	4.11	35.50
TCR	1.71	3.22	2.72	1.31	1.52	2.22	1.92	1.61	1.61	1.01	1.88	-1.90
PGT	1.41	0.70	0.80	0.50	0.51	0.71	0.71	0.81	0.91	0.51	0.76	4.60
MPM	4.23	2.82	2.72	3.82	1.62	3.02	2.82	3.13	3.42	1.31	2.89	0.80
KDE	8.75	8.25	6.04	1.31	4.65	7.26	6.96	5.85	6.74	2.93	5.87	4.80
WYD	19.72	17.61	21.63	20.58	16.97	16.23	21.88	20.79	24.75	31.75	21.19	24.80
CNR	15.90	18.71	12.58	11.95	16.06	16.94	17.64	18.87	16.40	10.01	15.50	11.00
KSD	6.94	8.65	3.62	4.12	4.34	3.93	3.02	3.33	2.31	1.52	4.18	-23.40
State	100	100	100	100	100	100	100	100	100	100	100	13.90

Source : Same as in table 3.1

of Kollam (0.6%), Pathanamthitta (0.3%), Kottayam (0.5%), Palakkad (4.6%), Malappuram (0.8%), Kozhikode (4.8%) and Kannur (11.0%) were lower than state level growth rate. Compound growth rates of production of pepper was negative in Thiruvananthapuram (-4.0%), Alappuzha (-65.1%), Thrissur (-1.9%) and Kasaragod (23.4%) districts.

3.3.4. Ginger Production

Share of Kottayam in ginger production was 14.49% in 1985-86 but it decreased to only 1.21% in 1994-95 (table 3.10). Similarly share of Idukki decreased from 11.27% to 9.09%, but that of Wayanad increased from 25.35% to 55.15%. Other districts also show changes in their share to total production.

On the whole increase in ginger production at state level was at a rate of 0.5%. Decrease in the growth was 100.2% in Thiruvananthapuram, 1.6%in Kollam, 19.5% in Alappuzha, 74.5% in Kottayam, 59.1% in Ernakulam, 1.1% in Palakkad, 7.2%% in Kozhikode and 22.7% in Kasaragod districts. But an increase in the growth rate was seen in Pathanamthitta (11.7%), Idukki (4.2%), Thrissur (18.5%), Malappuram (14.4%), Wayanad (5.8%) and Kannur districts.

Table 3.10

Share and growth rates of districts to state ginger production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	1.91	1.51	0.40	0.40	0.30	0.70	0.50	1.91	2.31	0.00	1.00	-100.2
QLN	6.14	5.12	2.12	2.11	1.71	2.62	2.22	5.03	5.63	3.03	3.57	-1.60
PTA	3.02	2.61	1.71	2.71	2.02	3.92	4.03	3.62	3.02	3.64	3.03	11.70
ALP	1.51	1.10	0.60	0.40	0.30	0.30	0.50	0.40	0.30	1.21	0.66	-19.50
KTM	14.49	13.15	8.87	7.33	6.25	5.23	3.32	3.12	3.42	1.21	6.64	-74.50
IDK	11.27	16.06	16.13	14.96	13.91	12.58	10.37	28.67	26.76	9.09	15.98	4.20
EKM	18.11	19.18	15.22	11.04	11.39	11.97	10.88	2.72	2.41	6.06	10.90	-59.10
TCR	0.40	0.60	0.91	1.00	1.01	0.80	0.60	1.91	1.61	0.61	0.95	18.50
PGT	2.62	2.41	2.82	3.41	3.23	2.72	2.92	0.80	0.91	11.52	3.33	-1.10
MPM	1.61	1.31	0.91	0.80	0.71	0.70	0.70	3.12	3.42	1.21	1.45	14.40
KDE	4.93	4.22	3.63	5.62	4.84	2.92	1.81	5.84	6.74	2.42	4.30	-7.20
WYD	25.35	25.70	39.52	43.47	48.59	50.60	58.01	20.72	24.75	55.15	39.19	5.80
CNR	5.03	4.32	4.44	4.12	3.63	4.02	3.32	18.81	16.40	3.64	6.77	19.50
KSD	3.62	2.71	2.72	2.61	2.12	0.91	0.81	3.32	2.31	1.21	2.23	-22.70
State	100	100	100	100	100	100	100	100	100	100	100	-0.50

Source : Same as in table 3.1

3.3.5. Turmeric Production

Ernakulam contributed highest share (15.52%) and Thiruvananthapuram (0.23%) least share in turmeric production (table 3.11). Other district's share lies in between these 2 figures.

Analysis revealed that state level production of turmeric increased at a rate of 4.4%. Increase in turmeric was greater than state level in districts like Thiruvananthapuram (7.1%), Pathanamthitta (13.4%), Idukki (47.1%), Ernakulam (16.3%), Palakkad (21.0%), Malappuram (41.1%), Kozhikode (26.5%) and Kannur (16.8%). Turmeric production decreased in the districts like Alappuzha (55.6%), Kottayam (42.7%), Thrissur (11.6%), Wayanad (10.9%) and Kasaragod (33.0%). Thus, growth rate of production of turmeric was the highest in Idukki and the lowest in Alappuzha.

3.3.6. Arecanut Production

Kasaragod (19.71%) contributed the highest share and the lowest share was from Alappuzha (1.75%) (table 3.12). Other district shares lie in between these figures.

Between 1985-86 to 1994-95, state level arecanut production increased at a rate of 13.1%. Growth rate of districts which lie above

Table 3.11

Share and growth rates of districts to state turmeric production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	0.33	0.20	0.20	0.20	0.20	0.20	0.10	0.20	0.20	0.50	0.23	7.10
QLN	1.76	1.71	3.72	3.30	3.42	3.92	4.32	1.11	1.21	3.93	2.84	4.00
PTA	1.32	1.11	2.52	2.00	2.01	2.11	1.81	2.21	1.81	1.91	1.88	13.40
ALP	0.55	0.60	0.40	0.50	0.60	0.50	0.60	0.10	0.00	0.40	0.43	-55.60
KTM	36.22	27.87	26.66	22.80	21.55	17.81	15.28	10.26	11.88	5.84	19.62	-42.70
IDK	0.99	9.76	9.05	8.40	7.85	8.85	10.85	13.98	12.08	9.16	9.10	47.10
EKM	13.72	13.18	12.78	14.70	14.30	15.09	14.57	17.71	17.52	21.65	15.52	16.30
TCR	4.50	4.23	3.82	3.60	3.32	2.72	3.02	2.41	1.51	4.13	3.33	-11.60
PGT	10.10	8.85	8.95	10.10	10.47	10.06	12.96	14.49	15.21	15.11	11.63	21.00
MPM	2.63	2.21	1.91	2.30	2.62	3.22	3.92	5.03	6.45	6.04	3.63	41.10
KDE	6.04	5.23	6.94	6.60	7.96	10.66	10.15	9.96	9.47	11.98	8.50	26.50
WYD	11.20	12.88	10.56	11.30	10.88	11.17	8.84	9.05	9.47	5.24	10.06	-10.90
CNR	7.79	9.15	9.66	11.00	12.19	11.47	11.96	12.07	12.49	12.89	11.07	16.80
KSD	2.85	3.02	2.82	3.20	2.62	2.21	1.61	1.41	0.70	1.21	2.17	-33.00
State	100	100	100	100	100	100	100	100	100	100	100	4.40

Source : Same as in table 3.1

Table 3.12

Share and growth rates of districts to state arecanut production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	3.46	4.02	2.82	2.32	2.31	2.11	1.61	1.41	1.31	0.71	2.21	-28.50
QLN	3.97	4.53	3.22	3.12	3.22	2.62	2.52	2.73	2.42	1.71	3.01	-7.00
PTA	3.15	3.52	3.12	2.52	2.41	2.22	2.52	2.12	1.71	1.71	2.50	-5.40
ALP	2.44	3.92	2.42	1.11	1.11	1.21	1.51	1.41	1.11	1.31	1.75	-10.80
KTM	2.85	3.42	2.82	2.01	2.11	1.51	1.41	1.31	1.11	0.81	1.94	-24.50
IDK	2.95	3.02	3.02	4.73	3.82	3.63	3.73	4.24	4.23	3.63	3.70	21.40
EKM	12.41	12.58	10.47	7.85	6.93	4.73	4.54	4.14	2.92	2.92	6.95	-34.30
TCR	11.19	11.17	12.59	10.98	9.15	9.26	11.29	11.11	9.57	11.39	10.77	10.80
PGT	3.15	2.21	2.11	2.32	2.61	2.92	2.52	2.83	2.92	2.52	2.61	15.80
MPM	12.41	13.08	12.89	15.31	16.08	17.42	17.94	19.29	16.52	14.21	15.52	21.90
KDE	10.58	9.56	7.85	8.46	9.05	6.55	7.96	1.82	10.88	13.21	8.59	5.50
WYD	2.14	2.72	3.02	2.52	2.31	2.11	2.62	3.64	4.13	2.72	2.79	23.00
CNR	12.82	10.36	14.70	17.32	18.99	21.65	20.36	22.22	22.26	18.85	17.95	32.70
KSD	16.48	15.90	18.93	19.44	19.90	22.05	19.46	21.72	18.93	24.29	19.71	22.10
State	100	100	100	100	100	100	100	100	100	100	100	13.10

Source : Same as in table 3.1

the state average include 21.4% in Idukki, 15.8% in Palakkad , 21.9% in Malappuram, 23.0% in Wayanad, 32.7% in Kannur and 22.1% in Kasaragod. Production in northern districts (Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha and Kottayam) including Ernakulam decreased during the selected period.

3.3.7. Banana Production

Share of banana production was more or less the same in all the 14 districts (table 3.13). Their range was 5.64% to 8.57% in Thiruvananthapuram, 5.64% to 7.75% in Kollam, 5.04% to 7.75% in Pathanamthitta, 2.32% to 4.13% in Alappuzha, 8.87% to 12.58% in Kottayam, 3.62% to 7.46% in Idukki, 9.06% to 12.14% in Ernakulam, 6.74% to 8.97% in Thrissur, 8.27% to 10.67% in Palakkad, 9.88% to 15.01% in Malappuram, 3.83% to 6.84% in Kozhikode, 4.02% to 8.36% in Wayanad, 6.04% to 7.65% in Kannur and 1.51% to 3.93% in Kasaragod districts.

Growth rate of banana production was 13.2% at state level. Districts having growth rates, which lies above this state average were Idukki (13.9%), Thrissur (15.3%), Palakkad (18.4%), Malappuram (22.2%), Wayanad (35.8%), Kannur (16.0%) and Kasaragod (21.4%). Other district growth rates were less than that of state level.

Table 3.13

Share and growth rates of districts to state banana production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	8.25	8.27	8.57	7.96	7.85	6.75	6.44	6.95	6.45	5.64	7.31	2.70
QLN	7.75	7.66	7.16	7.35	6.55	6.04	5.84	5.94	5.64	6.95	6.69	5.90
PTA	5.84	7.36	7.36	7.65	7.75	6.65	6.34	6.04	5.04	6.24	6.63	7.40
ALP	3.92	4.13	3.63	3.12	3.22	3.42	2.92	2.92	2.32	3.02	3.26	1.70
KTM	12.58	8.87	10.38	10.37	10.07	10.17	10.87	10.67	10.37	9.57	10.39	11.50
IDK	3.62	7.46	5.14	4.23	4.23	4.23	4.53	4.53	5.24	5.24	4.84	13.90
EKM	12.17	10.28	12.40	11.48	10.88	11.38	11.87	11.98	11.38	9.06	11.29	10.20
TCR	6.74	8.97	7.36	6.85	7.75	8.66	7.85	7.05	7.35	8.76	7.73	15.30
PGT	8.85	8.27	8.37	9.26	9.97	10.07	10.46	10.67	9.16	9.77	9.49	18.40
MPM	10.26	11.09	9.88	12.19	11.18	10.57	10.97	11.88	15.01	14.00	11.70	22.20
KDE	6.84	5.14	4.44	4.73	5.14	5.44	4.63	4.13	3.83	4.13	4.84	2.70
WYD	4.02	4.33	4.64	5.04	5.04	5.24	6.24	6.55	8.36	7.85	5.73	35.80
CNR	6.54	6.65	6.85	6.04	6.45	7.65	7.55	7.35	6.65	6.95	6.87	16.00
KSD	2.62	1.51	3.83	3.73	3.93	3.73	3.52	3.32	3.22	2.82	3.22	21.40
State	100	100	100	100	100	100	100	100	100	100	100	13.20

Source : Same as in table 3.1

3.3.8. Tapioca Production

District-wise share and growth rate of tapioca production was given in table 3.14. Share of tapioca production was greater in southern districts like Thiruvananthapuram, Kollam, Kottayam etc. and was lower in northern districts like Kozhikode, Wayanad, Kasaragod etc.

During the selected decenial period state level tapioca production decreased at a rate of 9.1%. The rates of decline were greater in Thiruvananthapuram(18.0%), Pathanamthitta (14.8%), Alappuzha(20.3%), Kottayam(17.3%), Ernakulam(13.2%), Thrissur(10.4%) and Kasaragod(30.5%). Tapioca production in Kozhikode (6.2%) and Palakkad (4.7%) districts increased.

3.3.9. Rubber Production

Share and growth of rubber production across districts are presented in table 3.15. As the table shows major part of production was contributed by Kottayam(24.93%) and least share by Alappuzha(1.12%) and Wayanad (0.75%). Other districts lie in between them.

The growth rates of rubber production were greater than the state level of 26.2% in districts like Thiruvananthapuram, Pathanamthitta, Idukki,

Table 3.14

Share and growth rates of districts to state tapioca production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	23.56	23.34	21.75	20.32	22.08	19.86	20.77	22.84	17.14	15.90	20.76	-18.00
QLN	14.90	16.40	16.72	20.82	20.26	18.85	21.88	21.93	20.06	20.22	19.20	-1.00
PTA	9.06	8.45	6.85	8.05	7.76	8.67	7.66	6.84	6.96	7.14	7.74	-14.80
ALP	5.84	4.63	6.14	4.53	5.04	4.33	4.13	4.23	3.83	4.02	4.67	-20.30
KTM	11.98	12.68	10.27	11.57	10.48	10.99	10.38	10.56	10.38	8.05	10.74	-17.30
IDK	5.44	5.63	5.84	6.74	5.75	6.65	5.95	5.53	6.65	7.85	6.20	-3.30
EKM	5.84	5.84	5.44	4.63	4.64	5.34	5.04	4.53	5.44	4.93	5.17	-13.20
TCR	1.91	2.72	2.32	2.01	2.12	2.52	2.12	2.01	1.92	2.41	2.21	-10.40
PGT	4.83	4.43	7.05	6.44	6.65	6.65	7.46	7.14	8.87	7.75	6.73	4.70
MPM	6.04	6.54	8.56	6.24	6.75	7.76	6.55	6.14	7.86	8.05	7.05	-5.40
KDE	1.11	1.11	1.71	1.81	1.92	1.61	1.51	1.41	1.81	3.02	1.71	6.20
WYD	1.41	1.91	1.71	1.91	1.81	1.81	1.61	1.51	1.71	3.32	1.87	-0.70
CNR	5.44	4.43	4.23	3.72	3.63	4.13	3.93	4.23	6.15	6.24	4.61	-3.50
KSD	2.62	1.91	1.41	1.11	1.11	0.81	1.01	1.11	1.21	1.11	1.34	-30.50
State	100	100	100	100	100	100	100	100	100	100	100	-9.10

Source : Same as in table 3.1

Table 3.15

Share and growth rates of districts to state rubber production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	4.54	4.54	4.63	4.64	4.62	4.73	7.55	5.84	5.75	5.74	5.26	40.00
QLN	10.79	10.60	10.27	10.18	10.05	10.46	11.27	8.56	8.47	8.36	9.90	18.70
PTA	8.17	8.48	8.96	8.67	8.54	8.35	14.79	11.38	11.19	11.28	9.98	40.30
ALP	1.41	1.41	1.41	1.41	1.41	1.41	0.91	0.60	0.60	0.60	1.12	-3.50
KTM	27.42	27.25	26.49	25.81	25.03	24.14	15.19	26.38	25.91	25.68	24.93	21.70
IDK	7.96	7.87	7.65	7.36	7.94	7.95	11.17	8.66	8.37	8.26	8.32	30.80
EKM	10.58	10.80	11.08	11.19	11.16	11.17	5.03	12.89	13.10	13.19	11.02	29.20
TCR	3.43	3.23	3.52	3.53	3.52	3.52	3.82	2.82	3.02	3.12	3.35	22.40
PGT	3.83	4.04	4.03	4.44	4.62	4.73	5.84	4.23	4.54	4.63	4.49	32.70
MPM	6.15	6.26	6.14	6.25	6.43	6.54	6.14	4.93	4.94	5.04	5.88	18.30
KDE	6.65	6.46	6.45	6.45	6.53	6.34	5.33	3.93	4.13	4.03	5.63	8.60
WYD	0.81	0.81	0.81	0.71	0.80	0.80	0.91	0.60	0.60	0.60	0.75	17.10
CNR	4.64	4.74	5.04	5.75	5.53	5.63	6.94	5.24	5.44	5.54	5.45	32.20
KSD	3.63	3.53	3.52	3.63	3.82	4.23	5.13	3.93	3.93	3.93	3.93	31.80
State	100	100	100	100	100	100	100	100	100	100	100	26.20

Source : Same as in table 3.1

Ernakulam, Palakkad, Kannur and Kasaragod. Decrease in production occurred only in Alappuzha district.

3.3.10. Cashewnut Production

Kannur and Kasaragod contributed major shares of cashewnut production and lowest shares were from Kottayam, Idukki and Wayanad (table 3.16). State level cashewnut production increased at a rate of 2.1% during 1985-86 to 1994-95. This increment was lower than district increments of Thiruvananthapuram, Alappuzha, Idukki, Kozhikode, Wayanad and Kannur. State level production growth rate was very small due to the negative growth rate of Kollam, Pathanamthitta, Kottayam, Ernakulam, Thrissur, Palakkad, Malappuram and Kasaragod.

Thus, on the whole, during the selected 10 year period, state production of coconut, pepper, turmeric, arecanut, banana, rubber and cashewnut increased while that of rice, ginger and tapioca showed a declining trend. In every districts 2 to 7 crops showed negative growth rate. Alappuzha and Kottayam had negative growth rate for 7 crops while Idukki, Palakkad, Kozhikode and Kannur had negative growth rate for only 2 crops.

Table 3.16

Share and growth rates of districts to state cashewnut production

District	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	Average	CGR
TVM	3.02	2.02	2.72	2.82	3.22	3.22	3.32	3.62	3.36	3.02	3.03	10.30
QLN	5.54	7.26	8.17	6.44	6.34	5.84	5.34	6.03	6.83	4.94	6.27	-3.00
PTA	1.11	2.92	2.72	2.01	1.91	1.41	1.11	1.21	0.98	1.01	1.64	-21.10
ALP	0.81	1.71	2.32	1.41	1.51	2.22	2.62	2.71	2.28	2.52	2.01	26.40
KTM	0.20	0.60	0.60	0.40	0.40	0.30	0.30	0.40	0.22	0.20	0.36	-13.20
IDK	0.20	0.20	0.20	0.50	0.50	0.50	0.40	0.50	0.43	0.30	0.38	22.30
EKM	2.42	1.41	1.51	1.21	1.11	1.01	1.31	1.21	0.98	0.81	1.30	-18.10
TCR	3.43	4.03	3.73	2.92	3.02	2.42	3.32	3.72	2.82	2.92	3.23	-3.20
PGT	6.75	5.75	5.95	4.23	4.33	3.63	3.83	3.52	3.47	2.82	4.43	-19.90
MPM	10.18	9.38	9.48	9.86	9.26	11.18	9.47	10.25	0.87	6.55	8.65	-29.70
KDE	2.32	1.92	1.81	1.91	2.01	2.11	3.12	3.32	2.82	2.12	2.35	11.70
WYD	0.20	0.60	0.60	0.30	0.30	0.20	0.30	0.30	0.33	0.71	0.39	6.50
CNR	33.77	43.35	38.81	44.16	42.15	42.90	48.34	45.33	49.89	56.15	44.49	12.10
KSD	30.04	18.85	21.37	21.83	23.94	23.06	17.22	17.89	24.73	15.93	21.49	-5.60
State	100	100	100	100	100	100	100	100	100	100	100	2.10

Source : Same as in table 3.1

3.4. District-wise growth of Agricultural Productivity

District-wise growth rates of agricultural productivity (both crop-wise and total for the period 1985-86 to 1994-95) are presented in table 3.17. Below are given a brief explanation about them.

3.4.1. Rice Productivity

During the selected period rice productivity at the state level increased at a rate of 4.0%. This growth was greater than that of state average in Pathanamthitta, Kottayam, Idukki, Thrissur, Palakkad, Malappuram and Wayanad and lesser in districts like Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Kozhikode, Kannur and Kasaragod. Thus, rice productivity increment was the highest in Wayanad and lowest in Ernakulam.

3.4.2. Coconut Productivity

Coconut productivity in Kerala increased at a rate of 7.4% during the selected decennial period. Its productivity increment was greater than state increment in districts like Thiruvananthapuram, Idukki, Palakkad, Malappuram, Kozhikode, Wayanad, Kannur and Kasaragod. But was less than state average in districts like Kollam, Pathanamthitta, Kottayam, Ernakulam and Thrissur. Productivity of coconut decreased only in Alappuzha district.

Table 3.17

Districtwise growth rates of Agricultural Productivity (1985-86 to 1994-95)

District	Rice	Coconut	Rubber	Pepper	Ginger	Turmeric	Arecanut	Banana	Tapioca	Cashewnut
TVM	1.4	9.8	14.0	(-)0.0	44.6	32.0	-2.7	4.0	2.3	32.5
QLN	2.5	6.6	18.3	0.7	29.4	-9.2	4.0	-7.5	6.3	1.5
PTA	5.9	2.3	19.2	1.5	5.9	-11.7	1.9	2.0	0.9	-2.3
ALP	2.2	-2.7	2.8	-26.9	-1.7	-18.7	-9.0	-3.5	1.9	10.0
KTM	5.4	3.0	13.4	10.8	11.9	-7.6	-1.0	6.2	4.3	7.6
IDK	5.2	10.5	22.0	12.6	23.5	1.0	29.3	11.7	8.4	35.3
EKM	1.1	4.7	15.9	3.0	-3.5	13.3	-9.6	4.5	5.4	2.0
TCR	4.1	6.5	17.5	-7.0	36.8	5.0	9.7	-7.0	8.2	4.9
PGT	6.4	8.9	13.2	-14.9	-25.3	2.9	4.0	1.6	10.1	-7.6
MPM	4.2	11.2	6.3	-19.1	39.5	5.9	17.7	9.6	9.8	5.9
KDE	3.2	10.4	8.7	-4.6	62.1	15.5	-5.5	4.2	7.9	12.9
WYD	7.2	13.4	15.1	-4.8	-12.0	-7.8	1.8	6.6	14.8	19.5
CNR	1.4	10.5	14.9	-7.9	37.4	6.2	8.7	-1.9	2.4	19.9
KSD	3.1	18.4	17.4	-12.6	14.8	14.6	10.5	5.5	0.1	-2.5
State	4.0	7.4	14.2	-4.2	23.7	1.5	6.2	2.4	5.9	8.7

Source : Same as in table 3.1

3.4.3. Rubber Productivity

Rubber productivity increased in all districts during mid-eighties to mid-nineties. District productivity growth was greater than state productivity growth of 14.2% in Kollam(18.3%), Pathanamthitta(19.2%), Idukki(22.0%), Ernakulam(15.9%), Thrissur(17.5%), Wayanad(15.1%), Kannur(14.9%) and Kasaragod(17.4%). This rate was greater in Thiruvananthapuram, Alappuzha, Kottayam, Palakkad, Malappuram and Kozhikode. Thus rubber productivity growth was the greatest in Idukki and lowest in Alappuzha.

3.4.4. Pepper Productivity

During the selected decennial period, pepper productivity decreased at a compound rate of 4.2%. This decrement of growth rate was the greatest in Alappuzha(26.9%), followed by Malappuram(19.1%), Palakkad(14.9%), Kasaragod(12.6%), Kannur(7.9%), Thrissur(7.0%), Wayanad(4.8%), Kozhikode(4.6%) and Thiruvananthapuram(very small %). But we can see increase of productivity in Kollam(0.7%), Pathanamthitta(1.5%), Kottayam(10.8%), Idukki(12.6%) and Ernakulam(3.0%). One special feature was the decline of pepper productivity in northern districts during 1985-86 to 1994-95.

3.4.5. Ginger Productivity

State ginger productivity increased at a rate of 23.7% during mid eighties to mid nineties. District-wise analysis showed that state productivity growth rate was lesser than that of districts in Thiruvananthapuram (44.6%), Kollam (29.4%), Thrissur (36.8%), Malappuram (39.5%), Kozhikode (62.1%) and Kannur (37.4%). They were smaller in Pathanamthitta (5.9%), Kottayam (11.9%), Idukki (23.5%) and Kasaragod (14.8%). Alappuzha, Ernakulam, Palakkad and Wayanad showed a decline in their rate of productivity growth of ginger.

3.4.6. Turmeric Productivity

Turmeric productivity increment was only 1.5% during 1985-86 to 1994-95. Kollam, Pathanamthitta, Alappuzha, Kottayam and Wayanad showed a decrease in the productivity rate of turmeric. Increment was the highest in Thiruvananthapuram (32.0%), followed by Kozhikode (15.5%), Kasaragod (14.6%), Ernakulam (13.3%), Kannur (6.2%), Malappuram (5.9%), Thrissur (5.0%), Palakkad (2.9%) and Idukki (1.0%). Thus its increment was highest in Thiruvananthapuram and lowest in Idukki and decrement was highest in Alappuzha and lowest in Kottayam.

3.4.7. Arecanut Productivity

Arecanut productivity increased at a compound rate of 6.2% at state level during the selected decennial period. Increment was greater than this in Idukki (29.3%), Thrissur (9.7%), Malappuram (17.7%), Kannur (8.7%) and Kasaragod (10.5%) and lower in Kollam (4.0%), Pathanamthitta (1.9%), Palakkad (4.0%) and Wayanad (1.8%). During 1985-86 to 1994-95, arecanut productivity decreased in Thiruvananthapuram, Alappuzha, Kottayam, Ernakulam and Kozhikode. Thus, arecanut productivity growth varied from –9.6% to +29.3% during the period under study.

3.4.8. Banana Productivity

Increase in banana productivity was only 2.4% at state level whereas in Thiruvananthapuram (4.0%), Kottayam (6.2%), Idukki (11.7%), Ernakulam (4.5%), Malappuram (9.6%), Kozhikode (4.2%), Wayanad (6.6%), Kasaragod (5.5%) etc. growth rate was much greater than state average. In Pathanamthitta, Palakkad etc. growth rate was lower than state increment. In some districts (Kollam, Alappuzha, Thrissur and Kannur) banana productivity showed a decelerating trend.

3.4.9. Tapioca Productivity

During 1985-86 to 1994-95, tapioca productivity increased in all districts. Thiruvananthapuram, Pathanamthitta, Alappuzha, Kottayam, Ernakulam, Kannur, and Kasaragod had relatively lower growth rate compared to the state average of 5.9%. But this growth rate was greater in Kollam, Idukki, Thrissur, Palakkad, Malappuram, Kozhikode and Wayanad. Table shows that tapioca productivity growth was the highest in Wayanad and the lowest in Kasaragod.

3.4.10. Cashewnut Productivity

Eventhough cashewnut productivity declined in Pathanamthitta, Palakkad and Kasaragod, state productivity showed an increment of 8.7%. This increment was the greatest in Idukki, followed by Thiruvananthapuram, Kannur, Wayanad, Kozhikode, Alappuzha, Kottayam, Malappuram, Thrissur, Ernakulam and Kollam.

In nutshell, at the state level only pepper had declining productivity at the selected period. Productivity of rice, rubber and tapioca increased in all districts while others showed decelerating trend in some districts.

3.5. Growth of Prices

Rates of growth of price are estimated for both wholesale and farm prices of agricultural commodities. Table 3.18 reveals that growth rate of wholesale prices during 1960-61 to 1995-96 ranged from 18.0% to 22.7%. Rate of growth was the highest in spices and condiments and lowest in plantation crops. This rate was highest for pepper and ginger prices (22.7%) followed by tapioca (22.4%), arecanut and turmeric (22.0%), coconut (21.4%), banana (19.8%), tea (19.1%) and rubber (18.0%).

In the case of farm prices, growth rate during the selected period ranged from 15.4% to 29.7% (see table 3.19). Farm prices of cashewnut had the highest growth rate (29.7%), followed by tapioca (23.4%), pepper (23.2%), ginger (22.9%), coconut (22.5%), banana (20.0%), sugarcane (18.8%), arecanut (18.6%) and paddy (15.4%). Thus, farm prices had higher growth rate than wholesale prices of agricultural commodities in Kerala.

Growth of agricultural commodities is now compared in figures 3.1 to 3.12. Eventhough production and productivity of some commodities had declining trend during the selected period, prices (both wholesale and farm prices) had a tremendous increase for all commodities. This leads to the acceptance of our null hypothesis that growth of prices was greater than that of production and productivity in Kerala agriculture.

Table 3.18

Growth rates of Wholesale Prices

Commodities	Growth Rates
Tapioca	22.40
Coconut	21.40
Pepper	22.70
Ginger	22.70
Arecanut	22.00
Banana	19.80
Turmeric	22.00
Rubber	18.00
Tea	19.10

Source : Same as in table 3.1

Table 3.19

Growth rates of Farm Prices

Commodities	Growth Rates
Paddy	15.4
Tapioca	23.4
Coconut	22.5
Pepper	23.2
Ginger	22.9
Arecanut	18.6
Banana	20
Cashewnut	29.7
Sugarcane	18.8

Source : Same as in table 3.1

Figure 3.1

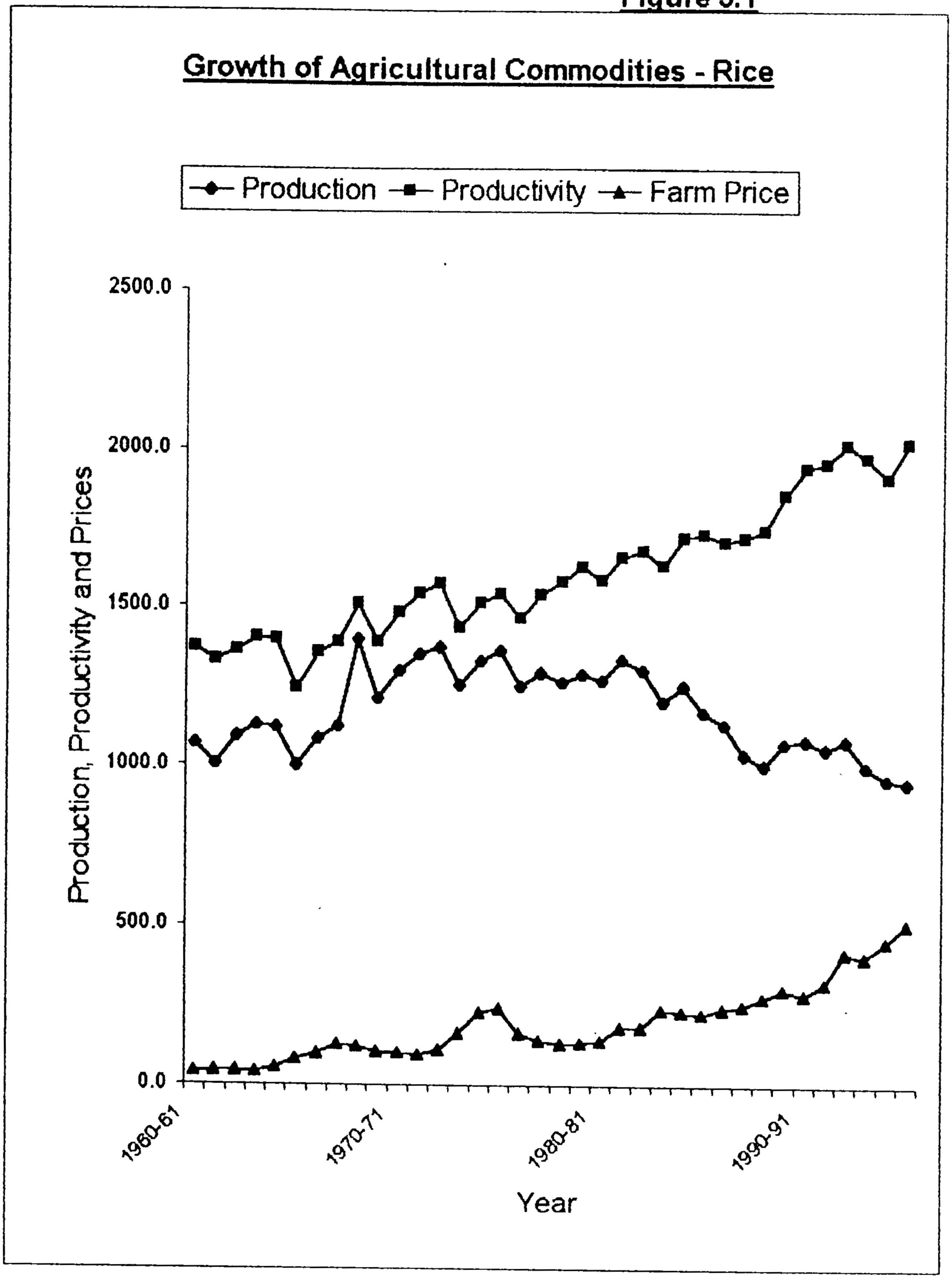

Growth of Agricultural Commodities - Rice
Production
Productivity
Farm Price
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Production, Productivity and Prices
1960-61
1970-71
1980-81
1990-91
Year

Figure 3.2

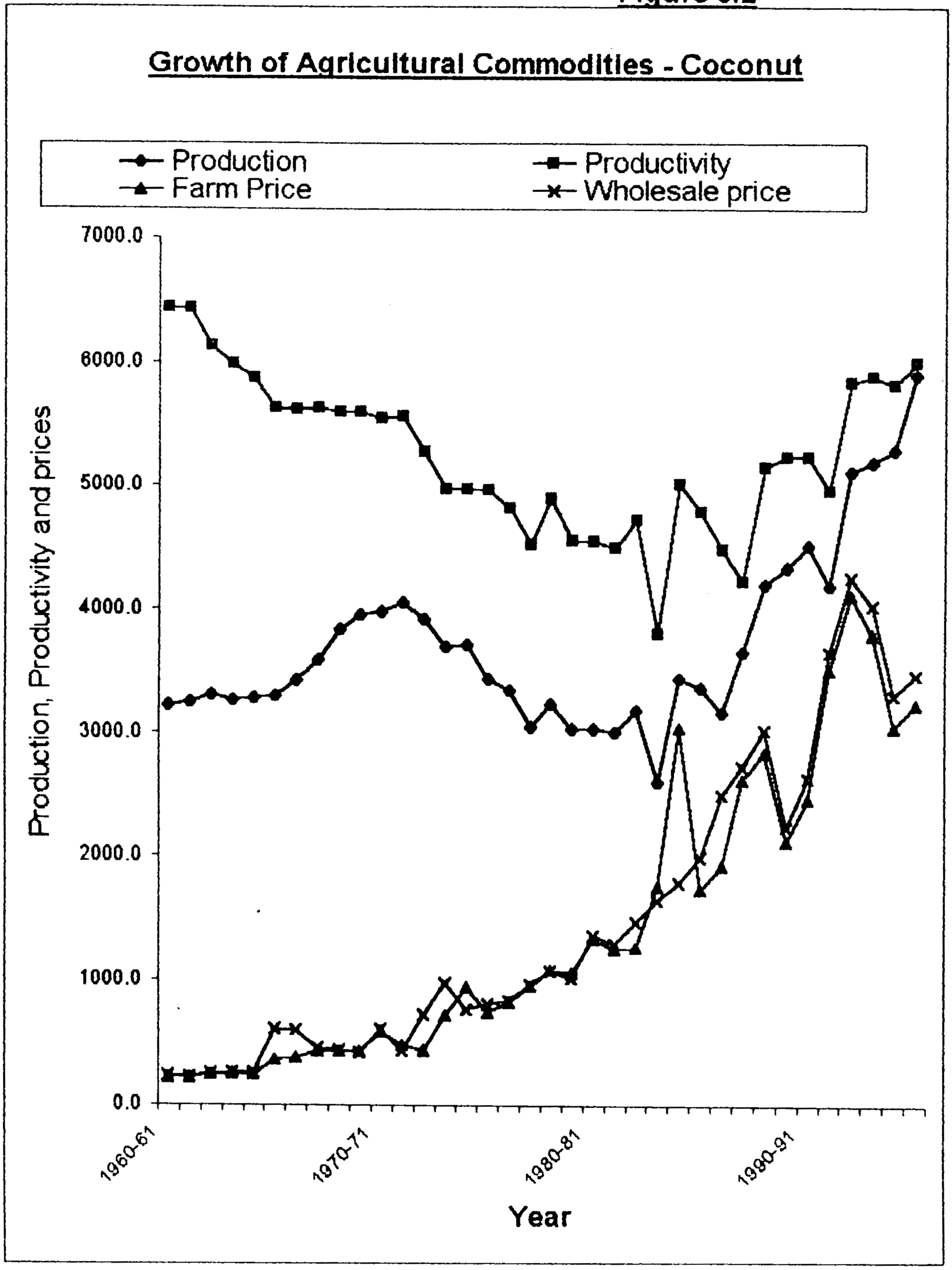

Growth of Agricultural Commodities - Coconut
Production
Productivity
Farm Price
Wholesale price
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
Production, Productivity and prices
1960-61
1970-71
1980-81
1990-91
Year

Figure 3.3

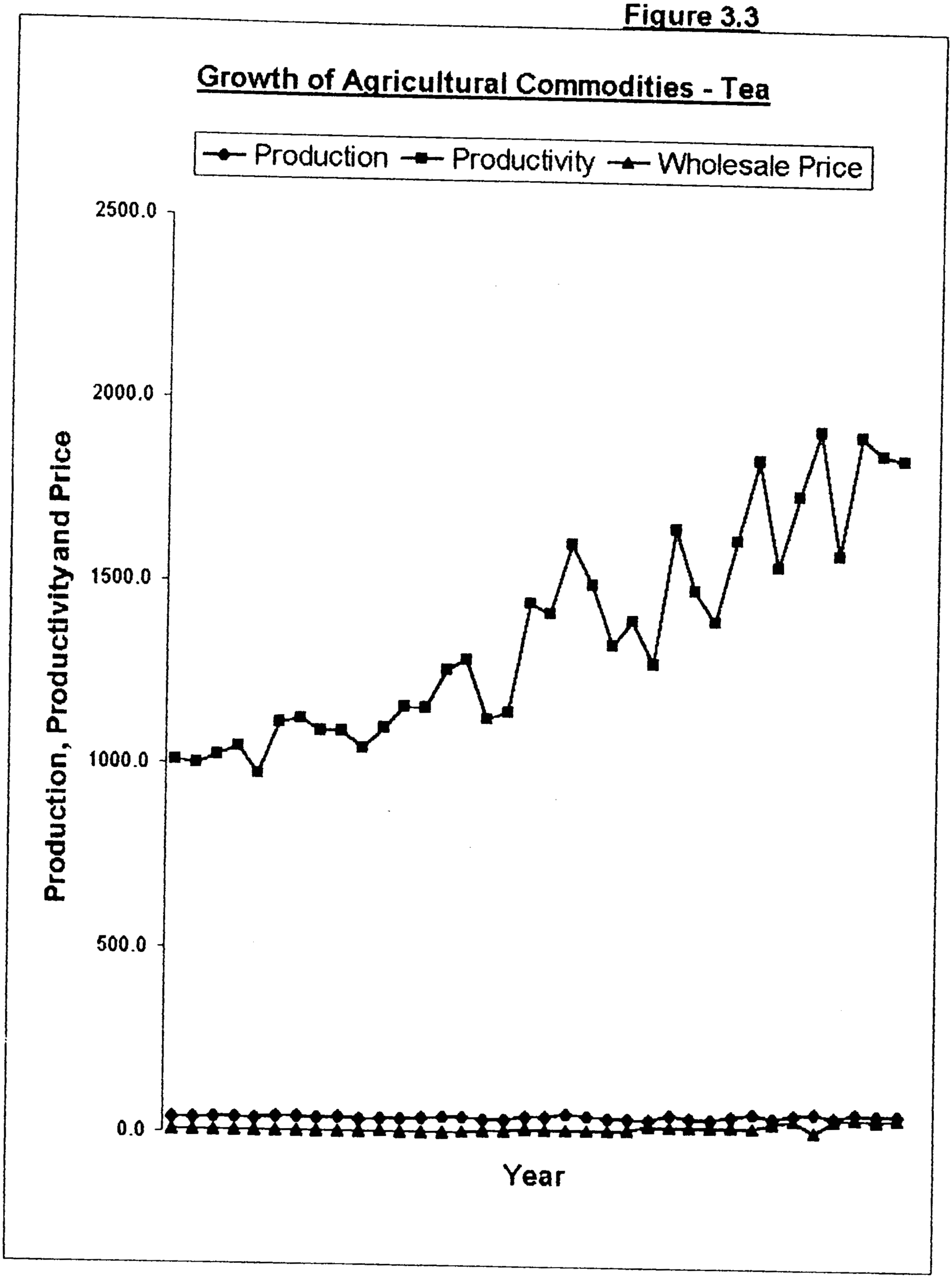

Growth of Agricultural Commodities - Tea
Production
Productivity
Wholesale Price
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Production, Productivity and Price
Year

Figure 3.4

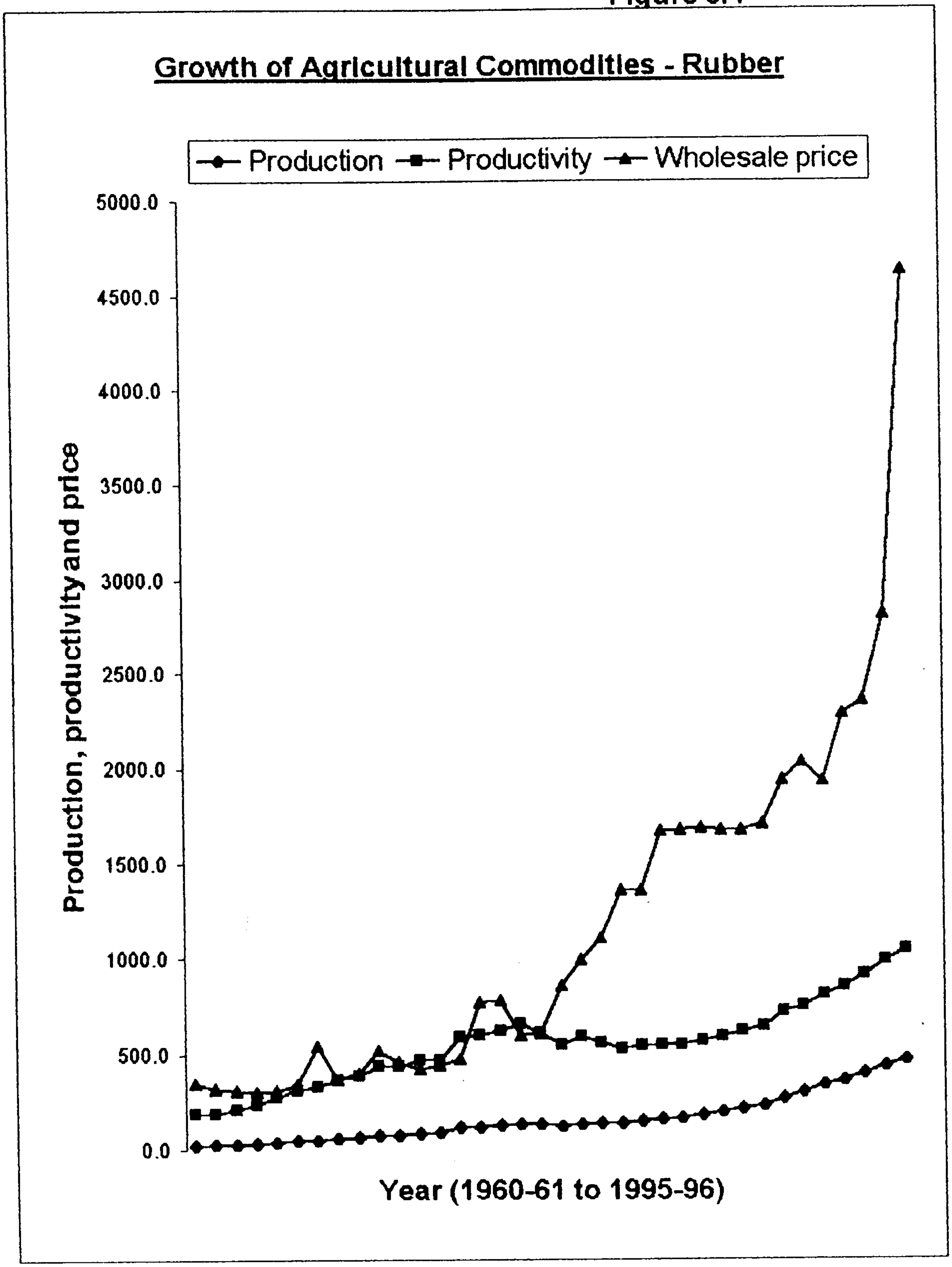

Growth of Agricultural Commodities - Rubber
Production
Productivity
Wholesale price
5000.0
4500.0
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Production, productivity and price
Year (1960-61 to 1995-96)

Figure 3.5

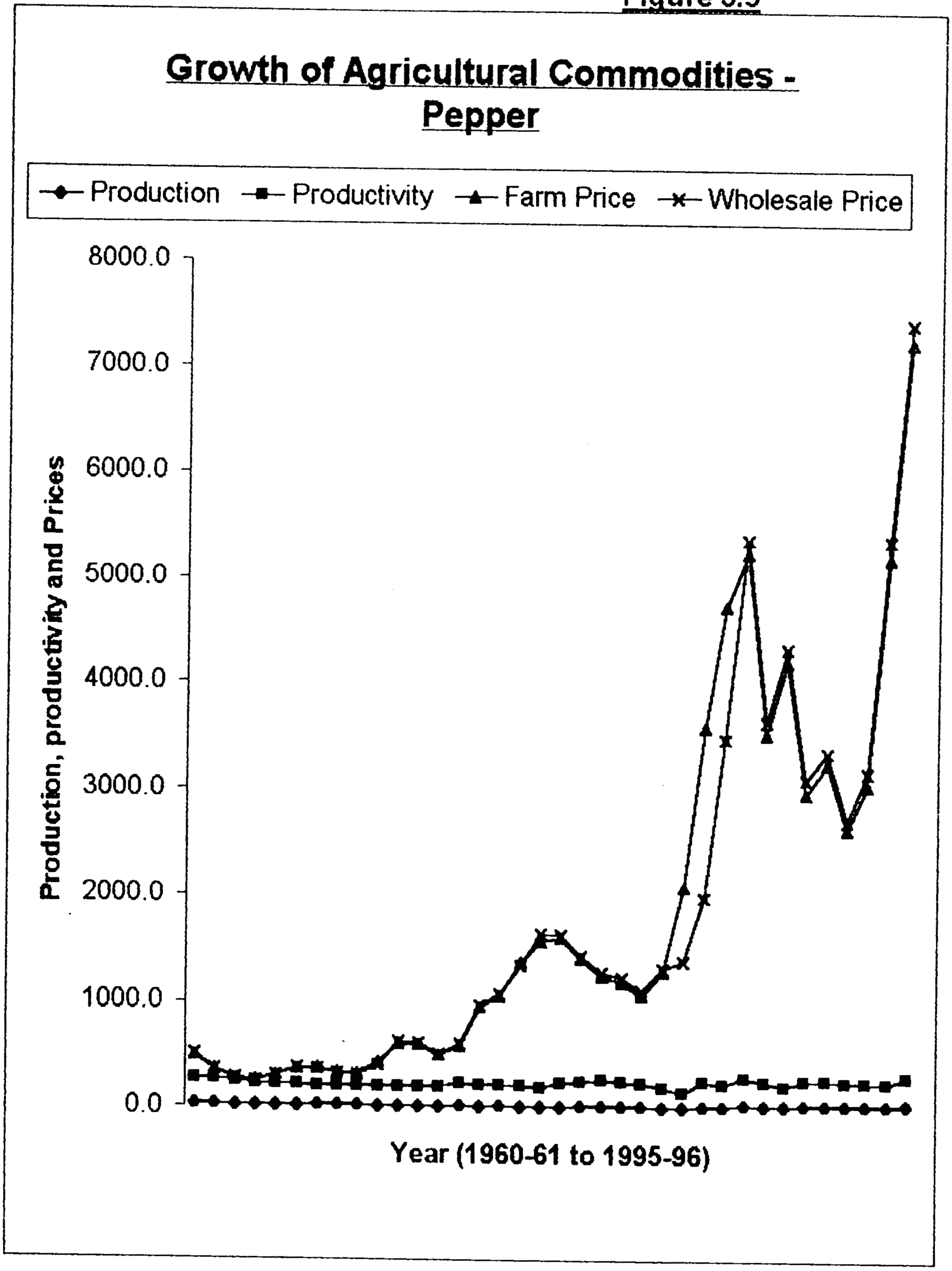

Growth of Agricultural Commodities - Pepper
Production
Productivity
Farm Price
Wholesale Price
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
Production, productivity and Prices
Year (1960-61 to 1995-96)

Figure 3.6

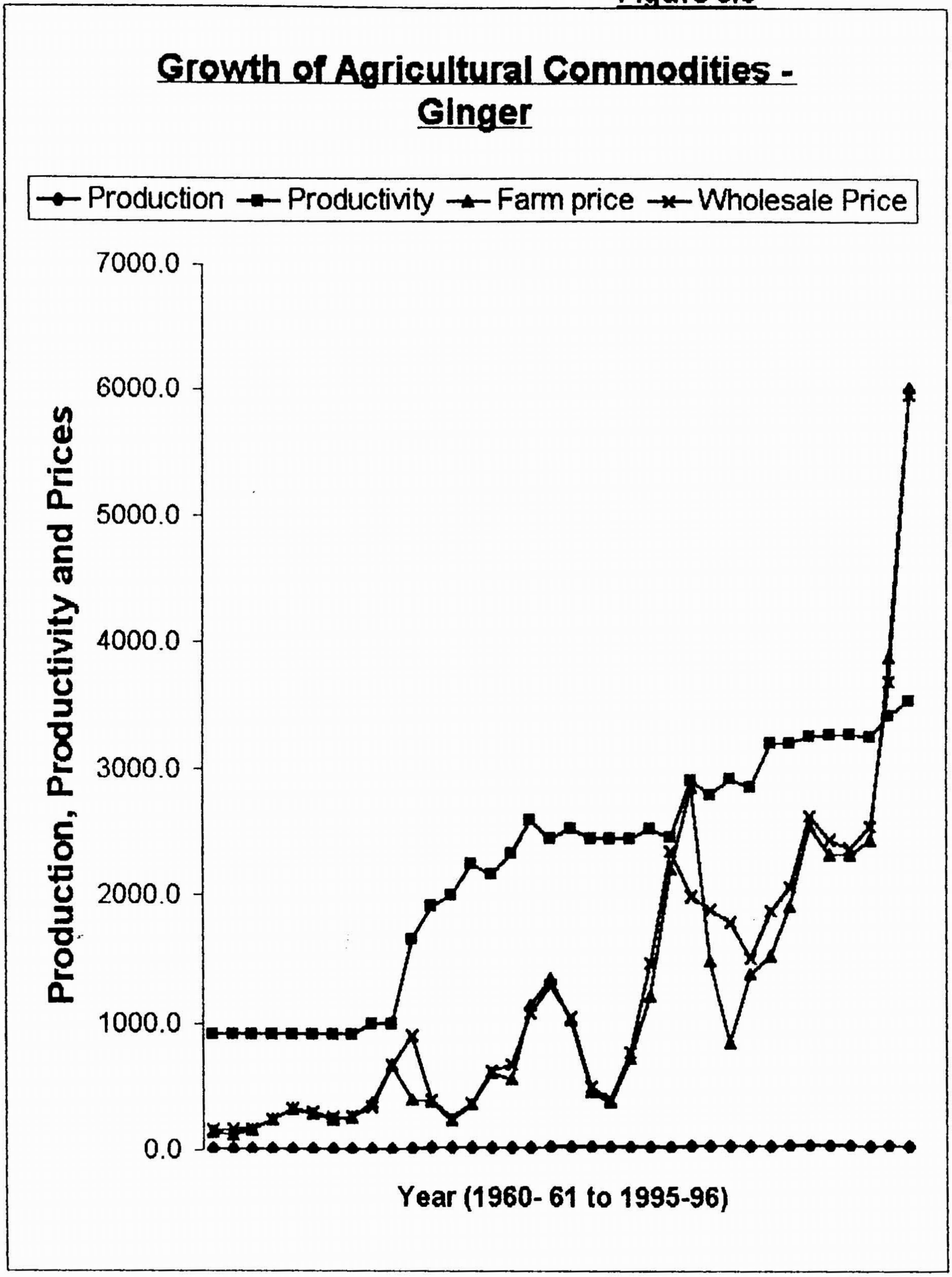

Growth of Agricultural Commodities - Ginger
Production
Productivity
Farm price
Wholesale Price
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
Production, Productivity and Prices
Year (1960- 61 to 1995-96)

Figure 3.7

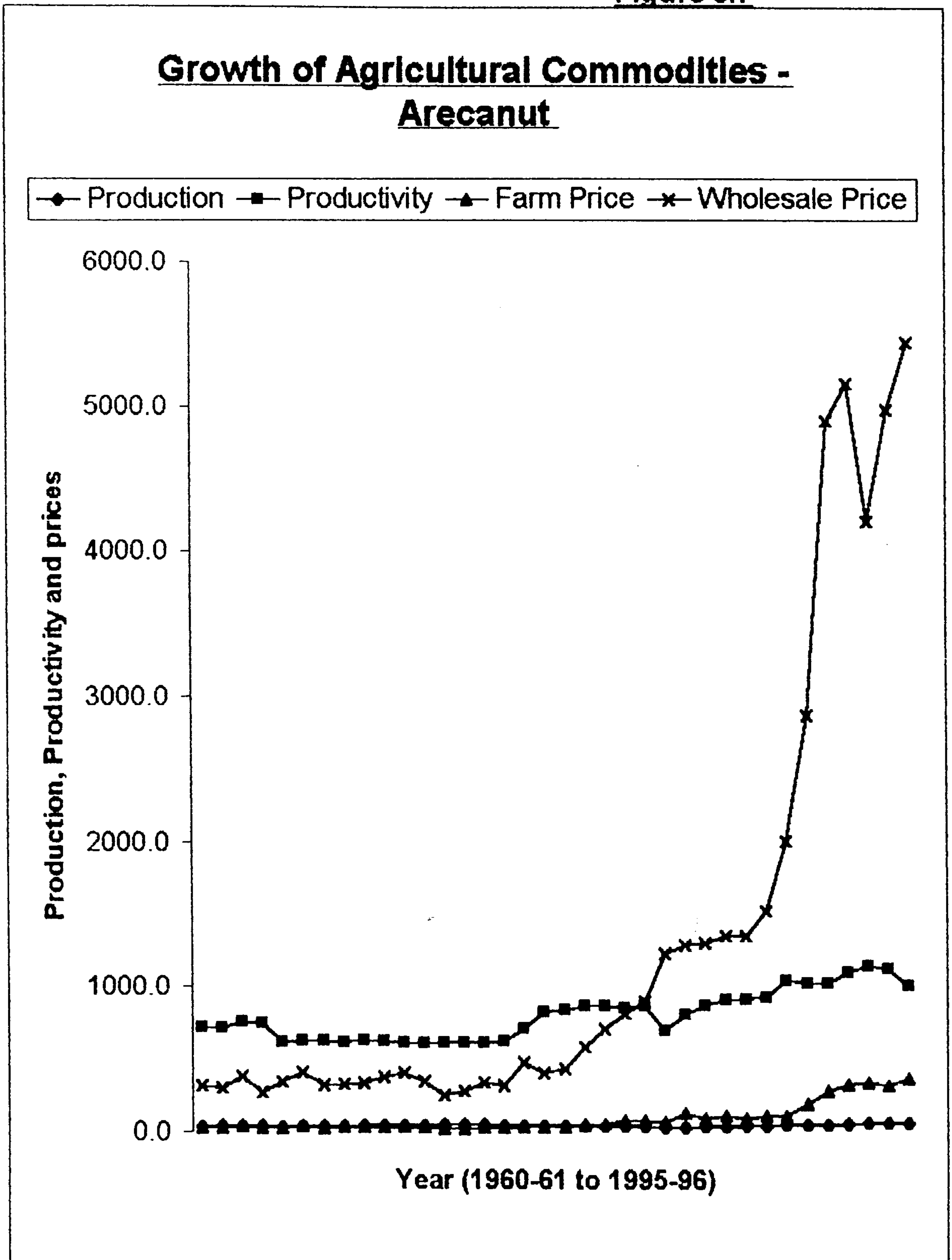

Growth of Agricultural Commodities - Arecanut
Production
Productivity
Farm Price
Wholesale Price
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
Production, Productivity and prices
Year (1960-61 to 1995-96)

Figure 3.8

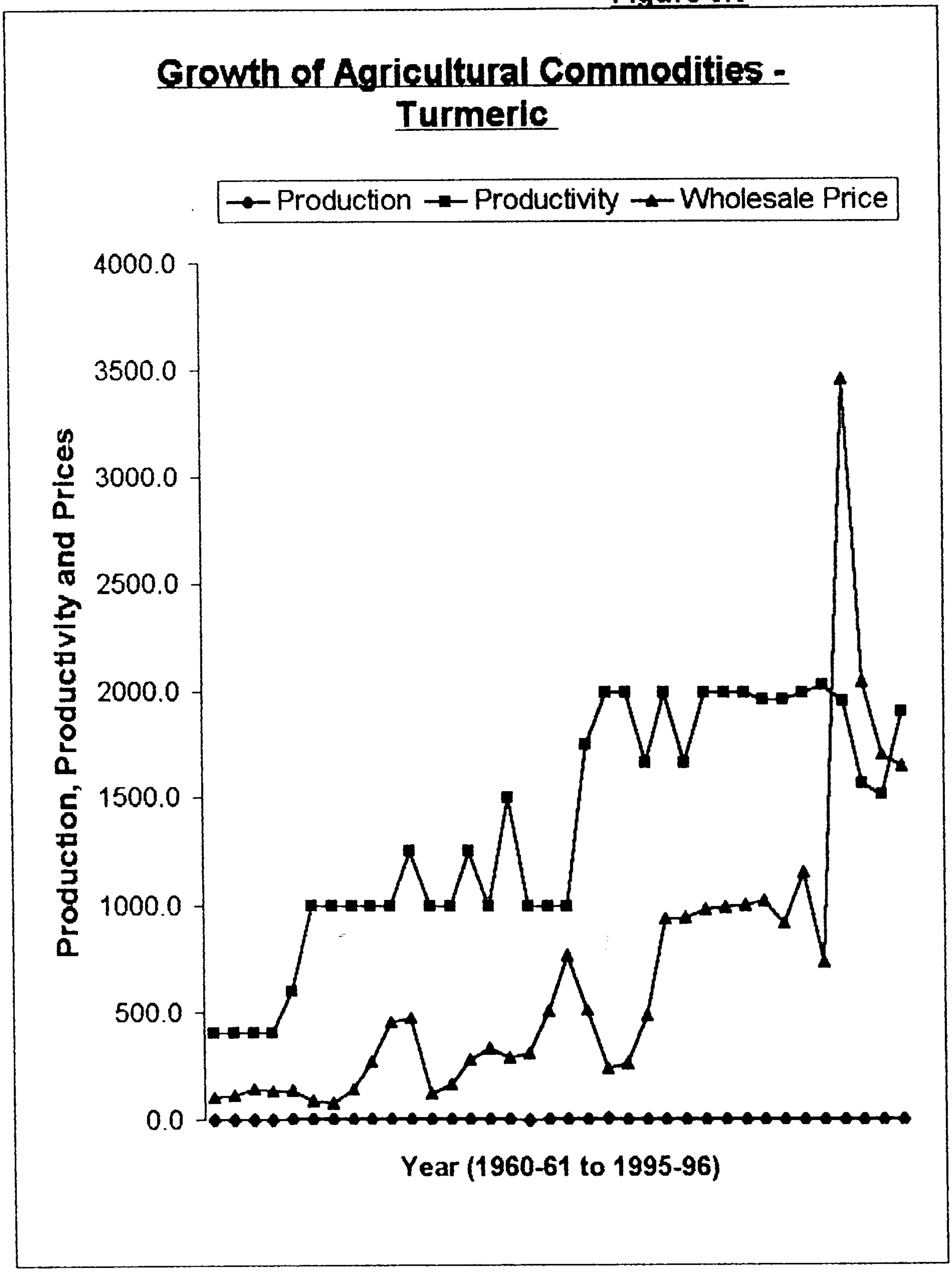

Growth of Agricultural Commodities - Turmeric
Production
Productivity
Wholesale Price
4000.0
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Production, Productivity and Prices
Year (1960-61 to 1995-96)

Figure 3.9

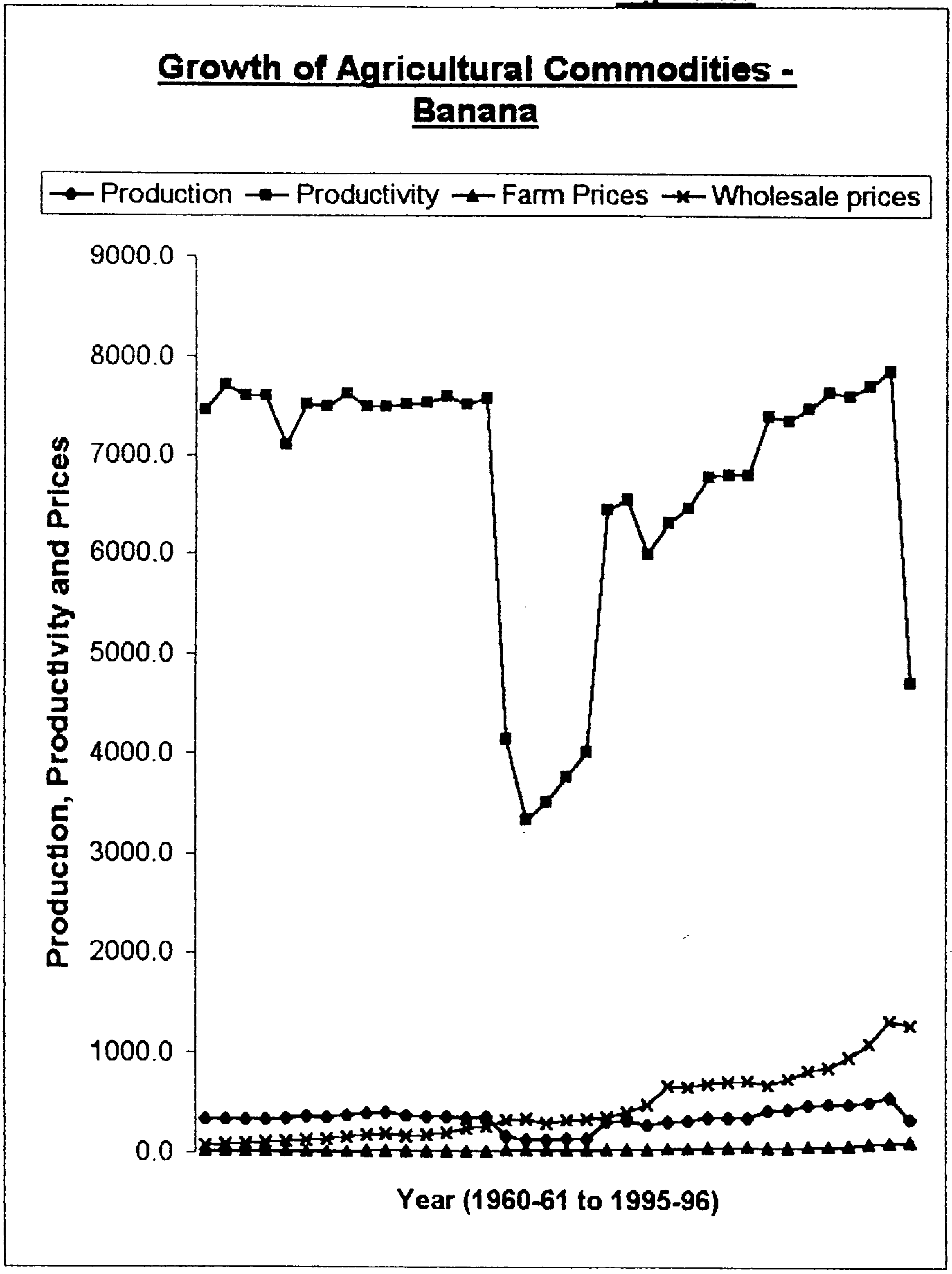

Growth of Agricultural Commodities - Banana
Production
Productivity
Farm Prices
Wholesale prices
9000.0
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
Production, Productivity and Prices
Year (1960-61 to 1995-96)

Figure 3.10

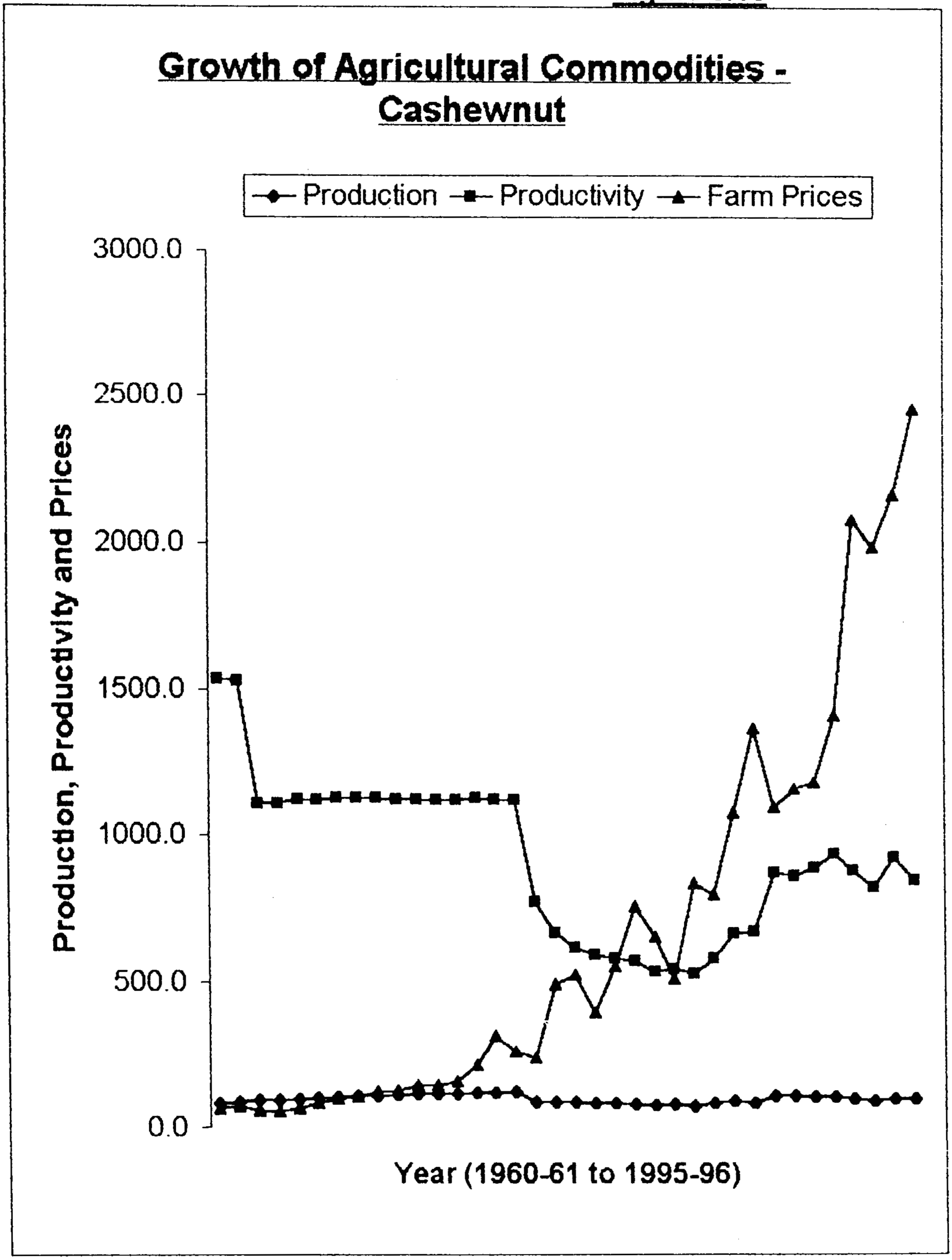
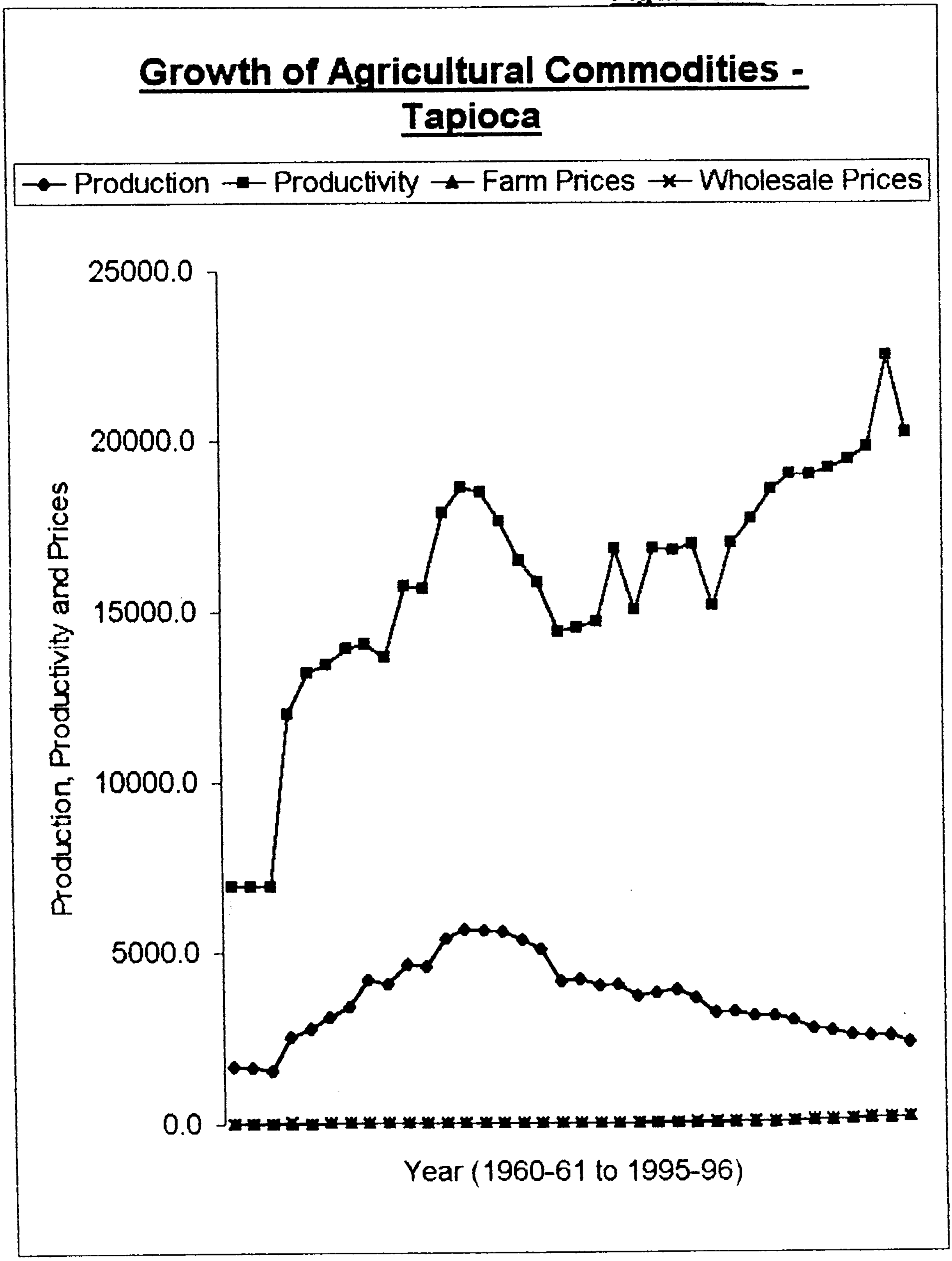

Growth of Agricultural Commodities - Cashewnut
Production
Productivity
Farm Prices
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Production, Productivity and Prices
Year (1960-61 to 1995-96)

Figure 3.11


Growth of Agricultural Commodities - Tapioca
Production
Productivity
Farm Prices
Wholesale Prices
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
Production, Productivity and Prices
Year (1960-61 to 1995-96)

3.6. Instability in Agriculture

We have seen that Kerala agriculture achieved high growth rate after 1960s but instability too has increased. In this section an attempt is made to estimate the instability of agriculture using Caddy Ville Index (CVI). A linear trend was fitted to the time series data and whenever the trend was significant, the Coefficient of Variation (CV) was calculated using the formula

$$CV = \text{Standard Deviation} / \text{average} \times 100.$$

The greater the value of CV, the lower will be its stability. Since, it is denoted in percentages, if the value of CV were greater than 100, it shows greater variability and vice versa. To quantify the instability we use the instability index, CVI. For this CV for unadjusted data was multiplied by the square root of the unexplained portion of the variation in the trend equation. The expression for instability index is :

$$CVI = CV \sqrt{(1-R^2)}$$

Where R^2 is the coefficient of determination. Greater the value of CVI, greater will be the instability.

3.6.1.Agricultural Production

The percentage changes (CV) and the instability in production and productivity of agricultural commodities are estimated separately for the time period 1960-61 to 1995-96 and presented in table 3.20.

The results showed that percentage variation (indicated by CV) of agricultural production ranged from 11.15 to 74.26%. Plantation crops had the highest and cereals had the lowest variability. Variability in spices and condiments ranged from 18.11 to 46.52% and in fruits and vegetables this range was from 14.03 to 31.24%. Percentage variation of crops production was highest in rubber (74.26), followed by ginger (46.52), turmeric (32.45), tapioca (31.24), banana (29.49), sugarcane (22.06), arecanut (20.47), coconut (19.47), pepper (18.11), tea (17.05), cashewnut (14.03) and rice (11.15). Variation was significant (more than 50%) only for rubber production. Variation in all other crops seems to be insignificant.

Magnitude of instability (indicated by CVI) of production ranged from 5.78 to 21.99. It was the highest in fruits and vegetables and lowest in cereals. Instability index ranged from 13.79 to 21.99 in fruits and vegetables, from 6.67 to 19.69 in spices and condiments and from 7.66 to 15.68 in plantation crops. Instability was highest in the production of banana (21.99), followed by sugarcane (20.96), turmeric (19.69), tapioca (16.86), rubber (15.68), cashewnut

Table 3.20

Instability in agricultural Production and Productivity

Crops	Production				Productivity			
	CV (%)	Rank	CVI	Rank	CV (%)	Rank	CVI	Rank
Rice	11.15	12	5.78	12	13.13	11	3.33	12
Coconut	19.47	8	12.49	7	11.79	12	5.42	11
Tea	17.05	10	7.66	10	21.41	7	7.72	10
Rubber	74.26	1	15.68	5	38.62	3	14.45	5
Pepper	18.11	9	6.67	11	13.62	10	10.43	7
Ginger	46.52	2	11.65	8	40.65	1	9.79	8
Turmeric	32.45	3	19.69	3	40.19	2	17.05	3
Arecanut	20.47	7	10.87	9	21.18	8	8.15	9
Banana	29.49	5	21.99	1	19.92	9	17.54	2
Cashewnut	14.03	11	13.79	6	28.97	4	16.13	4
Tapioca	31.24	4	16.86	4	22.2	6	12.18	6
Sugarcane	22.06	6	20.96	2	25.27	5	20.12	1

Source : Same as in table 3.1

(13.79), coconut (12.49), ginger (11.65), arecanut (10.87), tea (7.66), pepper (6.67) and rice (5.78).

Eventhough instability (CVI) was highest in banana production, its variation (CV) was lower than that of other crops (indicated by their ranks). Comparing ranks of variation and instability, instability was greater than variation for banana, coconut, cashewnut and sugarcane. Instability was lower than variation for rubber, pepper, ginger and arecanut. Ranks of instability and variation were same for rice, tea, turmeric and tapioca.

3.6.2. Agricultural Productivity

Analysis showed that percentage of variation in agricultural productivity ranged from 11.79 to 40.65. Cereals and oilseeds had the lowest and spices and condiments had the highest variability. In the case of plantation crops, variability ranged from 21.41 to 38.62%, while in spices and condiments this range was 13.62 to 40.65%. Fruits and vegetables had moderate variability and their range of variation was 19.92 to 28.97%. Percentage of variation was the highest for ginger (40.65%), followed by turmeric (40.19%), rubber (38.62%), cashewnut (28.97%), sugarcane (25.27%), tapioca (22.20%), tea (21.41%), arecanut (21.18%), banana (19.92%), pepper (13.62%), rice (13.13%) and coconut ((11.19%). Productivity variation of all commodities was moderate (less than 50 percentage).

Instability (CVI) of productivity ranged from 3.33 to 20.12. It was lowest in miscellaneous crops. Instability index ranged from 7.72 to 14.45 in plantation crops, from 9.79 to 17.05 in spices and condiments and from 12.18 to 17.54 in fruits and vegetables. Instability was highest in sugarcane (20.12) followed by banana, turmeric, cashewnut, rubber, tapioca, pepper, ginger, arecanut, tea, coconut and rice.

Compared to the ranks of instability and variation of productivity, instability was greater than variation for crops like coconut, pepper, banana and sugarcane and instability was lower than variation for rice, tea, rubber, ginger, turmeric and arecanut. For cashewnut and tapioca, variation and instability had the same ranks.

3.6.3. Agricultural Prices

Both wholesale and farm prices had different instability indices and therefore we can discuss them in separate sections.

Wholesale prices

Variability and instability of wholesale prices are estimated and presented in table 3.21. Table showed that percentage variation of

Table 3.21

Instability in Wholesale Prices

Crops	CV (%)	Rank	CVI	Rank
Coconut	80.48	8	58.11	1
Tea	82.15	6	14.99	8
Rubber	81.76	7	42.49	3
Pepper	96.34	3	39.28	4
Ginger	94.57	4	37.43	5
Turmeric	102.6	2	52.45	2
Arecanut	119.54	1	34.42	6
Banana	76.1	9	11.98	9
Tapioca	92.59	5	19.9	7

Source : Same as in table 3.1

Table 3.22

Instability in Farm Prices

Crops	CV (%)	Rank	CVI	Rank
Rice	70.46	9	22.04	6
Coconut	87.85	6	24.49	4
Pepper	105.39	5	45.01	2
Ginger	111.31	2	50.49	1
Arecanut	111.19	3	32.06	3
Banana	87.69	7	18.55	9
Cashewnut	111.76	1	21.25	7
Tapioca	109.46	4	22.09	5
Sugarcane	85.33	8	19.8	8

Source : Same as in table 3.1

wholesale prices of agricultural commodities varied from 76.10 to 102.6%. Variability in plantation crops was from 81.76 to 82.15% and that of fruits and vegetables was from 76.10 to 92.59%. Spices and condiments varied from 94.57 to 119.54%. Percentage of variation was the highest for arecanut followed by turmeric, pepper, ginger, tapioca, tea, rubber, coconut and banana. Variation of prices of all commodities was significant. Thus wholesale prices had less stability.

Instability of wholesale prices ranged from 11.98 to 58.11. It was lowest in fruits and vegetables and was highest in spices and condiments. Instability was highest for the prices of coconut (58.11), followed by turmeric (52.45), rubber (42.49), pepper (39.28), ginger (37.43), arecanut (34.42), tapioca (19.90), tea (14.99) and banana (11.98).

Compared to the ranks of variability and instability, instability of wholesale prices was greater than variability for the prices of coconut and rubber and variability was greater than instability for prices of tea, pepper, ginger, arecanut and tapioca. Ranks of instability and variability were same for turmeric and banana.

Farm Prices

Table 3.22 gives variability and instability of farm prices. Table revealed that variability in farm prices ranged from 70.46 to 111.76%. Variability was smaller in the case of cereals and miscellaneous crops. But it ranged from 105.39 to 111.31% in spices and condiments and from 87.69 to 111.76% in fruits and vegetables. Variability was the highest in the prices of cashewnut (111.76%), followed by ginger (111.31%), arecanut (111.19%), tapioca (109.46%), pepper (105.39%), coconut (87.85%), banana (87.69%), sugarcane (85.33%) and rice (70.46%). Variation of all farm prices was significant.

Instability of farm prices varied from 18.55 to 50.49%. Instability was greater in spices and condiments and lower in fruits and vegetables. It was the highest for ginger (50.49), followed by pepper (45.01), arecanut (32.06), coconut (24.49), tapioca (22.09), rice (22.04), cashewnut (21.25), sugarcane (19.80) and banana (18.55).

Instability was greater than variability for the prices of rice, coconut, pepper and ginger and variability was greater than instability for banana, cashewnut and tapioca. For arecanut and sugarcane, both these possess same ranks.

Comparison of variability and instability of production, productivity and prices of agricultural commodities is done by considering figures 3.13 to 3.36. Figures reveal that rank of variability and instability was same for coconut, tea, rubber, ginger, cashewnut and tapioca. In the case of tea and cashewnut, productivity had higher variation and less stability than production while in others the reverse happens. For rice, turmeric, arecanut and sugarcane, variability of productivity was greater than production whereas instability of productivity was lesser than production. Quite reverse happens in the case of pepper. One important result to be noted was the highest variability and instability of prices (excepting instability of banana and sugarcane). For banana and sugarcane instability of prices was the lowest. These figures also imply the fact that wholesale prices were more variable and unstable than farm prices.

3.6.4. Seasonal Variation in Agricultural prices

A special feature of agricultural prices was their variation according to seasons. Prices will be lowest during harvest seasons and highest greatest during non-harvest seasons. In this section we analyse this type of variation of agricultural prices of Kerala by constructing seasonal indices (Method of constructing seasonal indices is explained in appendix 11). If seasonality indices are greater than 100, it shows non-harvest seasons and if it is less than that, lean seasons.

FIGURE 3.13

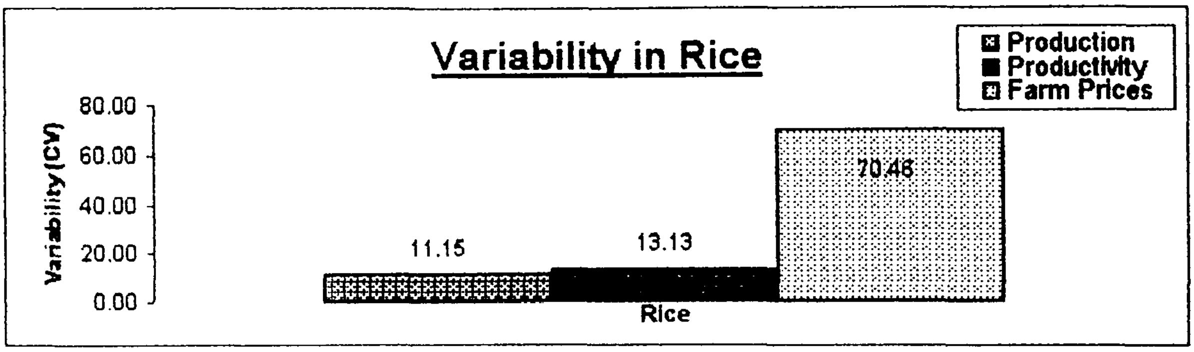


FIGURE 3.14

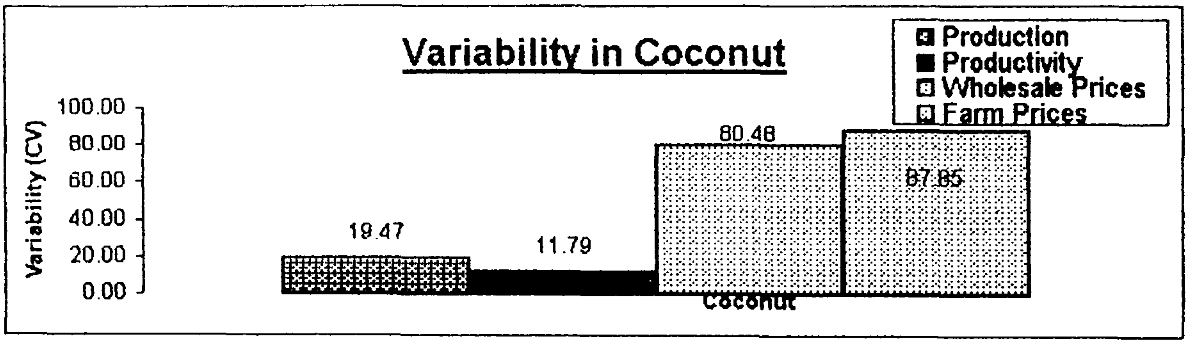


FIGURE 3.15

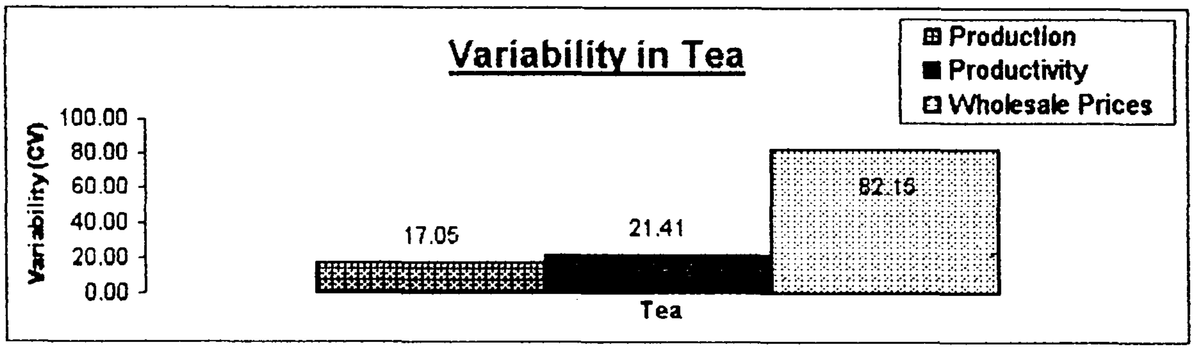


FIGURE 3.16

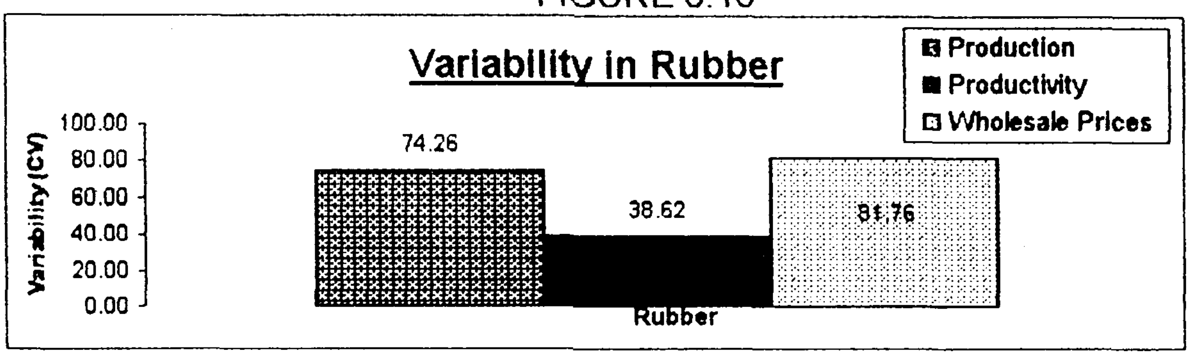


FIGURE 3.17

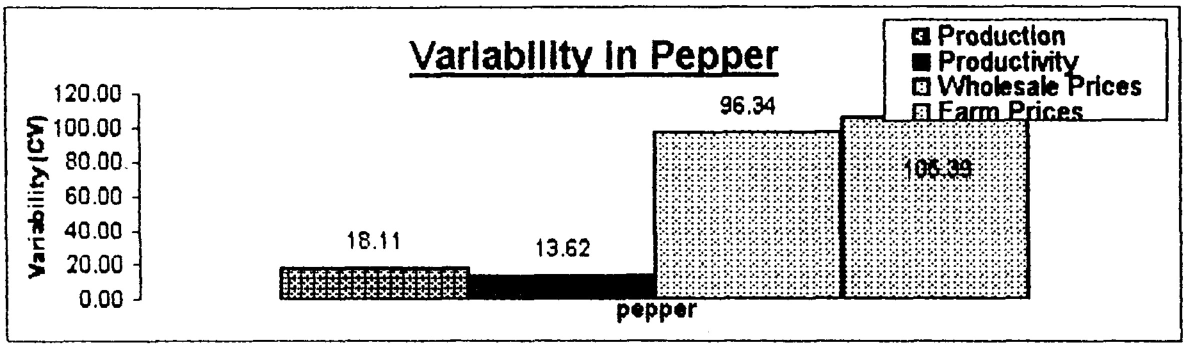


FIGURE 3.18

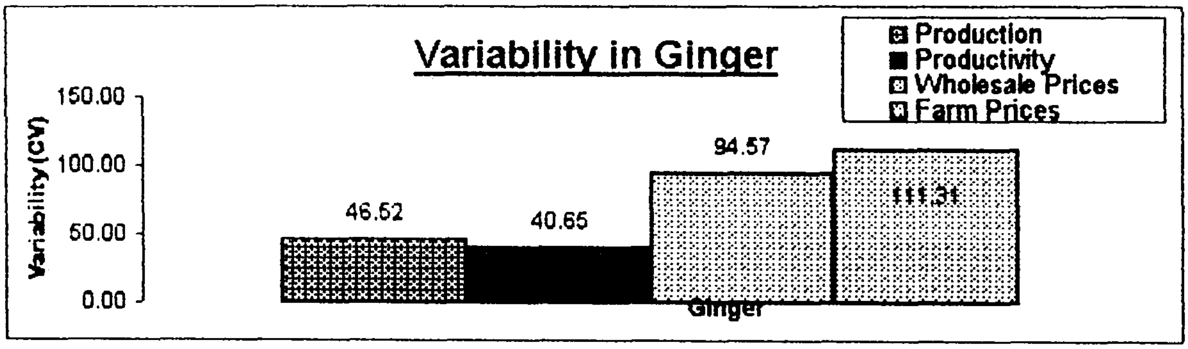


FIGURE 3.19

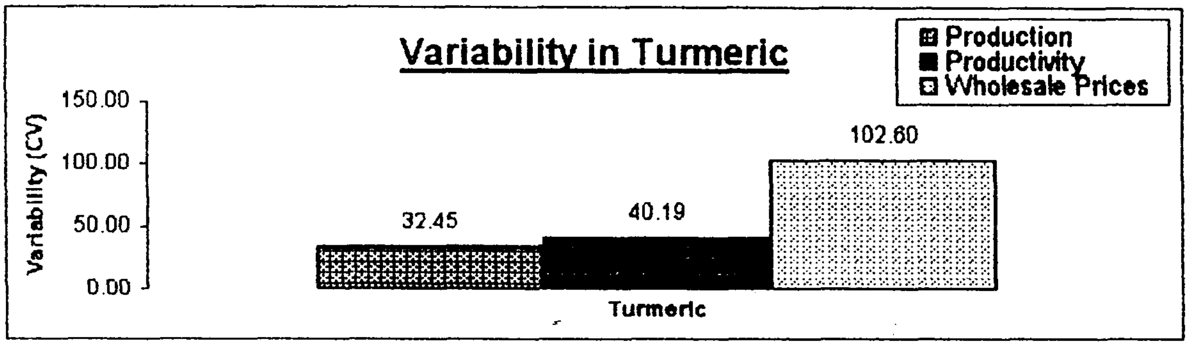


FIGURE 3.20

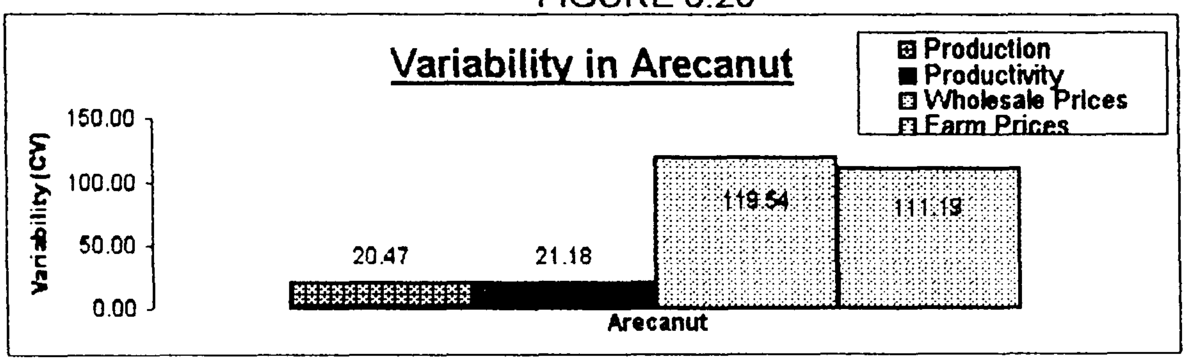


FIGURE 3.21

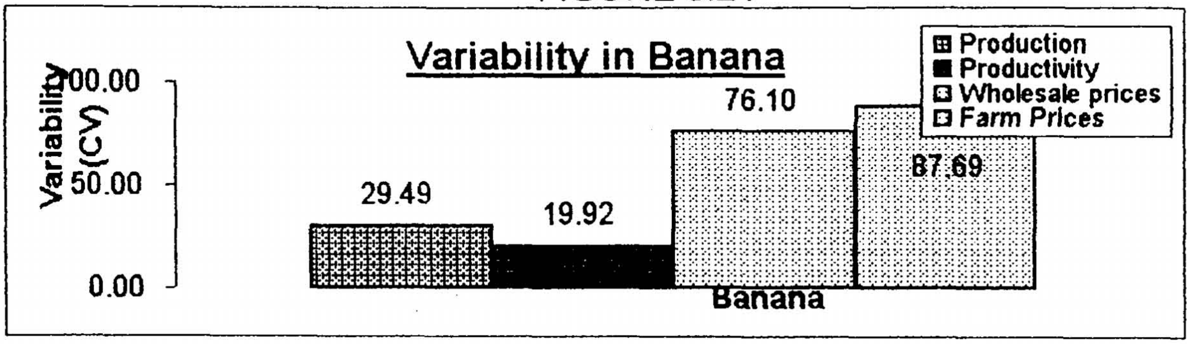


FIGURE 3.22

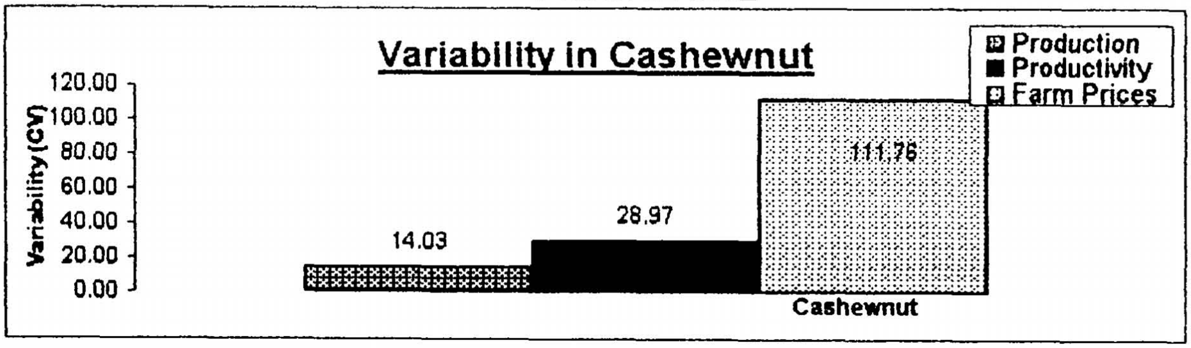


FIGURE 3.23

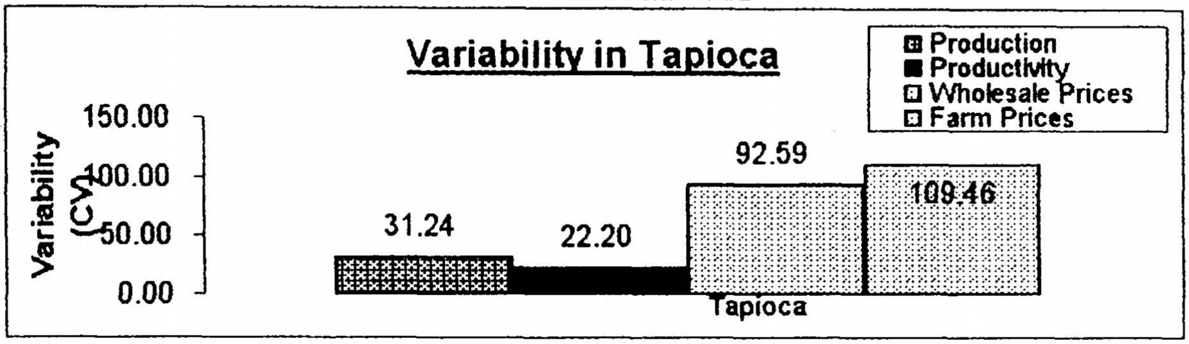


FIGURE 3.24

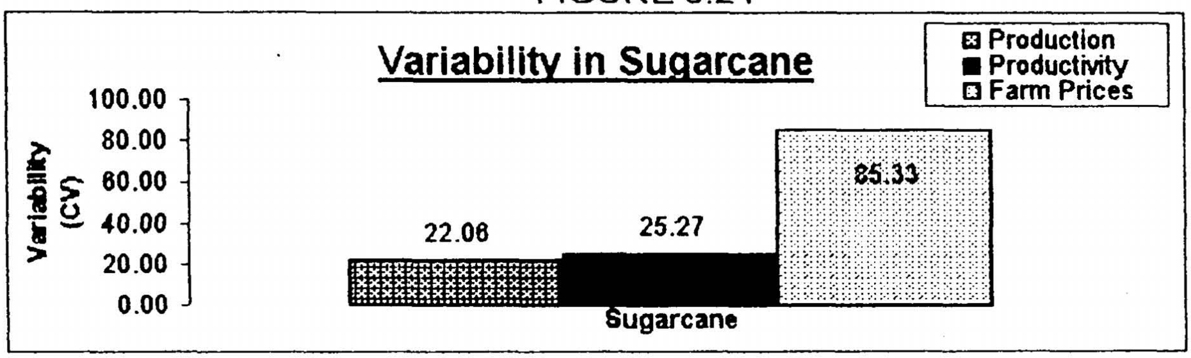


FIGURE 3.25

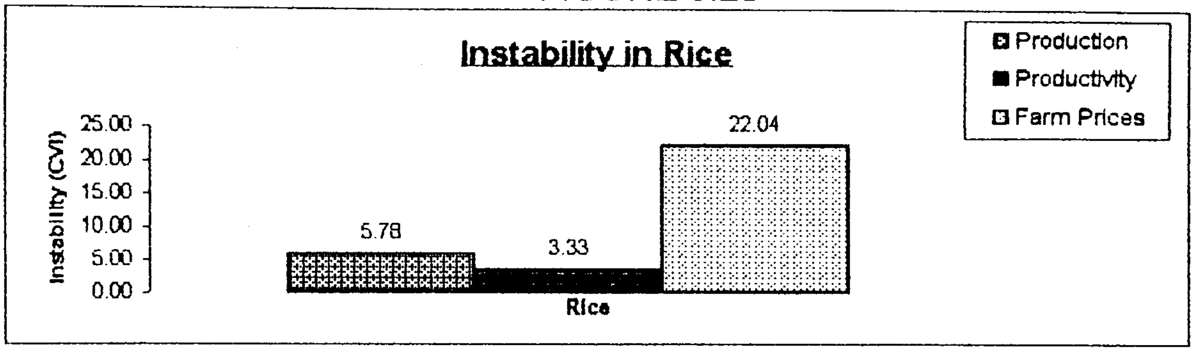


FIGURE 3.26

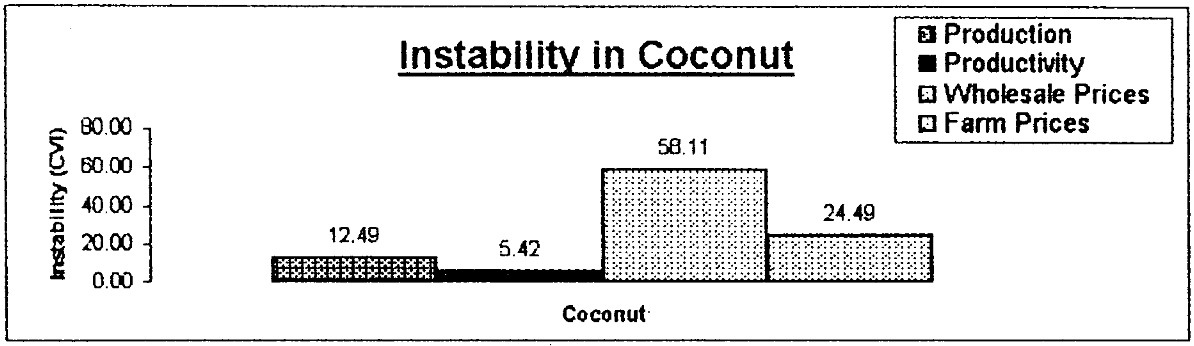


FIGURE 3.27

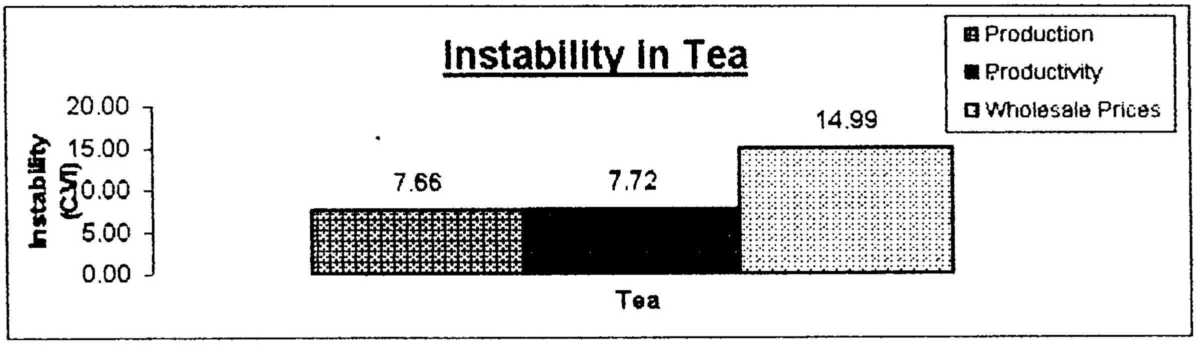


FIGURE 3.28

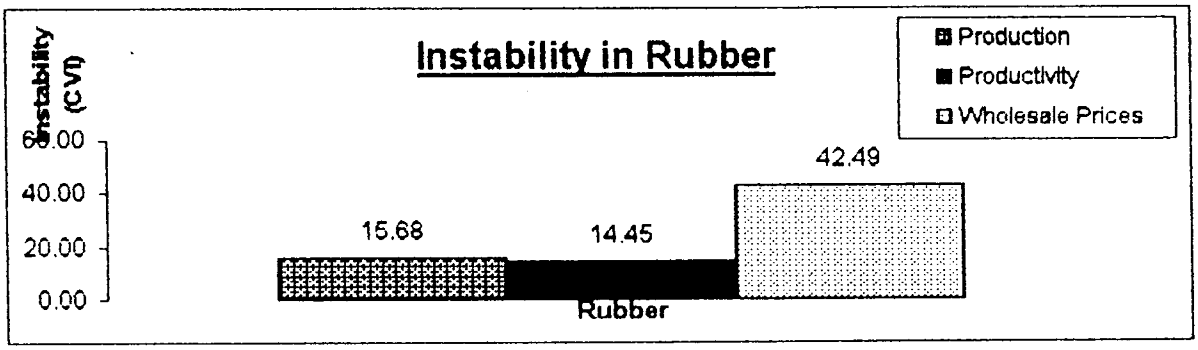


FIGURE 3.29

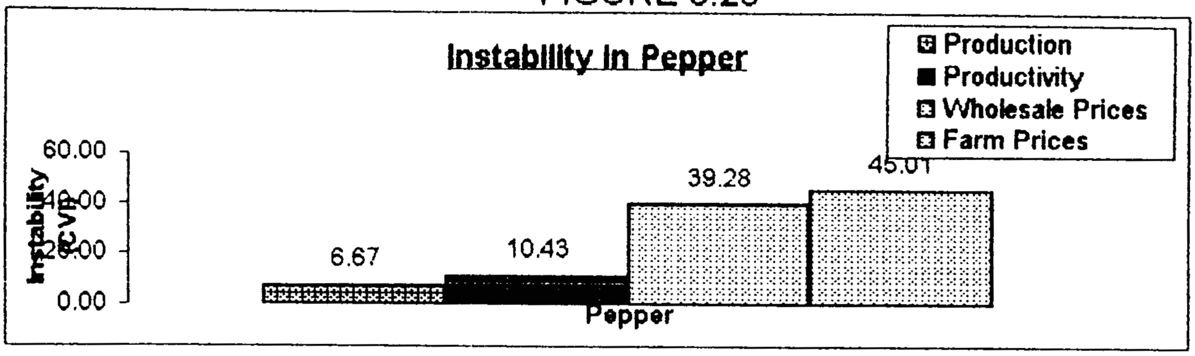


FIGURE 3.30

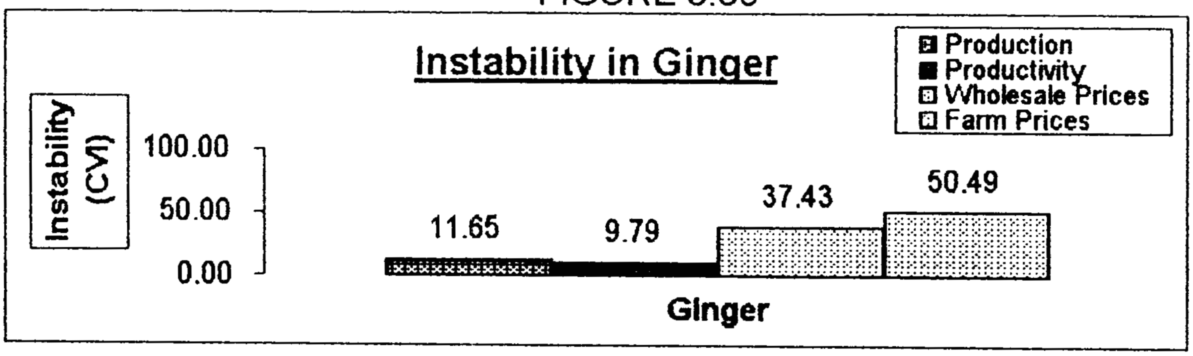


FIGURE 3.31

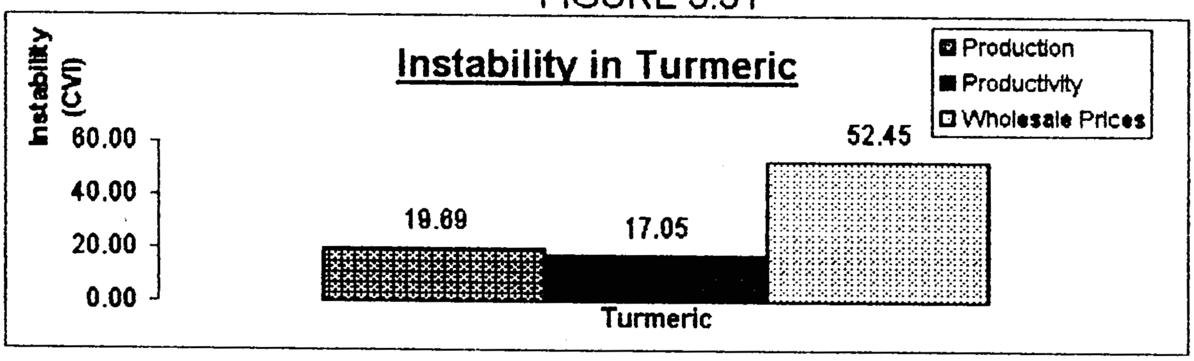


FIGURE 3.32

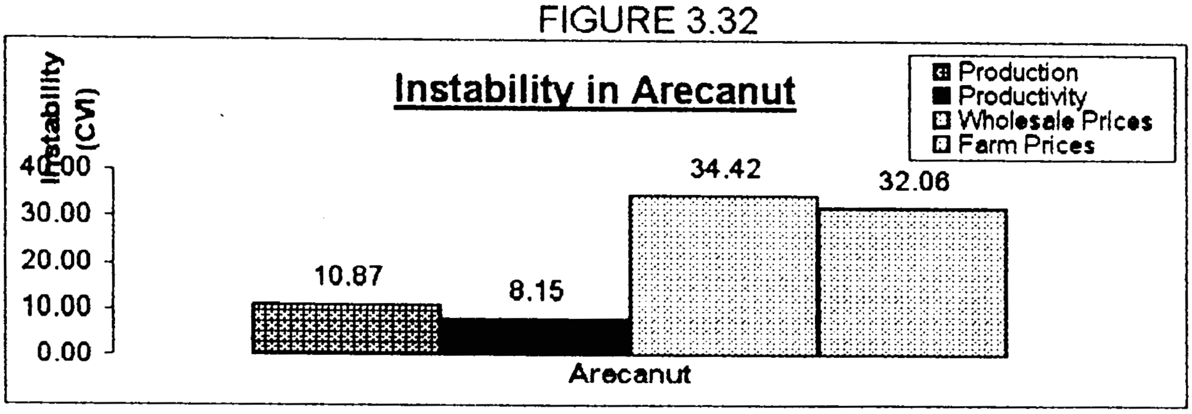


FIGURE 3.33

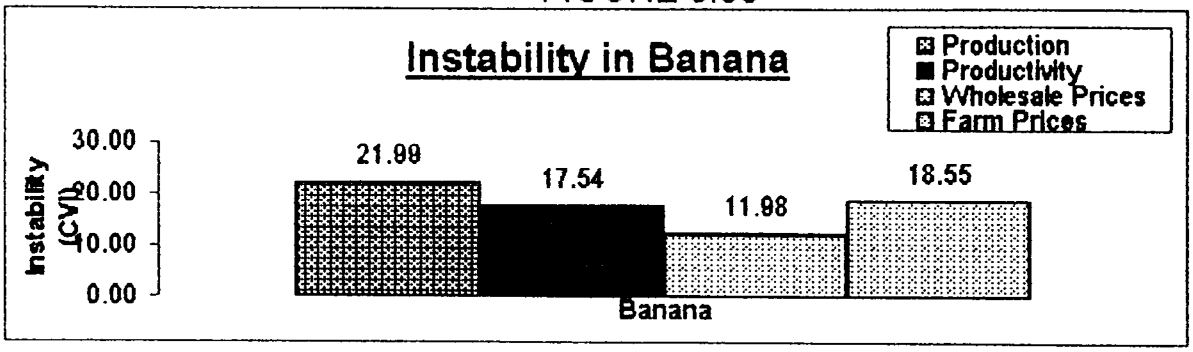


FIGURE 3.34

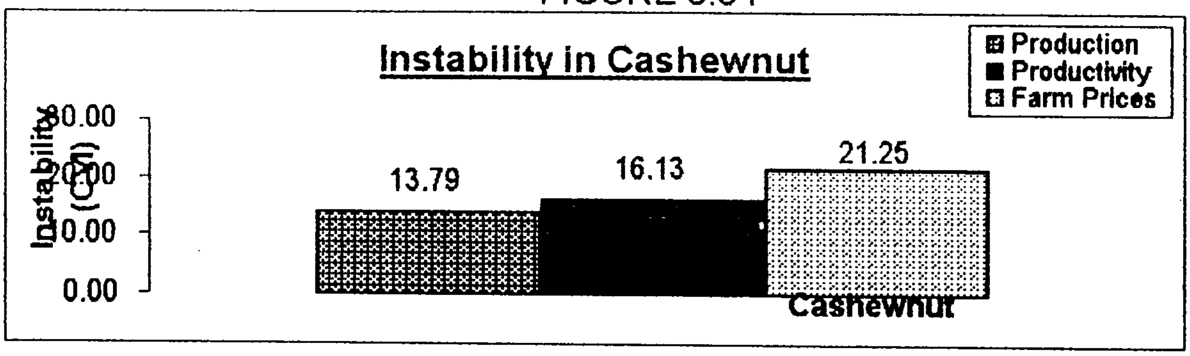


FIGURE 3.35

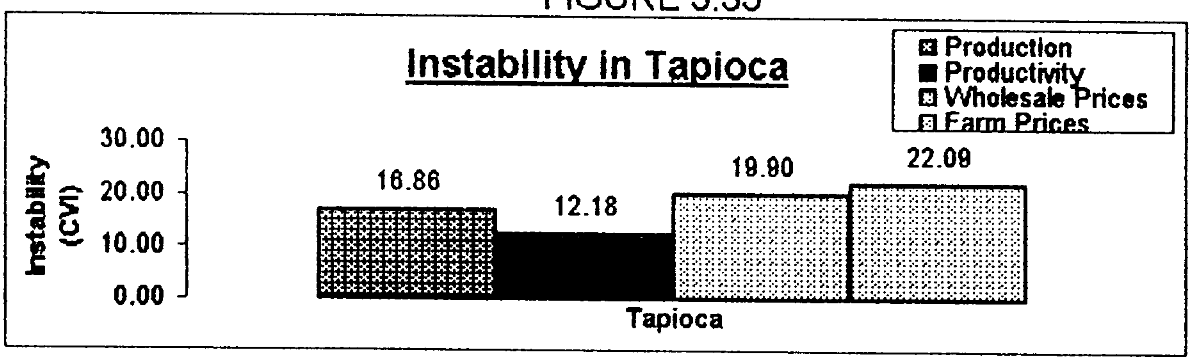


FIGURE 3.36

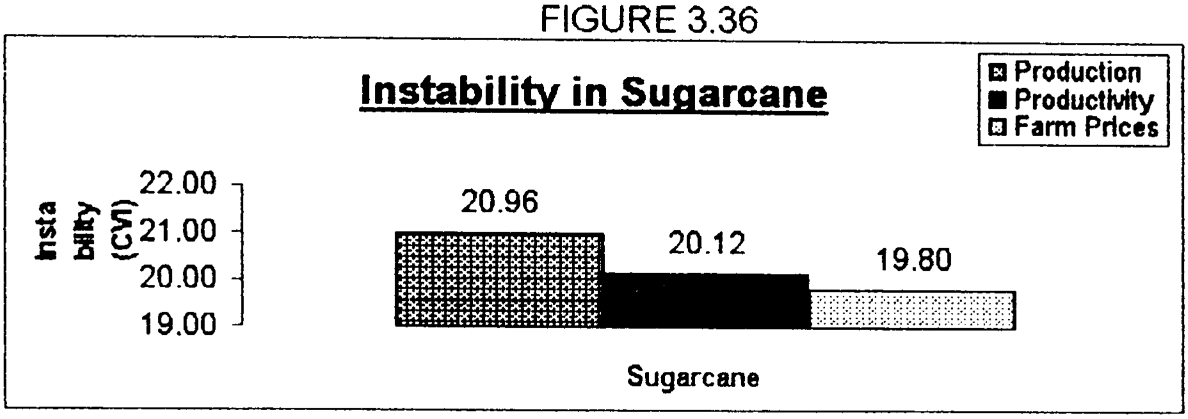


Table 3.23

Seasonal Indices of Wholesale Prices

Crops	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Rice	97	98	95	96	98	102	103	104	102	99	102	105
Coconut	100	98	94	94	94	96	96	98	104	107	112	105
Tea	101	104	102	102	99	95	95	96	101	105	100	100
Rubber	93	96	99	101	103	107	104	101	101	99	95	99
Pepper	95	96	98	98	96	96	97	99	104	109	108	102
Ginger	93	94	98	99	97	97	98	99	104	107	108	106
Turmeric	96	104	99	97	91	88	89	99	95	113	116	111
Arecanut	96	97	99	99	100	102	101	100	99	103	102	100
Banana	94	93	81	81	105	109	112	107	114	107	100	97
Tapioca	99	101	106	104	95	87	93	97	98	103	108	108
Sugarcane	96	96	96	100	103	102	102	103	102	99	99	100

Source : Same as in table 3.1

Table 3.24

Seasonal Indices of Farm Prices

Crops	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Paddy	97	97	97	97	98	101	103	104	100	99	102	105
Coconut	104	103	101	99	96	96	94	95	97	101	105	108
Pepper	91	97	97	98	96	96	98	101	107	110	108	100
Ginger	85	91	94	98	96	97	101	111	112	111	105	100
Arecanut	78	84	92	104	119	132	126	108	96	89	86	86
Banana	89	91	89	90	101	106	105	110	109	106	104	99
Cashewnut	125	165	162	159	152	146	111	67	37	21	21	33
Tapioca	96	97	99	100	101	98	97	99	101	103	104	105
Sugarcane	105	102	101	95	87	93	105	97	101	106	96	112

Source : Same as in table 3.1

Wholesale Prices

Seasonal variation of wholesale prices was presented in table 3.23. Table showed that price of rice was high during June to December and was low during January to May. Coconut prices were high in the months of September to January. In plantation crops, tea price was maximum during September to April while rubber price was high during April to September. During September to December, prices of pepper and ginger were high while October to February was good season to turmeric. Being a tree crop, arecanut had the highest prices during May to December. May to November was good for banana prices whereas October to April was better for tapioca price. Sugarcane price was high during April to December and was lean during January to march.

Farm Prices

Seasonal variations in farm prices (table 3.24) revealed that farm price of paddy was highest during June to December. Coconut farm prices started high in October to March. August to December was best time to pepper prices, July to December was good for ginger prices and April to August was non-harvesting season for arecanut prices. Prices of banana were high in May to November. Cashewnut price was high in January to July but very low in September to December. April, May and September to December were peak time to tapioca prices and July and September to March were better time for sugarcane prices. Thus, there was visible and similar seasonal variation in both farm and wholesale prices of agricultural commodities of Kerala.

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PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

By

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THESIS SUBMITTED TO THE UNIVERSITY OF CALICUT
FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
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August 1999

Chapter 4

CYCLICAL VARIATIONS IN AGRICULTURE

From the last chapter we came to know that production, productivity and prices of agricultural commodities of Kerala were not stable and there existed wide instabilities in the past. Instabilities may be annual, seasonal or cyclical. In this chapter we deal with a detailed study of cyclical fluctuations of agricultural commodities. First we separate cyclical values from the actual values and then try to answer the following questions.

(a) What type of cyclical series exists for the agricultural commodities?

(b) Whether the hypothesized length of cycle is significant or not?

In the present study a 6-year cycle model for agricultural production, productivity, farm and wholesale prices were hypothesized. Fourier coefficients were computed to test the hypothesized length of cycle. A brief description about the Fourier analysis is given below.

Given a time series x_1, x_2, ...x_N, then it will be convenient to group the data as shown in the box for investigating a given period P, where mP is equal to N or the nearest integer below N.

The periodic effects will be indicated by the column totals (Uj's), if a term of period P is present in the series. But if the remaining element is random, the effect of summing m rows will be to reduce the relative contribution of that, if there exist other elements with different periods they will be out of phase in successive rows and tend to cancel out in the totals. Then if there are

Box Indicating grouping of data

x_1	x_2	x_P
x_{P+1}	x_{P+2}....................	x_{2P}
....		
....		
$x_{(m-1)P+1}$	$x_{(m-2)P+2}$	x_{mP}
U_1	U_2	U_P

enough rows, the total (Uj) will reveal the periodic effect resulting from oscillatory components of different periods, which would have prevented discernment of the periodic effect in the primary series. The Fourier coefficients A_P and B_P are obtained following **Chatfield** (1975)[103] and given by

$$A_P = \frac{2\,[\Sigma\, U_j \, \mathrm{Cos}\,(360j/P)]}{MP}$$

$$B_P = \frac{2\,[\Sigma\, U_j \, \mathrm{Sin}\,(360j/P)]}{mP} \qquad \text{where } j=1,2,\ldots\ldots\ldots P$$

[103] Chatfield (1975), The analysis of time series : theory and practices, PP 133, London, Chapman and Hall.

To obtain the square of amplitude Rp^2 the Fourier coefficients Ap^2 and Bp^2 are added. The Fourier analysis was used to compute the square of amplitude for each specified period by assuming several periods. The significance of the amplitudes is tested by periodogram. The procedure of testing involves, first, to compute the square of amplitude (Rp^2). If no periodic fluctuations are observed, the mean square amplitude for a random series without periodic fluctuation is given by $Rm^2 = \sigma^2/N$ where σ^2 is the variance of the series Xi. Then K is calculated as follows :

$$K = Rp^2 / Rm^2$$

The statistical significance of K is determined by applying F test.

We use the method given by **Soliman** (1972)[104] to distinguish three types of oscillatory series namely moving averages, auto-regressive schemes and harmonic terms. This analysis is sometimes known as correlogram analysis. Here we apply the sample correlogram analysis. To compute this, we must first compute the sample covariance at lag k, $\hat{r}_k$ and the sample variance, $\hat{r}_0$, which are defined as

$$\hat{r}_k = \Sigma[(X_t - \overline{X})(X_{t+k} - \overline{X})] / n$$

[104] Soliman M A (1972), Statistical analysis of cyclical variations in the National Turkey market, Technical Bulletin, 276, Department of agricultural and applied economics, University of Minnesota.

$\hat{r}_0 = \Sigma(X_t - \overline{X})^2 / n$ where n is the sample size and $\overline{X}$ is the sample mean. Then, the sample autocorrelation function at lag k is

$$\hat{\rho}_k = \hat{r}_k / \hat{r}_0$$

which is simply the ratio of the sample covariance to sample variance. Since both covariance and variance are measured in the same units of measurement, ρ_k is a unitless or pure number. It lies between −1 and +1, as any correlation coefficient does. A plot of $\hat{\rho}_k$ against k is known as the sample correlogram. In this study we have assumed 36 years lag or we have taken k = 0,1,2,3,..........35.

The statistical significance of any $\hat{\rho}_k$ can be judged by its standard error (SE). This test is known as Barlett test. He has shown that if a time series is purely random, i.e., it exhibits white noise, the sample autocorrelation coefficients are approximately normally distributed with zero mean and variance 1/n where n is the sample size. For example, for a data with n = 88, implying a variance of 1/88, where SE of $1/\sqrt{88}$ = 0.1066. Then following the properties of the standard normal distribution, the 95% confidence interval for any ρ_k will be + or − 1.96(0.1066) = 0.2089, on either side of zero. Thus, if an estimated ρ_k falls inside the interval (+ or − 0.2089), we do not reject the hypothesis that the true ρ_k is zero. But if it lies outside this confidence interval then we can reject the hypothesis that the true ρ_k is zero.

To test the joint hypothesis that all the ρ_k (autocorrelation coefficients) are simultaneously equal to zero, we are using the Ljung-Box (LB) statistic, which is defined as

$$LB = n(n+2) \sum_{k=1}^{m} (\rho_k^2/n-k) \sim \chi^2 m$$

Where n is the sample size and m is the lag length. The LB statistic is approximately distributed as the chi-square distribution with m degrees of freedom. If the computed LB exceeds the critical LB value from the chi-square table at the chosen level of significance, one can reject the null hypothesis that all ρ_k are zero; at least some of them must be non-zero.

For a series generated by the moving average method, the correlogram will vanish after a certain order. In the case of series generated by auto-regressive method, the correlogram will oscillate and will not vanish, although its oscillation will dampen. For infinite cyclical series of harmonic terms, the correlogram is a harmonic with the period equal to that of original harmonic component; it will not vanish or be dampened.

To calculate the cyclical values first we calculated trend values using second degree polynomial function. Then the deviation of actual series from the computed trend values as percentage of the corresponding trend values were considered as cycle measures. These cyclical values show the deviation of actual values from trend values due to cyclical and irregular variations.

The empirical results using annual data for the selected 36 years are given below.

4.1. Cyclical fluctuations in Agriculture

4.1.1. Fluctuations in Agricultural Production

In this section cyclical analysis of agricultural production for the selected 12 commodities is done by the above method. Each of these crops shows cyclical fluctuations but the cyclical patterns are different for different crops. Cyclical values of these crops are compared in table 4.1 (Trend values are shown in appendix 6).

4.1.1. 1. Cereal Production

It was observed that actual production of rice in 1960-61 was 1068 whereas the computed value was 1009.83 thousand tones. Trend values in percentages worked out as 105.8 in 1960-61. The cyclical relative was +5.8% indicating that the actual production was 5.8% higher than the trend value because of cyclical and irregular variations. Actual production was highest in 1968-69 but its trend value was highest in 1976-77. During 1977-78 the difference between actual and trend values was the least (only –0.66). In 1995-96 actual production was 106.02% higher than trend value. Cyclical variations in rice production (table 4.1 column 2) ranged from 85.0(in 1965-66) to 114.4 (in 1968-69). It was observed that maximum length of cycle was 8 years (from 1985-86 to 1992-93) for rice production.

4.1.1. 2. Oilseeds Production

Actual production of coconut was 3220 during 1960-61 while its trend value was 3822.87 million nuts which indicated that actual production was 15.77% lesser than trend value. But in the later years difference became negligible and in 1995-96 production was 13.67% higher than its corresponding trend value. Difference between these actual and trend values was greater during 1971-72 (+26.08%). Cyclical variations in coconut production (table 4.1 column 3) ranged from 71.50 (in 1983-84) to 126.1 (in 1971-72). Maximum length of cycle was 18 years (from 1960-61 to 1977-78) neglecting slight difference during 1974-75.

4.1.1. 3. Production of plantation crops

Tea

Production of tea was 38 thousand tones in 1960-61, which was 5.42% less than its trend value. Actual production of tea was highest during 1991-92 but trend value was highest during 1995-96. The minimum difference between trend and actual value was seen in the year 1987-88 and maximum difference in 1979-80. Cyclical variations ranged from 85.3 (in 1983-84) to 117.3 (in 1979-80) (table 4.1, column 4). Maximum cycle length of tea production was 8 years (from 1969-70 to 1976-77).

Rubber

Rubber production in Kerala was 23 thousand tones in 1960-61 while trend value was 55% greater than its actual production. Both actual and trend value increased year after year and actual value reached 474.56 thousand tones in 1995-96 which was 10.96% greater than its trend value. Difference between actual and trend value was lowest during 1979-80(-0.32%) and greatest during 1960-61(-55.06%). Cyclical variations ranged from 44.9 (in 1960-61) to 147.70(in 1973-74) (table 4.1, column 5). Maximum length of cycle of rubber production was 23 years (from 1973-74 to 1995-96), neglecting a slight change during 1979-80.

4.1.1. 4. Production of spices and condiments

Pepper

Actual production was less than trend value of pepper during 1960-61 to 1965-66. But after that it became greater than trend value for 11 years (1966-67 to 1976-77). These difference became maximum during 1984-85 (about –46.29%). Cyclical fluctuations in pepper production ranged from 53.70 (in

1984-85) to 129.3(in 1987-88). Analyses reveal a maximum length of 8-year cycle (from 1963-64 to 1970-71) in pepper production (table 4.1, column 6).

Ginger

Production of ginger was stagnant during 1960-61 to 1968-69 while its trend value was increasing for the whole reference period. Actual production was less than the trend value upto the year 1970-71. Difference between actual and trend values were greater in 1960-61 (about +107%). Cyclical variations in the production of ginger ranged from 63.0 (in 1968-69) to 207.1 (in 1960-61). Maximum length of cycle was 12 years (from 1960-61 to 1971-72) (table 4.1, column 7).

Arecanut

Arecanut production was 12.29% lower than its trend value in 1960-61. This situation continued upto 1966-67 and then onwards production increased greater than its trend value for 8 years (from 1967-68 to 1974-75). In 1995-96 an increment of 4.71% in production was visible compared to its trend value. Difference between actual and trend value was greater during 1983-84 (about –25.21%). Cyclical variations in arecanut production ranged from 74.8 (in 1983-84) to 118. 9 (in 1974-75) and it's maximum cyclical length was 9 years (from 1983-84 to 1991-92).

Turmeric

Production of turmeric was 20 thousand tones in 1960-61 and it increased to 61 thousand tones in 1995-96. This was less than its trend value for the first 4 years and then it became greater for the following 7 years. Difference between them was minimum (-0.11%) during 1989-90 and maximum during 1976-77(-59.05%). Cyclical variations ranged from 41.0(in 1976-77) to 150.20(in 1980-81). Maximum length of 7-year cycles (from 1985-86 to 1990-91) existed in turmeric production (table 4.1, column 9).

4.1.1. 5. Production of fruits and vegetables

Banana

Production of banana was greater than its trend value during the years 1965-66 to 1974-75, 1980-81 to 1981-82, 1985-86 to 1986-87 and 1988-89 to 1994-95. Maximum difference between actual and trend value was –52.36(in 1976-77). Cyclical variations ranged from 47.60 (in 1976-77) to 136.6 (in 1969-70). Maximum length of 7-year cycles existed between 1960-61 and 1966-67 (table 4.1, column 10).

Tapioca

In the case of tapioca, actual production was 1683 thousand tones in 1960-61 while the corresponding trend value was 1877.89 thousand tones which indicates that actual was 10.38% lesser than trend value because of cyclical and irregular variations. Actual production was highest during 1972-73 whereas the trend value was highest during 1977-78. Difference between them was greater (+62.2) during 1995-96. Cyclical variations in tapioca production ranged from 61.50%(in 1962-63) to 162.2% (in 1995-96). Maximum length of cycle was 8 years (from 1960-61 to 1967-68 and from 1970-71 to 1977-78) for tapioca production (table 4.1, column 12).

Cashewnut

Cashewnut production was less than its trend value for the years 1960-61 to 1965-66, 1976-77 to 1987-88 and 1993-94. Maximum difference between actual and trend value was +25.92% in the year 1975-76. Cyclical fluctuations in cashewnut production ranged from 76.5 (in 1984-85) to 125.90 (in 1975-76). Maximum length of 12-year cycles existed (from 1960-61 to 1971-72 and from 1971-72 to 1982-83) in cashewnut production (table 4.1, column 11).

4.1.1. 6. Sugarcane Production

Sugarcane production was 381 thousand tones in 1960-61 while its trend value was 390.39 thousand tones. It means that actual production was 2.41% lower than its trend production. The difference between actual and trend value was greatest during 1983-84 (+71.64%). Cyclical variations in

Table 4.1

Cyclical Variations of Agricultural Production in Kerala -
Percent of trend (1960-61 to 1995-96)

Year col. 1	Rice col.2	Coconu col. 3	Tea col. 4	Rubbe col. 5	Peppe col. 6	Ginger col. 7	Arecan col. 8	Turmer col. 9	Banan col. 10	Cashe col. 11	Tapioc col. 12	Sugarc col. 13
1960-61	105.8	84.2	94.6	44.9	94.3	207.1	87.7	99.9	81.9	84.2	89.6	97.6
1961-62	96.1	87.1	99.0	51.3	98.9	159.5	91.9	89.5	86.4	85.3	74.7	94.1
1962-63	101.5	90.8	100.8	61.6	91.9	130.0	94.5	81.3	88.6	92.4	61.5	101.7
1963-64	101.9	91.6	102.6	73.7	87.8	109.9	96.8	74.7	92.1	92.5	90.6	105.2
1964-65	98.8	93.9	94.5	87.1	91.3	95.3	83.9	103.8	99.6	98.1	90.6	102.8
1965-66	86.0	96.0	105.7	100.7	94.5	84.3	90.4	129.2	109.1	99.7	94.0	94.0
1966-67	91.6	101.5	107.2	103.9	110.6	75.6	99.1	121.5	107.6	103.9	96.9	123.6
1967-68	93.3	108.0	101.5	119.2	113.5	68.7	105.2	114.8	120.1	109.1	112.7	110.7
1968-69	114.4	116.7	105.1	123.8	115.8	63.0	113.4	109.1	128.6	110.2	104.4	109.7
1969-70	97.9	121.5	92.9	134.7	112.8	63.5	114.7	104.1	136.6	113.4	114.5	107.8
1970-71	103.4	123.2	94.7	127.8	104.3	98.4	115.9	124.6	126.9	117.9	109.4	79.8
1971-72	106.6	126.1	97.1	133.0	104.6	105.9	114.7	95.8	126.5	115.8	124.9	82.1
1972-73	107.7	122.2	98.2	126.0	104.3	103.9	117.7	92.3	126.6	117.0	127.8	83.1
1973-74	97.7	115.5	105.7	147.7	117.5	110.3	118.4	111.6	126.1	119.3	124.7	105.7
1974-75	103.3	115.7	106.5	139.4	111.2	100.7	118.9	86.5	127.6	121.5	122.1	109.9
1975-76	105.4	106.5	92.2	134.4	113.5	103.2	98.7	63.1	60.7	125.9	115.8	102.4
1976-77	96.7	102.9	88.0	132.5	106.2	91.4	97.2	41.0	47.6	90.3	109.5	81.4
1977-78	100.0	92.9	108.4	118.1	85.9	107.6	101.6	79.9	49.7	87.8	89.3	75.6
1978-79	97.9	97.4	104.7	98.5	83.0	106.4	101.9	78.2	52.5	87.5	90.3	74.8
1979-80	100.5	89.9	117.3	99.7	107.8	99.2	102.0	134.0	49.6	86.5	86.9	96.7
1980-81	99.4	88.6	107.5	93.5	111.0	95.5	100.2	150.2	106.2	85.6	89.1	91.3
1981-82	105.5	86.1	94.1	86.0	102.5	92.2	96.4	110.8	107.3	83.7	82.7	94.7
1982-83	103.9	89.4	94.5	86.6	90.8	91.9	96.3	90.9	92.0	79.4	86.7	161.8
1983-84	97.2	71.5	85.3	84.7	73.1	99.8	74.8	107.5	97.9	81.6	90.6	171.7
1984-85	102.4	92.7	108.2	83.2	53.7	107.2	80.2	88.4	98.9	76.5	87.9	84.4
1985-86	97.1	88.4	95.3	83.0	98.9	114.2	85.3	104.9	104.2	85.1	80.9	84.2
1986-87	95.5	80.9	88.3	84.2	88.1	108.6	88.5	103.9	100.7	94.5	84.8	81.6
1987-88	89.3	91.0	99.5	84.2	129.3	103.3	89.8	103.0	96.8	87.1	86.1	83.9
1988-89	88.4	101.5	111.3	86.3	107.1	105.4	94.2	100.5	112.5	116.2	90.8	107.4
1989-90	96.6	101.9	92.1	93.2	91.8	102.8	102.9	99.9	110.8	114.5	93.7	107.0
1990-91	100.5	102.7	101.9	97.4	107.0	104.4	101.3	97.7	116.0	111.2	92.9	109.7
1991-92	101.1	92.4	110.1	102.0	109.6	106.0	96.8	99.0	113.3	113.7	99.7	111.3
1992-93	106.9	109.0	89.2	102.9	101.9	107.6	102.7	88.7	107.4	104.4	106.9	87.9
1993-94	102.6	107.0	106.0	107.3	97.0	94.9	112.7	96.9	107.9	96.0	120.8	92.7
1994-95	102.4	105.6	101.5	109.7	95.8	97.7	111.9	93.6	113.0	105.3	141.0	93.9
1995-96	106.0	113.7	99.2	111.0	104.7	80.0	104.7	102.0	66.2	107.2	162.2	98.2

Source : Estimated by the researcher.

sugarcane production ranged from 74.80(in 1978-79) to 171.70 (in 1983-84). Maximum length of 9-year cycle existed between 1966-67 and 1974-75(table 4.1, column 13).

4.1. 2. Fluctuations in Agricultural Productivity

Cyclical fluctuations in agricultural productivity are discussed by the same manner as we have done in the case of production because then it will be easy to compare between the cyclical fluctuations of production and productivity of different commodities. Cyclical values of the selected commodities are compared in table 4.2 (Trend values are presented in appendix 7).

4.1.2.1. Cereal Productivity

Productivity of rice was 1370.99 tones per hectare in 1960-61 and it increased to 2021.26 in 1995-96. Actual was 1.65% greater than its trend value due to cyclical and irregular variations in 1960-61 and this difference increased to –10.30% in 1965-66. Cyclical variations in rice productivity ranged from 89.70%(in 1965-66) to 106.9%(in 1972-73). Maximum length of cycle existed was 7 years (from 1984-85 to 1990-91).

4.1.2.2. Productivity of Oilseeds

Productivity of coconut was 6440 nuts per hectare in 1960-61 and it decreased tremendously to 3815 in 1983-84. Actual productivity was less than it during the first 7 years and was greater than trend productivity for the next 10 years due to cyclical and irregular variations. Cyclical variations ranged from 80.7(in 1983-84) to 109.4(in 1971-72). Maximum of 9-year cycles (from 1965-66 to 1973-74) existed in coconut productivity.

4.1.2.3. Productivity of Plantation crops

Tea

Tea productivity was 1009.8 tones per hectare in 1960-61 while its trend value was 986.74 tones per hectare; thus actual productivity was 2.34% greater than its trend productivity due to cyclical and irregular variations. These differences between actual and trend value was the lowest during 1961-62 (+0.0059%) and was the highest during 1979-80 (+17.9%). Absolute range of cyclical variations of tea productivity was 86.8(in 1983-84) to 117.9 (in 1979-80). Maximum length of 7-year cycles (from 1965-66 to 1971-72) existed in tea productivity.

Rubber

Rubber productivity was growing tremendously from 186.9 tones per hectare in 1960-61 to 1056 tones in 1995-96. Actual was lower than its trend value for the years 1960-61 to 1966-67, 1978-79 and 1980-81 to 1990-91. Difference between them was minimum during 1991-92 (+0.4413%) and maximum during 1976-77 (+28.48%). Absolute range of cyclical variations existed was 75.4 (in 1961-62) to 128.5 (in 1976-77). Maximum of 12-year cycles (from 1984-85 to 1995-96) existed in rubber productivity.

4.1.2.4. Productivity of Spices and condiments

Pepper

Productivity of pepper was 10.88% greater than its trend value during 1960-61 and it increased to 12.49% in the next year. Cyclical and irregular variations was greatest during 1987-88 (+22.70%) and lowest during 1984-85 (-33.40%). Thus, cyclical variations ranged from 66.60 (in 1984-85) to 122.70 (in 1987-88). Maximum of 6-year cycles existed from 1969-70 to 1974-75 and from 1980-81 to 1985-86 in pepper productivity.

Ginger

Ginger Productivity was almost stagnant for the first 8 years (from 1960-61 to 1967-68). But it increased from 916.66 (in 1960-61) to

3554.39 tones per hectare (in 1995-96). Trend value increased from 563.34 to 3491.20 during the same period. This caused wide cyclical variations in ginger productivity. Here its absolute range was 65.0 (in 1969-70) to 162.7 (in 1960-61). Maximum length of cycle was 12 years (from 1960-61 to 1971-72) ignoring a slight variation in 1969-70.

Turmeric

Turmeric productivity was only 400 tones per hectare in 1960-61 but it increased fivefold after twenty years. The influence of cyclical and irregular variations was greatest in 1965-66 (+38.22%) and was lowest in 1978-79 (-34.78%). Absolute range of cyclical variations was 65.2 (in 1978-79) to 138.2 (in 1965-66). Maximum length of cycle was 7 years (from 1985-86 to 1991-92) for turmeric productivity.

Arecanut

Actual productivity of arecanut was 4.94% greater than its trend value and this tendency continued for the next three years. But since 1964-65, the actual value was lower than its trend value (upto 1976-77). Difference between these was minimum in 1987-88 (-0.52%) and maximum in 1983-84 (-15.47%). Cyclical variations ranged from 84.5 (in 1983-84) to 115.1 (in 1979-82). Maximum cycle of 8 years (from 1972-73 to 1979-80) exists for arecanut productivity.

4.1.2.5. Productivity of Fruits and vegetables

Banana

We can see a declining trend in the productivity of banana during the middle years, i.e., for the period 1975-76 to 1987-88. It again declined in 1995-96. Trend productivity also showed the same pattern. Difference between actual and trend was minimum during 1963-64 (-0.46%) and maximum during 1976-77 (-44.99%). Range of cyclical variations in banana productivity was 55.0 (in 1976-77) to 122.7 (in 1974-75). Maximum length of 13-year cycle was visible during 1964-65 to 1976-77.

Tapioca

There was tremendous progress in the productivity of tapioca after 1963-64. Actual productivity was lower than its trend value during the first three years (from 1960-61 to 1962-63) but it was greater for the period 1963-64 to 1975-76. Then again it showed a down (from 1976-77 to 1988-89) and an up (from 1989-90 to 1995-96) in value compared to its trend value. These differences were minimum in 1990-91 (+0.25%) and maximum in 1962-63 (-34.85%). Absolute range of cyclical variations was 65.2 (in 1962-63) to 124.7 (in 1972-73). Maximum length of 10-year cycle was visible during 1970-71 to 1979-80.

Table 4.2

Cyclical Variations of Agricultural Productivity in Kerala - Percent of trend (1960-61 to 1995-96)

Year col. 1	Rice col.2	Coconu col. 3	Tea col. 4	Rubbe col. 5	Peppe col. 6	Ginger col. 7	Arecan col. 8	Turmer col. 9	Banan col. 10	Cashe col. 11	Taploc col. 12	Sugarc col. 13
1960-61	101.7	96.3	102.3	80.4	110.9	162.7	104.9	136.8	89.8	103.3	72.4	94.1
1961-62	98.4	99.1	100.0	75.4	112.5	135.0	105.1	104.2	95.7	107.2	68.4	91.4
1962-63	100.0	97.3	101.1	78.9	102.4	115.6	113.0	84.6	96.9	81.3	65.2	99.2
1963-64	102.3	97.7	102.1	83.9	95.0	101.3	112.6	71.6	99.5	84.9	107.8	92.8
1964-65	101.6	98.4	93.4	90.8	95.1	90.3	93.4	93.4	95.4	89.7	113.7	90.9
1965-66	89.7	96.9	105.1	98.6	96.1	81.6	95.0	138.2	103.5	93.4	111.3	92.5
1966-67	97.1	99.3	104.4	97.5	92.6	74.5	94.4	124.7	105.7	97.0	110.9	121.7
1967-68	98.6	101.9	100.0	104.3	92.5	68.7	94.2	114.0	110.0	102.2	108.4	122.6
1968-69	106.6	103.6	98.2	105.4	93.9	69.6	95.7	105.2	110.4	106.3	102.1	121.2
1969-70	97.2	105.9	92.7	113.0	91.3	65.0	93.8	98.0	112.6	110.4	114.0	118.7
1970-71	102.7	107.0	95.7	108.1	94.5	101.9	92.8	114.9	115.1	114.8	110.4	87.7
1971-72	106.0	109.4	99.0	110.9	95.6	110.6	91.1	86.7	117.2	118.8	122.7	89.7
1972-73	106.9	105.4	96.9	106.0	95.7	109.4	91.5	82.3	120.1	123.1	124.7	90.3
1973-74	96.5	101.1	103.8	127.9	107.7	117.1	90.1	98.0	120.3	128.3	120.8	91.4
1974-75	100.7	102.5	104.0	125.9	102.3	107.7	88.6	75.1	122.7	132.3	113.0	94.4
1975-76	101.4	103.4	89.5	125.0	104.3	111.0	88.8	108.2	67.6	135.8	103.2	97.0
1976-77	95.4	101.3	89.4	128.5	98.8	118.8	99.0	69.6	55.0	96.1	97.5	98.3
1977-78	99.0	96.0	109.9	114.3	88.4	108.2	113.3	67.3	58.2	85.4	87.2	90.4
1978-79	100.0	104.3	105.7	99.3	110.8	107.6	113.4	65.2	62.5	80.6	86.5	88.6
1979-80	102.1	97.5	117.9	104.2	111.0	100.9	115.1	111.0	66.8	79.0	86.3	98.3
1980-81	98.0	97.4	107.6	95.5	119.2	97.7	112.7	123.6	107.1	78.5	97.2	92.5
1981-82	101.3	96.2	93.7	86.8	111.8	94.7	108.0	120.8	108.3	78.2	85.9	94.8
1982-83	101.0	100.4	96.4	87.0	103.6	94.9	107.5	98.5	98.9	73.9	94.9	159.8
1983-84	96.9	80.7	86.8	84.5	89.1	89.7	84.5	116.0	103.3	75.6	93.6	167.2
1984-85	100.6	105.3	109.6	82.5	66.6	103.8	95.0	95.0	104.8	73.5	93.6	81.1
1985-86	99.8	99.5	96.3	83.5	110.7	97.3	100.6	112.2	108.8	80.7	83.0	79.6
1986-87	97.0	92.2	88.9	83.9	96.8	99.1	102.0	110.6	107.7	91.4	92.1	76.0
1987-88	96.3	85.9	101.0	85.1	122.7	94.7	99.5	109.3	106.1	91.6	95.3	76.8
1988-89	96.2	102.8	112.3	86.3	104.2	104.0	98.8	106.3	113.5	117.0	99.1	96.6
1989-90	100.8	102.5	92.7	94.5	87.0	101.9	107.4	105.3	110.7	113.9	101.0	92.2
1990-91	103.9	100.6	102.2	95.0	104.2	101.8	102.1	106.3	110.4	115.5	100.3	95.0
1991-92	103.1	93.5	110.2	100.4	104.5	100.3	99.1	107.5	110.5	118.5	100.9	93.3
1992-93	104.5	107.5	89.0	102.8	97.6	98.9	103.7	103.2	117.7	108.5	102.0	94.3
1993-94	100.8	105.9	104.9	107.6	95.5	96.5	104.7	82.1	106.6	98.6	103.5	109.8
1994-95	96.0	102.1	100.3	113.8	89.3	100.0	99.3	79.2	106.0	107.6	117.3	112.7
1995-96	99.8	102.7	97.3	117.5	106.1	101.8	86.8	100.0	62.1	95.0	105.2	106.1

Source : Estimated from collected data.

Cashewnut

Cashewnut productivity showed a declining trend upto 1984-85 and then onwards a slight increases. For the years 1960-61 and 1961-62 actual value was greater than trend value, for the next 5 years difference was negative, then again positive for 9 years, negative for the next 12 years, then positive for 5 years and so on. Range of cyclical fluctuations was, thus, from 73.5 % (in 1984-85) to 135.8% (in 1975-76). Maximum length of cycle in cashewnut productivity was 21 years (from 1962-63 to 1982-83).

4.1.2.6. Sugarcane Productivity

Sugarcane productivity was less than its trend value for the years 1960-61 to 1965-66, 1970-71 to 1981-82 and 1984-85 to 1992-93. Maximum difference between actual and trend values was +67.22% (in 1983-84) and minimum was -0.76% (in 1962-63). Absolute range of variation was from 76.0 (in 1986-87) to 167.2 (in 1983-84). 9-year length of cycle was visible from 1970-71 to 1978-79.

4.1. 3. Fluctuations in Farm Prices

Cyclical fluctuations in farm prices of paddy, tapioca, coconut, pepper, ginger, arecanut, cashewnut, banana and sugarcane are discussed below (see table 4.3 and appendix 8).

Cereal farm price

Cyclical fluctuation in cereal farm price is done by taking the example of paddy price. Actual farm price of paddy was Rs.40.9 per quintal in 1960-61, which was 45.79% lower than its trend price due to cyclical and irregular variations. This feature continued for the next 4 years and later in 1971-72 and 1977-78 to 1993-94 excepting the years 1983 and 1992. Difference between actual and trend value was minimum in 1994-95 (+4.20%) and maximum in 1974-75 (+88.44%). Cyclical variations ranged from 54.2 (in 1960-61) to 188.4 (in 1974-75). Maximum length of cycle existed in rice price was 10 years (from 1971-72 to 1980-81).

Coconut farm price

Coconut price was Rs. 207.31 in 1960-61 and it increased to Rs. 4144.75 per 1000 nuts in 1995-96. Difference between actual and trend value was minimum in 1983-84 (+1.07%) and maximum in 1984-85 (+61.09%). Cyclical variations ranged from 70.5 (in 1972-73) to 169.1 (in 1984-85). Maximum cycle of 5 years existed from 1960-61 to 1964-65, 1970-71 to 1974-75, 1974-75 to 1978-79, 1985-86 to 1989-90 and 1990-91 to 1994-95.

4.1.3.3. Farm prices of spices and condiments

Pepper

Pepper farm price was only Rs. 479.5 in 1960-61 but it increased to Rs. 7019.82 per quintal in 1995-96. Cyclical and irregular variations caused actual price to be lower than trend value during the years 1961-62 to 1964-65, 1967-68 to 1968-69, 1972-73 to 1973-74, 1979-80 to 1984-85 and 1990-91 to 1994-95. Difference between actual and trend value was minimum in 1994-95 (-0.77%) and maximum in 1987-88 (+65.91%). Cyclical variations ranged from 52.9 (in 1982-83) to 165.9 (in 1987-88). Cycles of 8 years (from 1976-77 to 1982-83) existed in pepper price.

Ginger

Ginger farm price was Rs. 142.71 in 1960-61 and it increased to Rs. 6037.49 per quintal in 1995-96. Difference between actual and trend values caused by cyclical and irregular variations was minimum during 1973-74 (-0.66%) and maximum during 1969-70 (+109.27%). Cyclical variations ranged absolutely from 29.0 (in 1961-62) to 290.3 (in 1969-70). 8-year cycles existed in the farm price of ginger during 1986-87 to 1993-94.

Arecanut

Increase in arecanut farm price was moderate during the selected 36 years. But cyclical and irregular variations caused actual price to be lower than its trend value during 1960-61 to 1964-65, in 1978, from 1982-83 to 1983-84 and 1985-86 to 1990-91. Difference between them was minimum in 1994-95 (0.14%) and maximum in 1970-71 (272.59%). Cyclical variations ranged from 38.0 (in 1960-61) to 372.6 (in 1970-71). Maximum cycle length seems to be 11 years (between 1963-64 to 1973-74) in the case of arecanut prices of Kerala.

4.1.3.4. Farm prices of fruits and vegetables

Banana

Increase in the farm price of banana was continuous but moderate. It was Rs. 6.62 in 1960-61 and increased to Rs. 125.64 per 100 numbers in 1995-96. Difference between actual and trend value was maximum during 1960-61 (-49.81%) and minimum during 1987-88 (-0.81%). Cyclical variations ranged from 50.2 (in 1960-61) to 134.6 (in 1968-69). Maximum cycle length seems to be 13 years (between 1960-61 to 1972-73) in banana price.

Cashewnut

Increase in cashewnut farm price was tremendous during 1960-61 to 1995-96. It was only Rs. 62.7 in 1960-61 but increased to Rs.

2456.65 per quintal in 1995-96. Maximum difference between actual and trend value was +110.33% (in 1968-69) and minimum was +0.81% (in 1986-87). Absolute range of cyclical variations was from 34.5 (in 1960-61) to 210.3 (in 1968-69). Maximum cycle length in cashewnut farm price seems to be 11 years (between 1962-63 to 1972-73).

Tapioca

Tapioca farm price was Rs. 8.14 in 1960-61 but its trend value was Rs. 29.39 per quintal. Influence of cyclical and irregular variations in tapioca farm price was maximum during 1968-69 (+166.81%) and minimum during 1990-91 (-1.41%). Cyclical variations ranged from 27.7 (in 1960-61) to 266.8 (in 1968-69). Maximum cycle length seems to be 7 years (from 1972-73 to 1978-79).

4.1.3.5. Sugarcane farm price

Farm price of sugarcane was only Rs. 30 in 1960-61 and it increased to Rs. 565.30 per quintal in 1995-96. Cyclical and irregular fluctuations caused actual price to be lower than its trend value during the years 1960-61 to 1963-64, 1978-79 to 1980-81, 1983-84 to 1987-88, 1989 and 1992-93 to 1993-94. Difference between actual and trend value was minimum in 1982-83 (+0.59%) and maximum in 1960-61 (-51.30%). Cyclical variations ranged from 48.7 (in 1960-61) to 145.5 (in 1968-69). Cycles of 12-year length were visible from 1960-61 to 1971-72 in sugarcane price.

Table 4.3

Cyclical Variations of Farm Prices in Kerala - Percent of trend (1960-61 to 1995-96)

Year col. 1	Paddy col.2	Coconut col. 3	Pepper col. 4	Ginger col. 5	Arecanut col. 6	Banana col. 7	Cashewnut col. 8	Tapioca col. 9	Sugarcane col. 10
1960-61	54.2	92.2	105.3	30.2	38.0	50.2	34.5	27.7	48.7
1961-62	57.4	93.2	87.5	29.0	47.0	63.7	49.6	37.0	61.6
1962-63	58.7	102.6	73.8	45.2	76.0	71.2	48.0	48.4	75.3
1963-64	55.5	104.6	74.3	77.9	64.4	81.9	58.0	52.6	86.9
1964-65	73.2	91.7	93.8	119.0	99.0	90.0	87.4	80.5	101.2
1965-66	106.1	126.6	113.6	117.5	151.4	103.6	131.2	159.2	112.7
1966-67	123.4	120.0	113.4	108.2	151.7	110.0	171.1	154.0	112.8
1967-68	155.0	123.6	97.0	119.4	208.3	127.8	195.9	195.0	121.9
1968-69	143.2	110.5	85.9	171.6	256.9	134.6	210.3	266.8	145.5
1969-70	117.6	97.6	102.6	290.3	317.9	129.9	186.5	207.5	137.1
1970-71	105.8	121.1	128.5	158.5	372.6	119.4	174.5	203.4	128.1
1971-72	94.6	86.9	111.3	135.0	304.9	108.7	139.9	193.9	124.9
1972-73	104.8	70.5	80.7	75.6	237.6	107.0	123.7	181.8	127.3
1973-74	143.8	104.1	83.6	99.3	180.5	113.6	134.9	200.3	117.8
1974-75	188.4	123.4	118.3	143.2	180.6	116.0	161.1	207.2	118.8
1975-76	186.8	87.0	115.4	113.9	138.8	123.5	110.0	180.1	109.4
1976-77	116.0	86.9	129.3	199.8	156.9	125.7	84.4	150.0	110.9
1977-78	93.3	91.5	133.5	204.8	109.3	109.5	144.9	103.5	106.8
1978-79	80.1	94.7	121.0	135.8	96.0	105.4	131.7	85.6	97.5
1979-80	77.1	84.3	95.9	53.5	108.9	101.9	85.6	93.0	90.3
1980-81	75.7	97.8	75.7	38.7	103.5	98.3	104.3	85.4	90.0
1981-82	91.1	84.6	65.6	65.9	111.0	97.2	124.8	73.6	113.1
1982-83	86.5	78.4	52.9	98.4	95.0	97.8	94.8	88.3	100.6
1983-84	104.4	101.1	58.2	159.6	76.5	106.8	65.9	101.8	92.7
1984-85	95.6	161.1	85.8	186.4	115.9	102.9	96.4	80.6	76.7
1985-86	87.5	85.6	134.6	88.2	77.6	101.4	82.4	76.9	85.0
1986-87	88.3	88.5	162.7	45.8	80.0	101.2	100.8	96.4	96.3
1987-88	85.5	111.5	165.9	67.9	58.1	99.2	116.2	93.3	90.8
1988-89	89.4	113.1	103.3	68.5	65.3	82.1	84.9	77.8	102.0
1989-90	92.0	79.4	113.9	78.8	56.9	81.4	82.2	86.4	96.3
1990-91	82.2	86.2	74.7	96.2	86.4	86.0	77.0	98.6	107.0
1991-92	87.8	115.5	76.1	81.2	115.6	83.5	84.7	92.9	106.0
1992-93	107.2	127.6	57.7	75.1	120.5	87.7	115.6	97.3	89.3
1993-94	98.6	110.9	62.4	73.4	114.1	96.0	102.2	104.2	70.1
1994-95	104.2	84.0	99.2	108.4	100.1	107.8	103.6	97.7	114.0
1995-96	111.2	84.3	129.3	156.7	106.3	105.8	109.7	108.4	119.4

Source : Estimated by the researcher.

4.1. 4. Fluctuations in wholesale Prices

Cyclical fluctuations in wholesale prices of tapioca, coconut, pepper, ginger, arecanut, banana, turmeric, rubber and tea for the selected 36 years are discussed below. (See table 4.4 and appendix 9).

4.1.4.1. Oilseeds

Coconut price was only Rs. 224.1 in 1960-61 and it increased to Rs. 3479.36 per 1000 nuts in 1995-96. Cyclical and irregular fluctuations caused actual coconut price to be lower than its trend value in the years 1960-61 to 1964-65, 1969-70, 1971-72, 1974-75 to 1985-86, 1989-90 to 1990-91 and 1994-95 to 1995-96. Their difference was minimum in 1974-75 (-0.25%) and maximum in 1965-66 (+82.97%). Absolute range of cyclical variations was from 65.6 (in 1960-61) to 182.9 (in 1965-66) and maximum cyclical length was 9 years (from 1981-82 to 1989-90).

4.1.4.2. Plantation crops

Rubber

Rubber price was increasing fastly during the selected 36 years. It was only Rs. 347.96 (in 1960-61) but increased to Rs. 4632.06 per quintal (in 1995-96). Actual price was less than trend value during the periods 1960-61 to 1965-66, 1971-72 to 1973-74, 1976-77 to 1977-78 and 1987-88 to

1994-95 due to the influence of cyclical and irregular fluctuations. Minimum difference between them was +0.21% (in 1986-87) and maximum was +54.2% (in 1966-67). Cyclical variations ranged from 75.7 (in 1961-62) to 154.2 (in 1966-67). Cycles of 8 years were visible between 1974-75 to 1981-82.

Tea

Increase in tea price was moderate. It increased from Rs. 5.65 (in 1960-61) to Rs. 52.49 per quintal (in 1995-96). But cyclical and irregular components influenced the actual price to be lower than its trend value during 1960-61 to 1962-63, 1971-72 to 1973-74, 1979-80 to 1982-83, 1985-86 to 1988-89 and 1994-95 to 1995-96. Difference between actual and trend values was minimum in 1992-93 (+0.44%) and maximum in 1970-71 (+44.29%). Cyclical variations ranged from 76.7 (in 1988-89) to 142.3 (in 1970-71). Maximum cycle length was 8 years (between 1966-67 to 1973-74 and 1983-84 to 1990-91).

4.1.4.3. Spices and condiments

Pepper

Actual pepper price was only Rs. 500 in 1960-61 but it increased to Rs. 7425.22 per quintal in 1995-96. Actual price was 17.56% lower than its trend value in 1960-61 but it became 30.95% greater than trend value in 1995-96. Maximum difference between actual and trend value due to cyclical and irregular variations was during 1987-88 (+74.77%) and minimum during 1972-73

(-0.19%). Cyclical variations ranged from 59.5 (in 1982-83) to 174.8 (in 1987-88). Maximum cycle length seems to be 8 years (between 1975-76 to 1982-83).

Ginger

Like the price of pepper, tremendous increase in the price of ginger was visible. It increased from Rs. 162.01 (in 1960-61) to Rs. 5976.87 (in 1995-96) per quintal. Due to cyclical and irregular variations actual price was lower than trend price in the years 1960-61 to 1963-64, 1966-67, 1972-73 to 1973-74, 1979-80 to 1981-82 and 1986-87 to 1993-94. Cyclical variations ranged from 34.6 (in 1960-61) to 297.6 (in 1970-71). Maximum length of 8-year cycles (between 1980-81 to 1987-88) existed in the wholesale prices of ginger.

Turmeric

Turmeric price was Rs. 101.93 in 1960-61 and it increased to Rs. 1654.24 per quintal in 1995-96. But its trend increase was from Rs. 236.56 to Rs. 2055.19 per quintal during the same period. Due to cyclical and irregular influences actual price was lower than its trend price during the years 1960-61 to 1966-67, 1971-72 to 1972-73, 1975-76 to 1976-77, 1980-81 to 1982-83, 1986-87 to 1991-92 and 1994-95 to 1995-96. Difference between these actual and trend values worked out to be maximum in 1969-70 (+210.76%) and minimum in 1979-80 (+2.91%). Cyclical variations ranged from 42.2 (in 1981-82) to 310.7 (in 1969-70). Maximum length of cycle was 8 years (during 1982-83 to 1989-90).

Arecanut

Arecanut price fluctuation was irregular in the first half of the period but in the second half it increased continuously. So also was its trend value. Thus cyclical and irregular influence was clearly visible in arecanut price and these factors caused actual price to be lower than its trend value during the years 1960-61 to 1963-64, 1969-70 to 1972-73, 1978-79, 1980-81 to 1990-91 and 1993. Percent of trend worked out to be highest in 1969-70. Cyclical variations ranged from 33.5 (in 1960-61) to 2956 (in 1969-70). Maximum length of cycles existed in arecanut price was 9 years (between 1983-84 to 1991-92).

4.1.4.4. Fruits and vegetables

Banana

Banana price was only Rs. 77.20 in 1960-61 but it increased to Rs. 1298.30 per hundred numbers in 1995-96. Due to cyclical and irregular variations actual price was lower than its trend value in the years 1960-61 to 1964-65, 1971-72, 1977-78 to 1982-83 and 1987-88 to 1992-93. Difference between them was highest in 1960-61 (-37.88%) and lowest in 1971-72 (-0.38%). Cyclical variations ranged from 62.1 (in 1960-61) to 130.4 (in 1968-69). Maximum length of 12-year cycle was visible during 1960-61 to 1971-72.

Table 4.4

Cyclical Variations of Wholesale Prices in Kerala - Percent of trend (1960-61 to 1995-96)

Year col. 1	Coconu col.2	Tea col. 3	Rubber col. 4	Pepper col. 5	Ginger col. 6	Arecanut col. 7	Turmeric col. 8	Banana col. 9	Tapioca col. 10
1960-61	65.6	83.8	76.2	82.4	34.6	33.5	43.1	62.1	23.1
1961-62	68.0	82.6	75.7	68.1	40.5	39.3	54.3	74.6	26.6
1962-63	77.9	78.7	77.3	60.2	46.6	62.9	77.9	86.5	33.8
1963-64	82.1	102.1	80.6	60.4	74.3	58.4	81.5	91.1	296.5
1964-65	80.7	108.2	85.5	85.1	110.3	100.5	91.8	98.8	47.0
1965-66	182.9	112.4	96.3	111.8	111.5	173.9	63.9	108.1	115.9
1966-67	171.1	105.3	154.2	114.3	98.9	217.1	56.9	115.0	112.0
1967-68	121.0	107.2	102.8	101.6	102.9	428.8	106.6	123.1	141.3
1968-69	104.9	108.8	108.5	95.1	130.9	1445	196.0	130.4	200.9
1969-70	93.0	114.0	133.7	112.5	240.7	2956	310.7	121.8	152.1
1970-71	120.8	142.3	110.7	159.2	297.6	1311	294.5	103.5	167.6
1971-72	78.7	97.5	95.5	138.8	118.3	1076	69.6	99.6	153.9
1972-73	116.5	89.2	91.6	99.8	67.2	1617	81.7	100.8	162.1
1973-74	141.5	84.5	90.8	102.3	86.2	1586	119.9	109.6	182.1
1974-75	99.7	103.8	134.1	142.2	126.9	493.6	126.7	109.2	177.5
1975-76	94.4	112.7	123.9	137.8	119.1	231.9	96.1	121.0	177.2
1976-77	88.2	106.8	86.9	148.6	166.9	125.2	90.0	113.8	135.1
1977-78	92.7	141.3	80.3	158.1	175.9	123.8	130.2	89.9	94.8
1978-79	93.6	112.2	102.3	137.8	125.5	96.9	174.6	91.2	81.9
1979-80	80.4	92.7	107.7	107.3	53.5	100.7	102.9	85.7	88.5
1980-81	98.9	90.4	109.7	85.0	38.2	95.7	42.8	84.8	82.9
1981-82	86.1	81.7	123.5	73.2	64.9	90.0	42.2	87.3	79.9
1982-83	89.8	84.6	112.9	59.5	110.6	81.9	69.9	96.6	99.5
1983-84	92.5	118.6	127.5	63.1	159.3	94.3	121.7	122.2	93.8
1984-85	92.8	105.2	117.6	60.1	122.1	84.3	111.1	112.4	90.3
1985-86	95.4	96.4	109.1	77.9	105.4	73.4	105.3	108.8	90.9
1986-87	110.5	90.3	100.2	124.2	91.1	66.5	97.1	103.9	90.8
1987-88	112.3	83.7	92.9	174.8	70.3	58.8	89.3	98.8	111.6
1988-89	115.8	76.7	87.9	107.1	80.4	58.8	83.7	86.6	76.4
1989-90	80.4	105.3	92.5	119.5	81.3	68.9	69.4	88.5	92.2
1990-91	87.9	121.6	90.5	78.9	95.4	88.6	80.5	92.2	97.4
1991-92	114.8	105.9	80.4	79.3	82.2	136.8	47.9	88.9	88.2
1992-93	125.6	100.4	88.6	59.5	74.1	130.9	207.2	94.4	99.2
1993-94	111.8	105.3	85.8	64.6	74.1	97.3	114.4	100.7	104.2
1994-95	86.3	89.1	96.2	101.7	100.0	105.6	88.9	115.1	97.7
1995-96	85.4	92.3	148.1	130.9	150.9	105.9	80.5	105.0	105.8

Source : Estimated by the researcher.

Tapioca

Tapioca price increased manifold in the selected 36 years. From Rs. 8.93 in 1960-61 it reached to Rs. 254.59 per quintal in 1995-96. Cyclical and irregular influence caused actual price to be lower than its trend price during 1960-61 to 1962-63, 1964-65, 1977-78 to 1986-87, 1988-89 to 1992-93 and 1994-95. Percent of trend worked out to be highest in 1963-64 (+196.45%). Cyclical variations ranged from 23.1 (in 1960-61) to 296.5 (in 1963-64). Maximum length of 7-year cycles existed in tapioca price during 1973-74 to 1979-80.

Thus cyclical fluctuations in Kerala agriculture was proved as a common phenomenon but characteristics of these fluctuations were different for different commodities. Summarised results (table 4.5) reveal that percentage of trend and relative range was highest in wholesale prices, followed by farm prices, production and productivity. Relative range was maximum in the wholesale prices of arecanut and minimum in the productivity of rice. During the selected 36 years, 5 to 11 cycles occurred in the series of production, productivity and prices. Maximum cycle length was 23(rubber production) and minimum was 5 years (coconut farm price).

Whether cycles occurred in production, productivity and prices were uniform or not is tested by looking to the periods of similar cyclical movements in figures 4.1 to 4.12. Periods with similar ups and downs are

Table 4.5

Number and maximum length of cycles of agricultural Production, Productivity and Prices

Production					
Category	Crops	Maximum % of trend	Relative range	No. of Cycles	Maximum length of Cycles
Cereals	Rice	114.35	0.14	10	8
Oilseeds	Coconut	126.08	0.28	7	18
Plantation crops	Tea	117.28	0.16	11	8
	Rubber	147.7	0.53	5	23
Spices & condiments	Pepper	129.3	0.41	9	8
	Ginger	207.14	0.53	9	12
	Arecanut	118.89	0.23	6	9
	Turmeric	150.23	0.57	10	7
Fruits& Vegetables	Banana	136.64	0.48	10	7
	Tapioca	162.19	0.45	8	8
	Cashewnut	125.92	0.24	7	12
Miscellaneous	Sugarcane	171.65	0.39	8	9
Productivity					
Cereals	Rice	106.89	0.09	10	7
Oilseeds	Coconut	109.37	0.15	9	9
Plantation crops	Tea	117.86	0.15	11	7
	Rubber	128.48	0.26	8	12
Spices & condiments	Pepper	122.7	0.3	9	6
	Ginger	162.72	0.43	9	12
	Arecanut	138.22	0.36	8	7
	Turmeric	115.09	0.15	9	8
Fruits& Vegetables	Banana	122.69	0.38	6	13
	Tapioca	124.71	0.31	8	10
	Cashewnut	135.8	0.3	6	21
Miscellaneous	Sugarcane	137.22	0.38	9	9

Continued.....

Farm Prices						
Cereals	Paddy	188.44	0.28	8	10	
Oilseeds	Coconut	169.09	0.41	10	5	
Spices &	Pepper	165.91	0.52	8	8	
condiments	Ginger	292.27	0.82	7	8	
	Arecanut	372.6	0.81	10	11	
Fruits&	Banana	134.64	0.47	5	13	
Vegetables	Cashewnut	210.33	0.72	8	11	
	Tapioca	266.81	0.81	8	7	
Miscellaneous	Sugarcane	145.48	0.5	8	12	
Wholesale Prices						
Oilseeds	Coconut	182.97	0.47	8	9	
Plantation crops	Tea	142.29	0.3	8	8	
	Rubber	154.2	0.34	8	8	
Spices &	Pepper	174.77	0.49	9	8	
condiments	Ginger	297.6	0.79	6	8	
	Turmeric	310.76	0.76	7	8	
	Arecanut	2956.3	0.98	6	9	
Fruits&	Banana	130.35	0.35	7	12	
Vegetables	Tapioca	296.45	0.86	11	7	

Source : Estimated by the researcher.

Figure 4.1

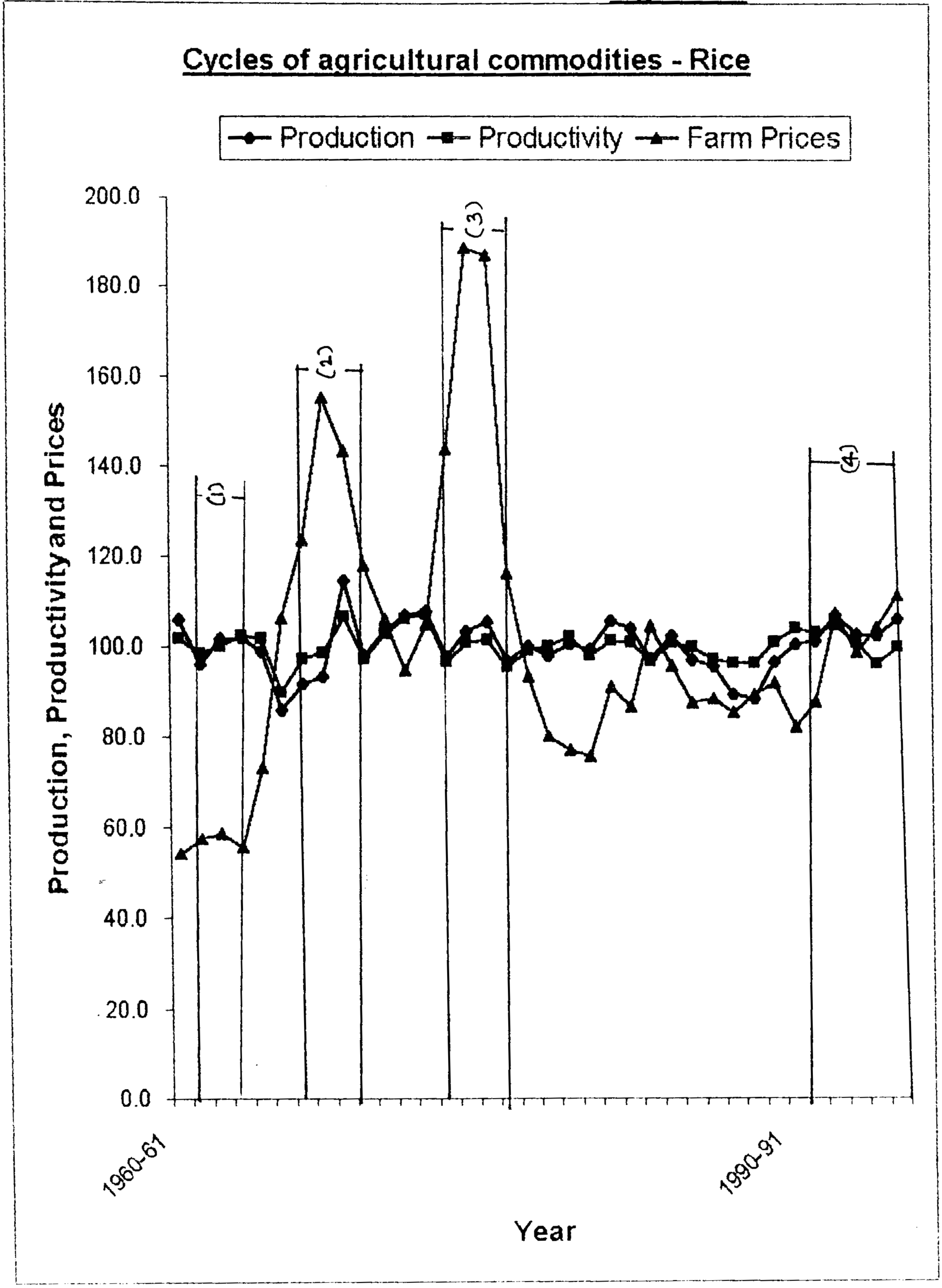

Cycles of agricultural commodities - Rice
Production
Productivity
Farm Prices
Production, Productivity and Prices
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

Figure 4.2

Cycles of agricultural commodities - Coconut

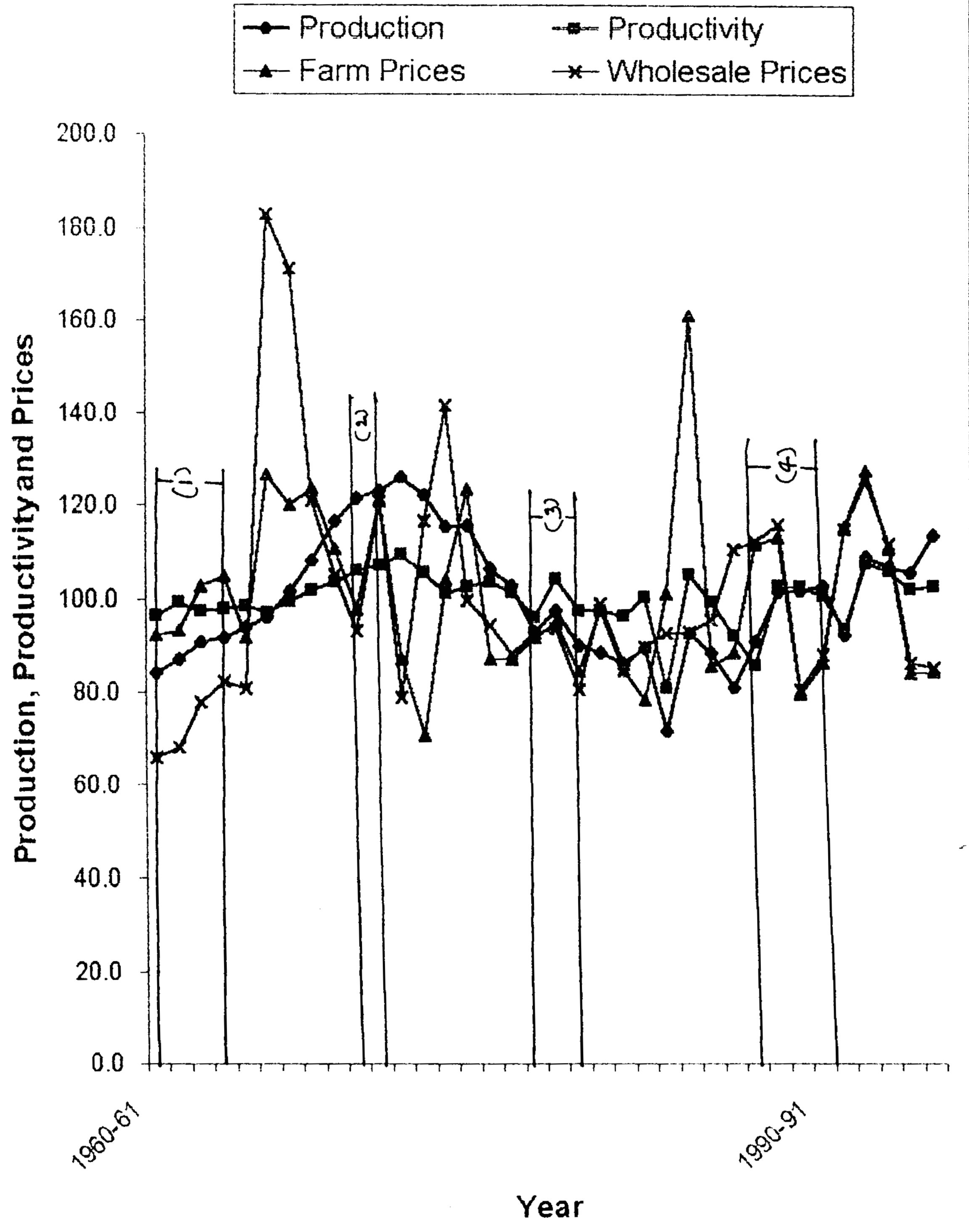
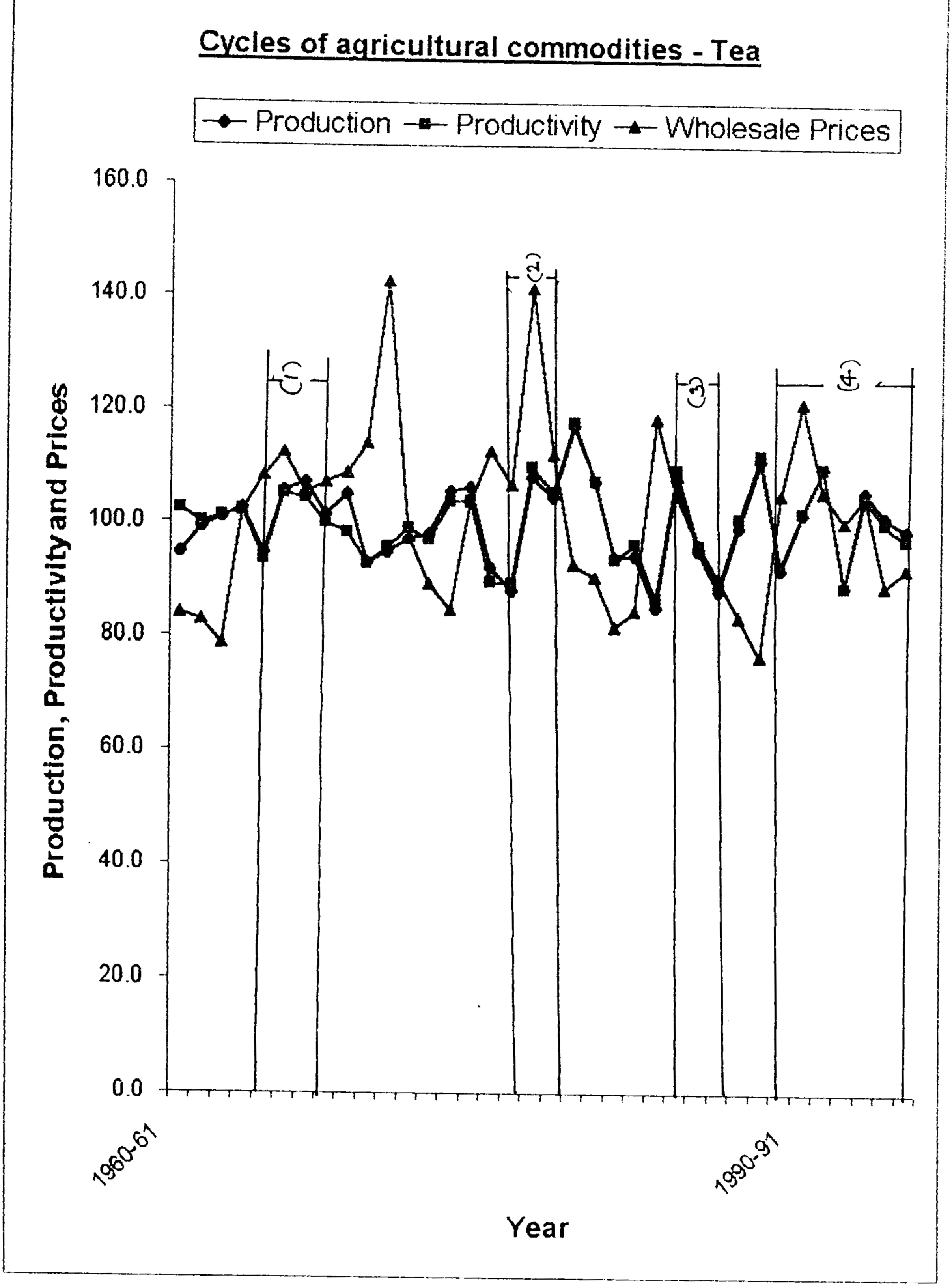


Figure 4.3



Cycles of agricultural commodities - Tea
Production
Productivity
Wholesale Prices
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Production, Productivity and Prices
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

Figure 4.4

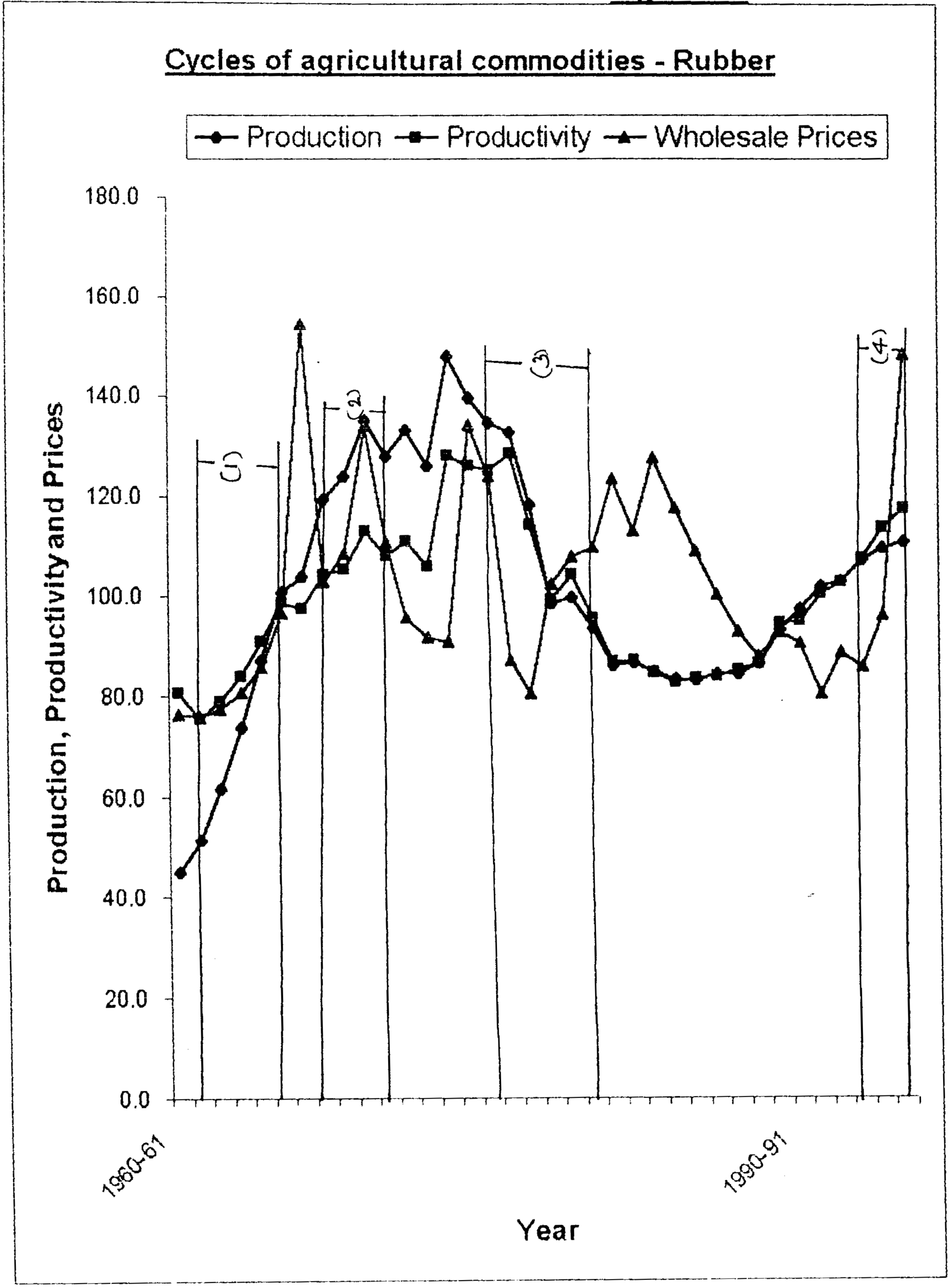
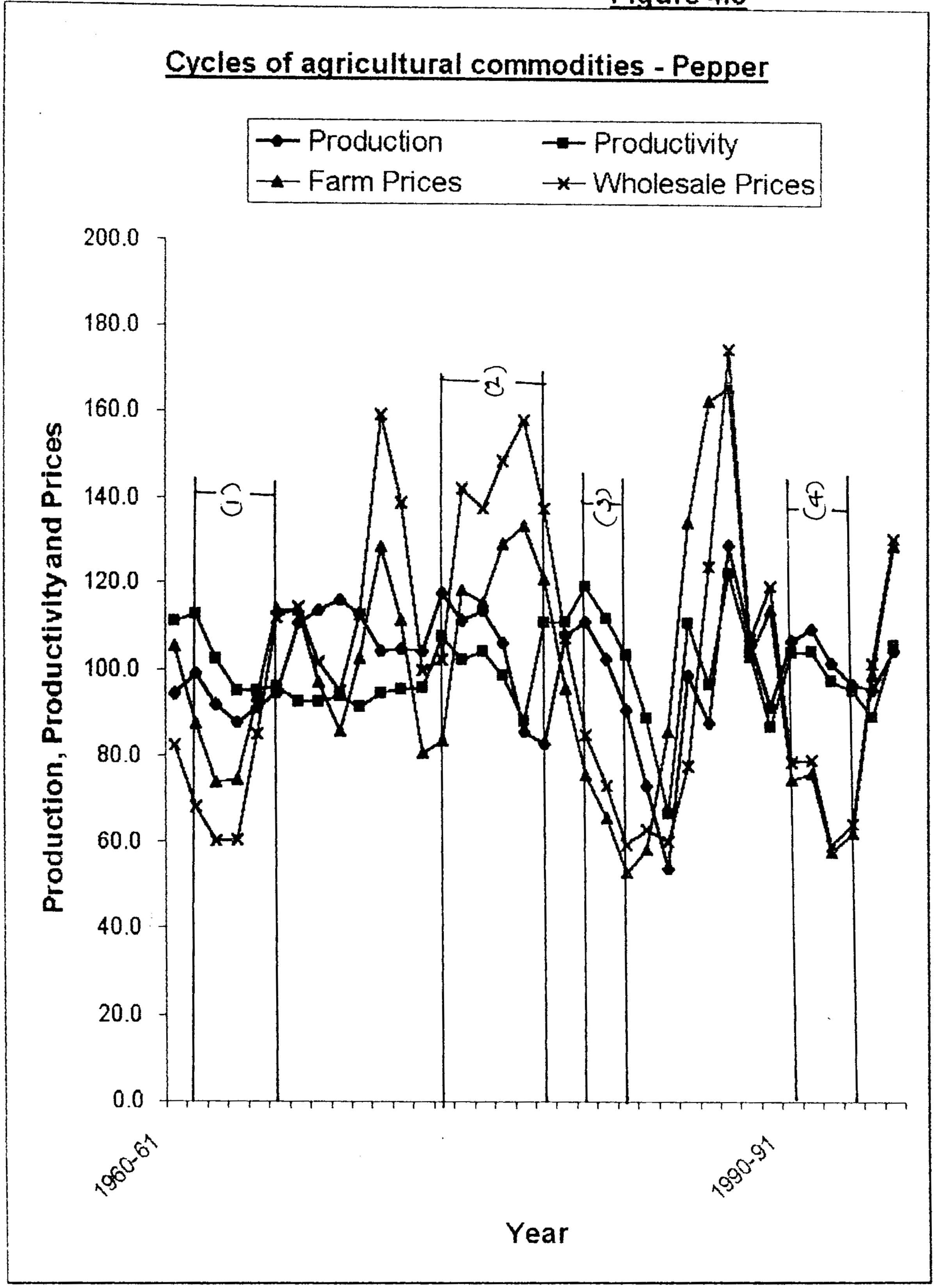

Cycles of agricultural commodities - Rubber
Production
Productivity
Wholesale Prices
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Production, Productivity and Prices
1960-61
1990-91
Year
(1)
(2)
(3)
(4)

Figure 4.5


Cycles of agricultural commodities - Pepper
Production
Productivity
Farm Prices
Wholesale Prices
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Production, Productivity and Prices
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

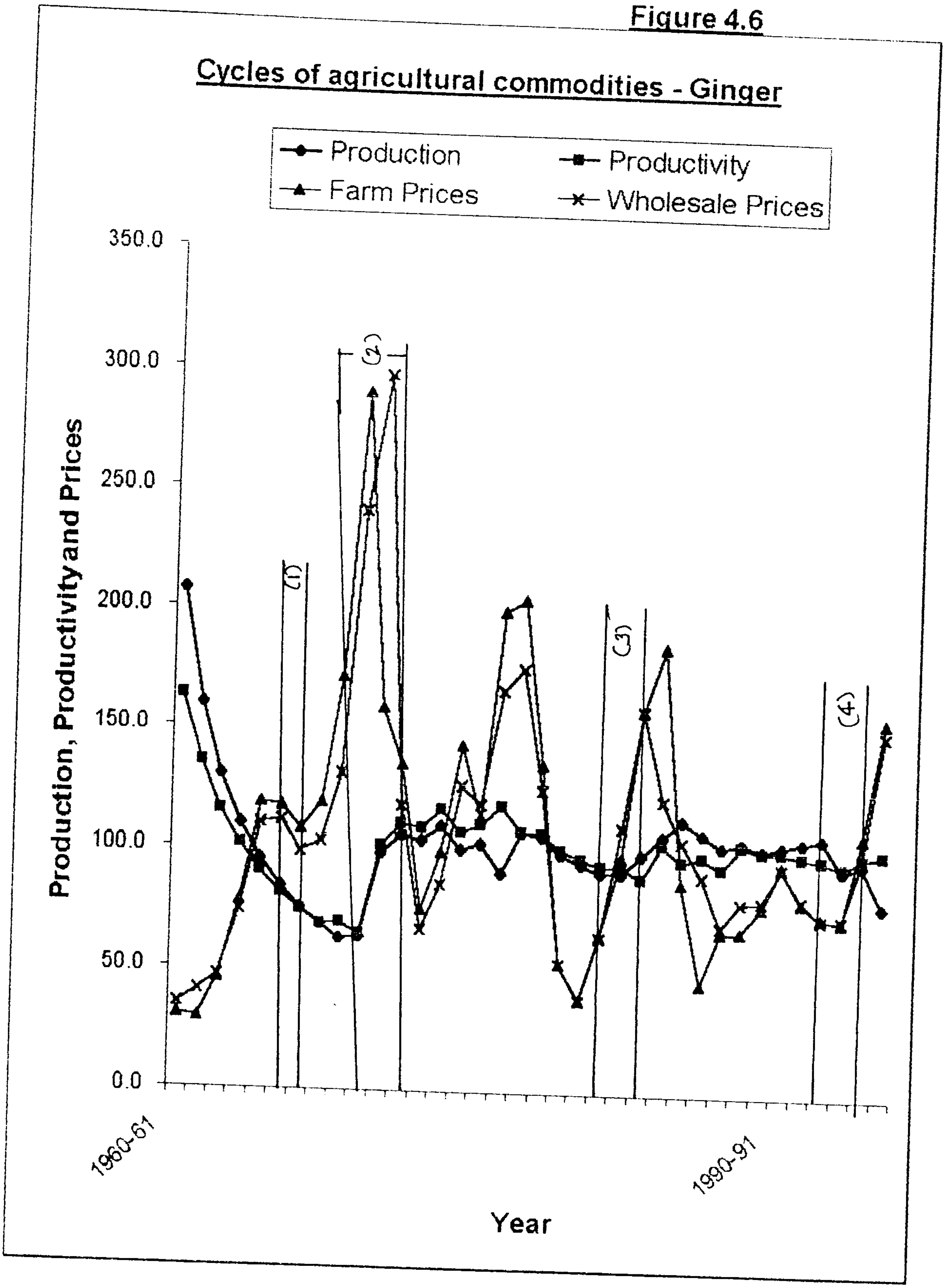
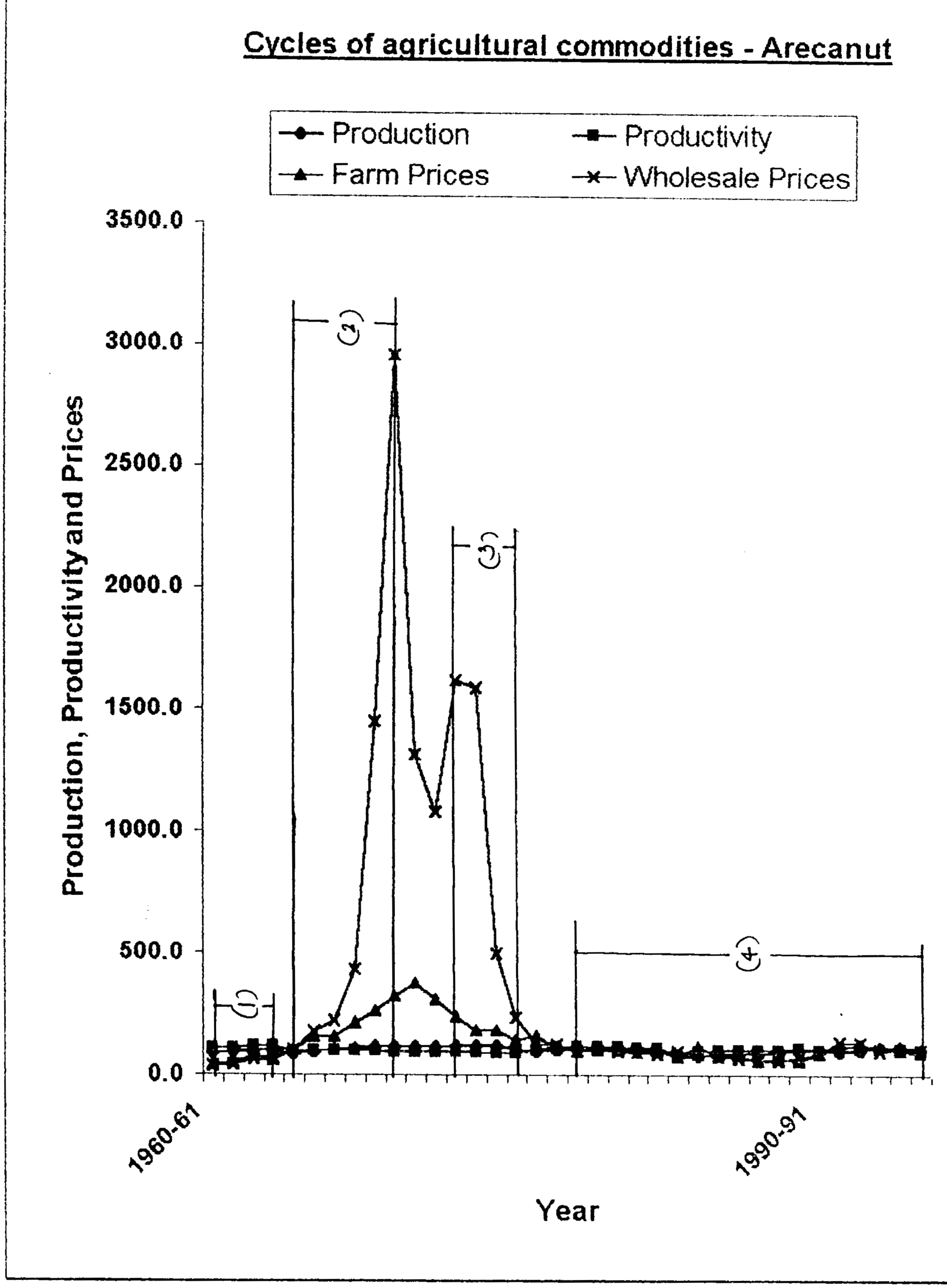


Figure 4.6
Cycles of agricultural commodities - Ginger
Production
Productivity
Farm Prices
Wholesale Prices
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Production, Productivity and Prices
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

Figure 4.7


Cycles of agricultural commodities - Arecanut
Production
Productivity
Farm Prices
Wholesale Prices
Production, Productivity and Prices
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3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

Figure 4.8

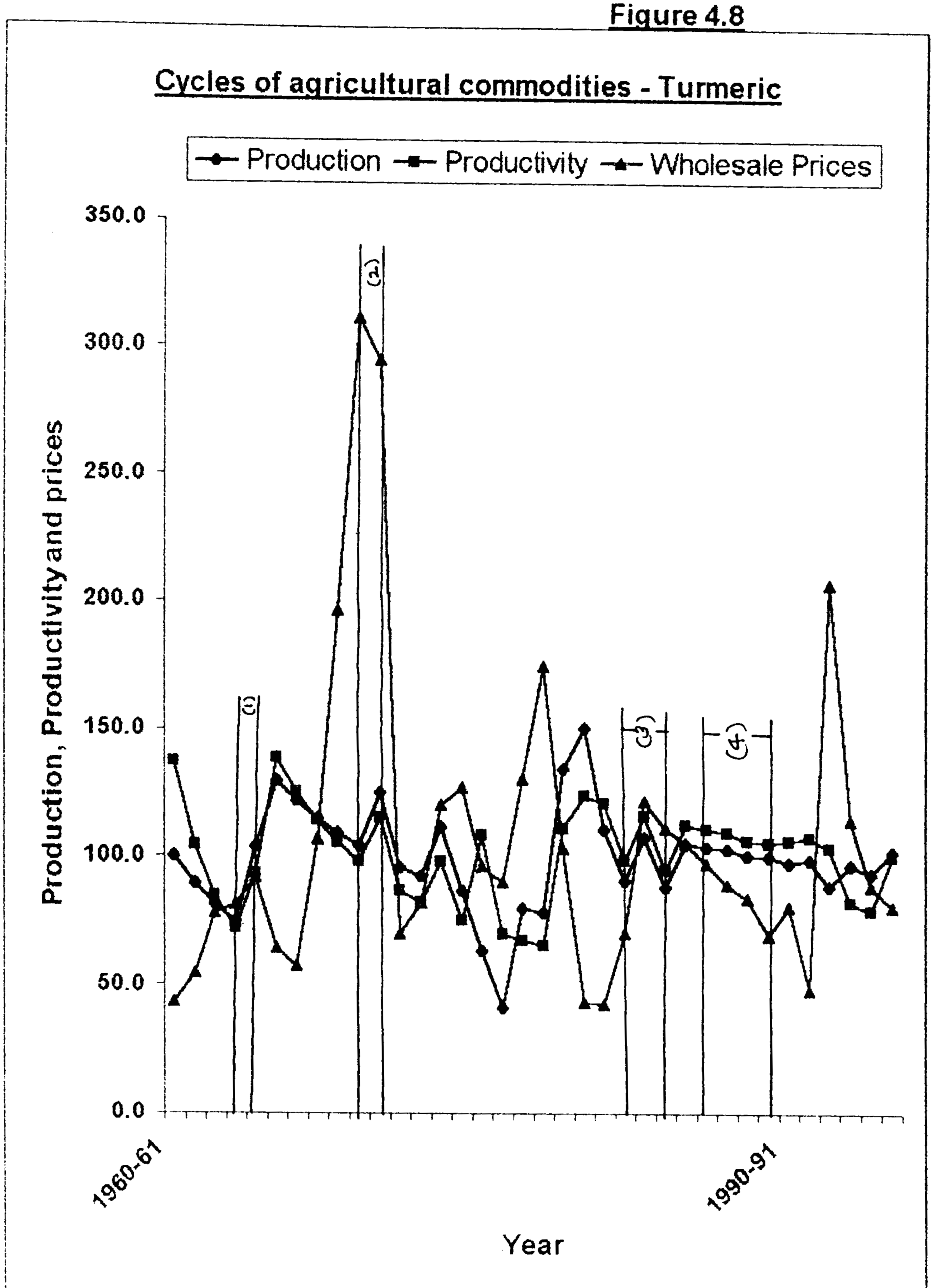

Cycles of agricultural commodities - Turmeric
Production
Productivity
Wholesale Prices
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Production, Productivity and prices
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

Figure 4.9

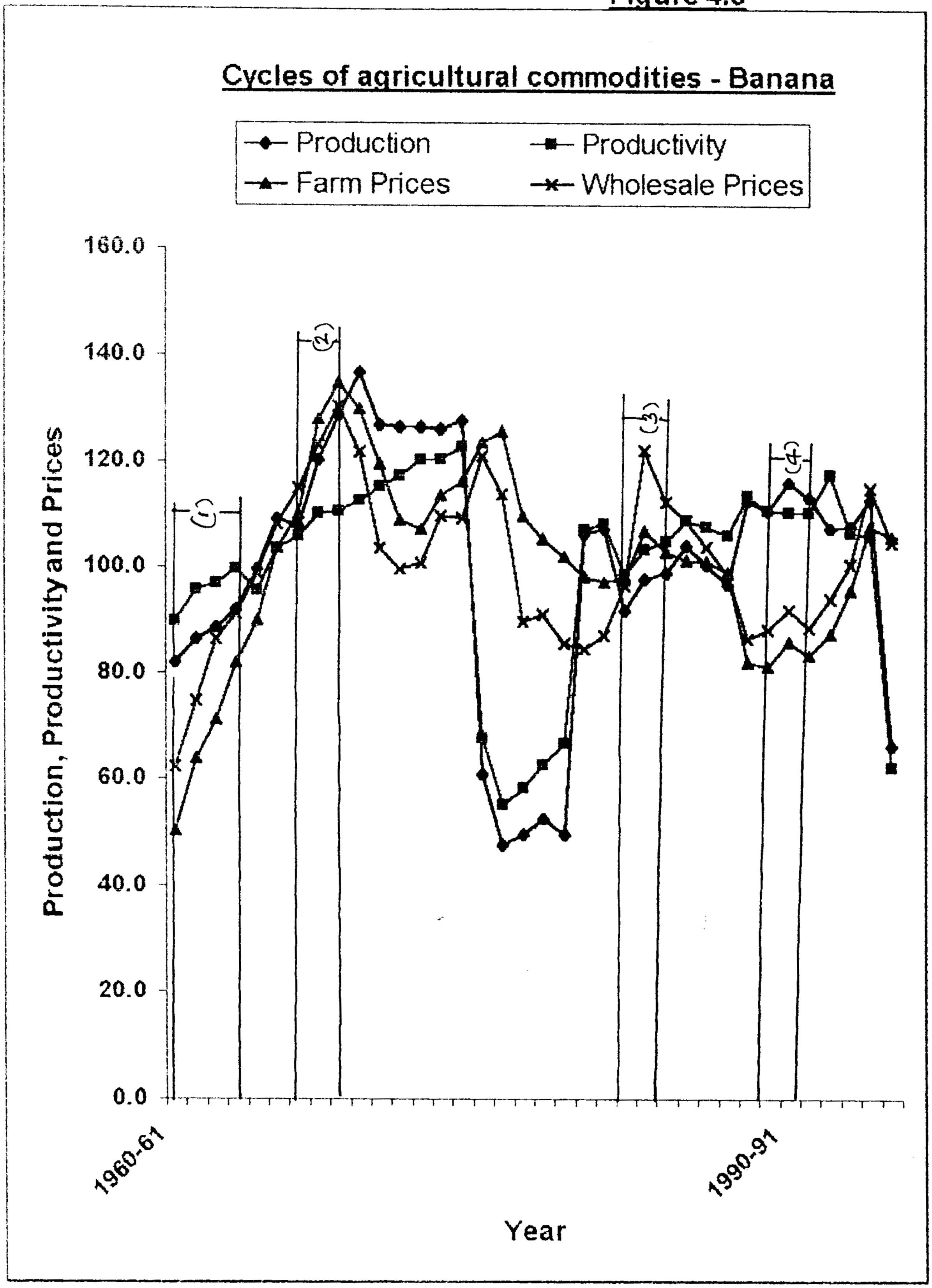

Cycles of agricultural commodities - Banana
Production
Productivity
Farm Prices
Wholesale Prices
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Production, Productivity and Prices
1960-61
1990-91
Year
(1)
(2)
(3)
(4)

Figure 4.10

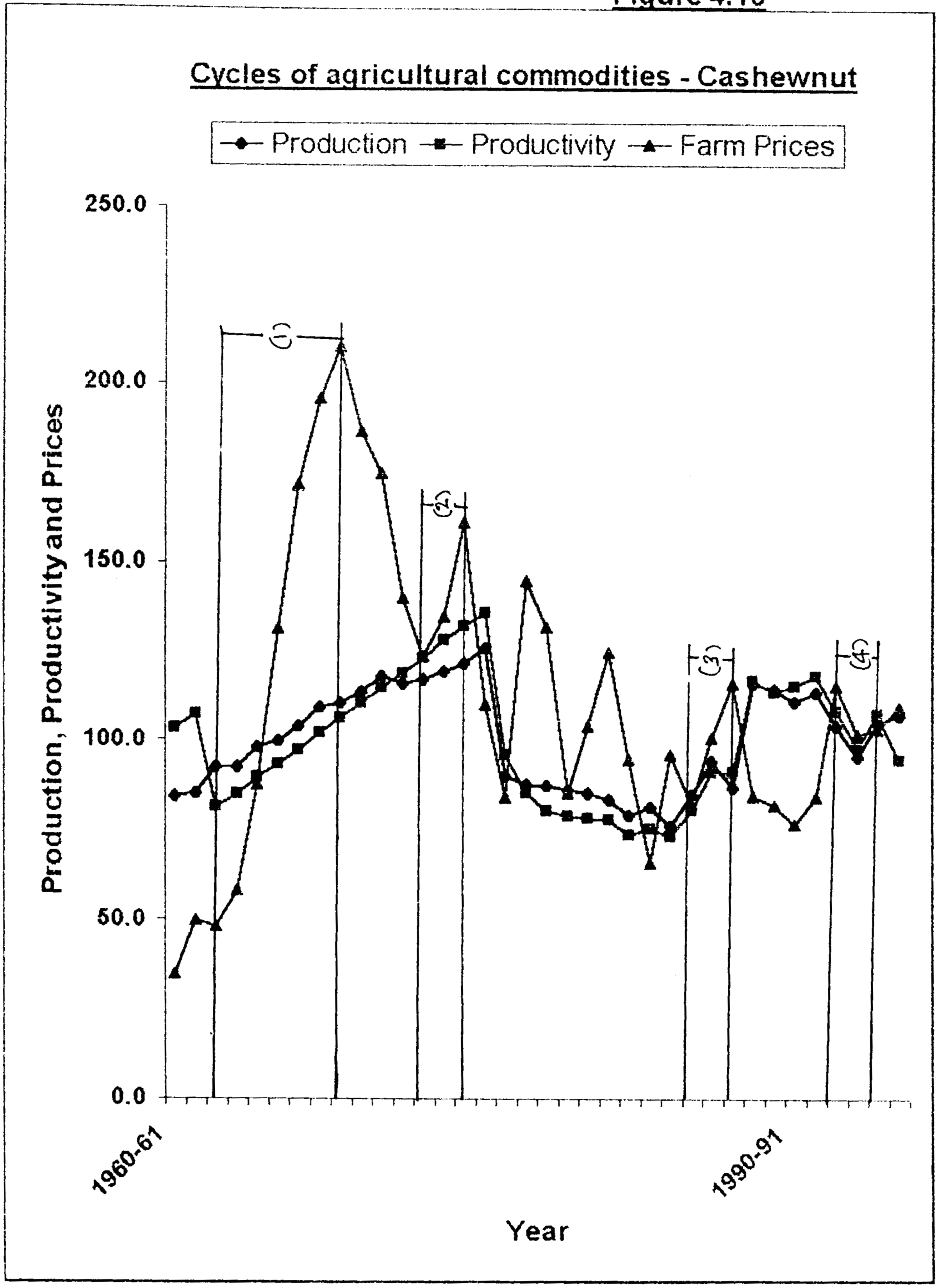

Cycles of agricultural commodities - Cashewnut
Production
Productivity
Farm Prices
250.0
200.0
150.0
100.0
50.0
0.0
Production, Productivity and Prices
(1)
(2)
(3)
(4)
1960-61
1990-91
Year

Figure 4.11

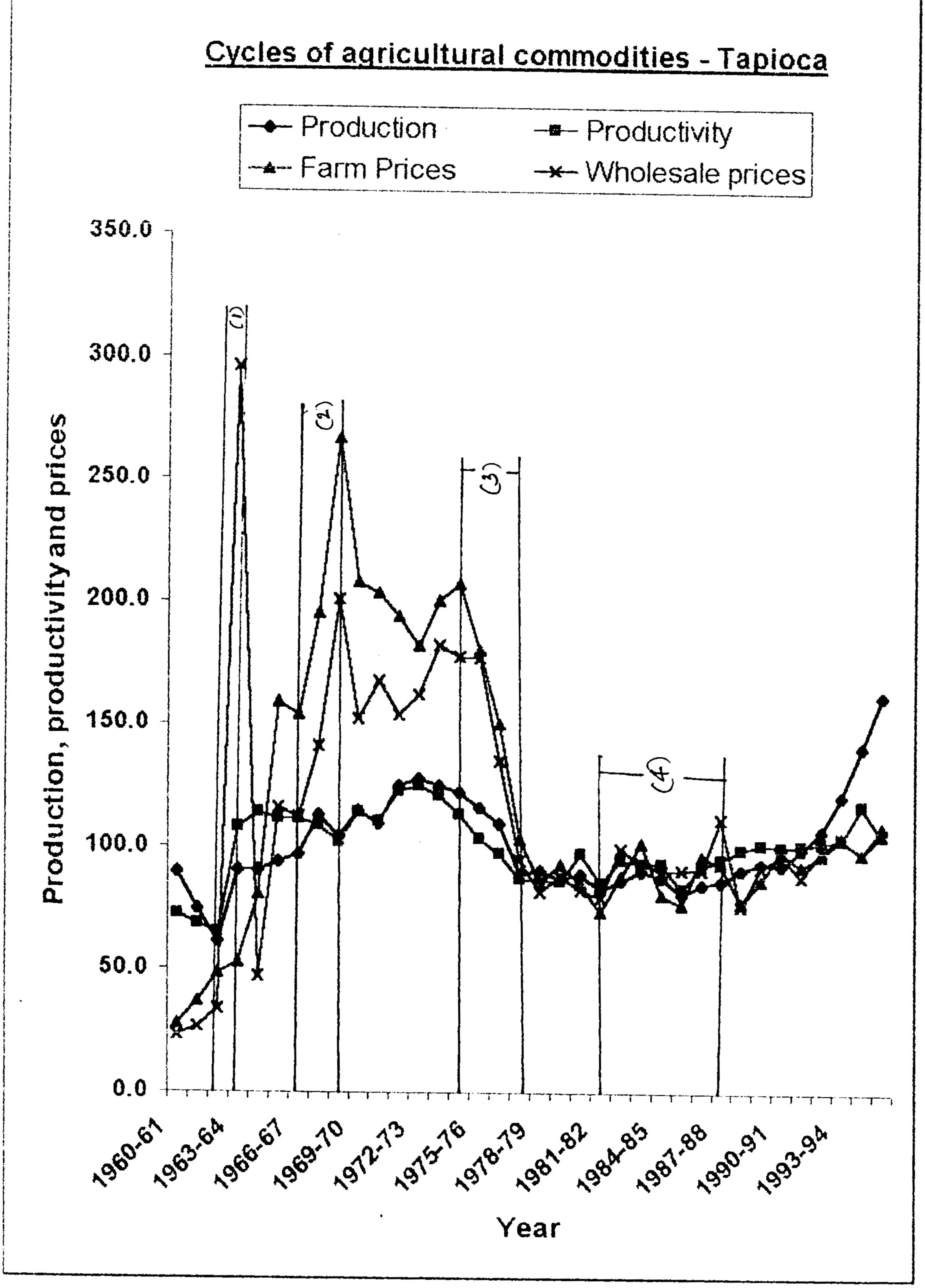
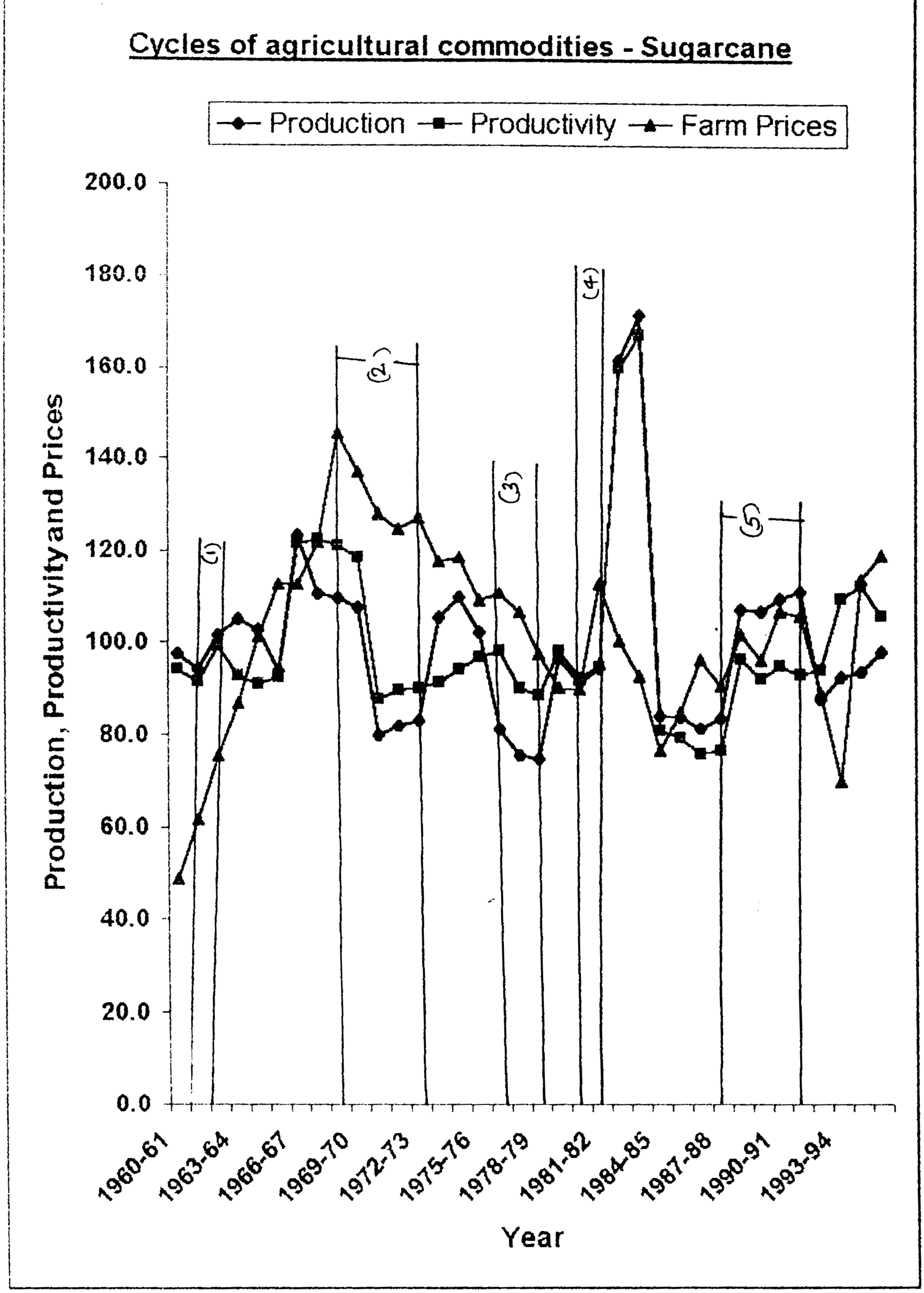

Cycles of agricultural commodities - Tapioca
Production
Productivity
Farm Prices
Wholesale prices
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Production, productivity and prices
(1)
(2)
(3)
(4)
1960-61
1963-64
1966-67
1969-70
1972-73
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
Year

Figure 4.12


Cycles of agricultural commodities - Sugarcane
Production
Productivity
Farm Prices
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Production, Productivity and Prices
(1)
(2)
(3)
(4)
(5)
1960-61
1963-64
1966-67
1969-70
1972-73
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
Year

marked using vertical lines and then numbered as 1,2,3, ... etc. These numbered vertical lines are called numbered groups. It is seen that eventhough width is different for different numbered groups and commodities, there existed 3 to 8 numbered groups. Number of numbered groups in the figures indicates that most of the cycles occurred in production, productivity and prices of agricultural commodities were of the same period. Cyclical movement in one affects the other two. That is upward and downward changes in production, productivity and prices are well related.

Being aware of the cyclical features of agriculture, a deeper analysis of this particular phenomenon is attempted in the next section.

4.2. Harmonic Analysis

As stated earlier we used harmonic analysis to test the existence and length of cycles statistically. Here we test our hypothesized 6-year cycle model for production, productivity and prices of agricultural commodities. The empirical results are presented below.

4.2.1. Agricultural Production

Fourier coefficients, amplitude (squared), mean square amplitude and the ratio K of agricultural production are presented in table 4.6. Table reveals that absolute value of Fourier coefficients using cosines were

Table 4.6

Fourier coefficients, amplitude (squared), mean square amplitude, and the ratio K for agricultural production (6 years) cycles

Category	Crops	Fourier Coefficients		Amplitude Squared Rp^2	Mean Square Amplitude Rm^2	Ratio K(= Rp/Rm)
		Ap	Bp			
Cereals	Rice	-22.07	0.346	487.0	476.41	1.022⊗
Oilseeds	Coconut	98.633	-139.5	29177	14643	1.993⊗
Plantation crops	Tea	0.338	0.395	0.270	2.009	0.135⊗
	Rubber	13.892	-22.18	684.9	403.98	1.696⊗
Spices & condiments	Pepper	-1.006	-1.900	4.625	3.502	1.321⊗
	Ginger	1.082	-0.563	1.488	5.189	0.287⊗
	Arecanut	-0.025	-2.226	4.954	3.346	1.481⊗
	Turmeric	1.111	0.674	1.689	6.319	0.267⊗
Fruits& Vegetables	Banana	-15.83	-8.934	330.2	294.44	1.122⊗
	Tapioca	-0.709	-0.869	1.258	5.001	0.252⊗
	Cashewnut	44.491	-55.05	5010	35691	0.14⊗
Miscellaneous	Sugarcane	17.438	-14.32	509	307.26	1.657⊗

⊗ significant at 5% level

Source : Estimated by the researcher.

greater than using sines for rice, ginger, turmeric, banana and sugarcane and for all others the reverse happens. Thus cyclical length was greater than cyclical height for crops like rice, ginger, turmeric, banana and sugarcane and cyclical length was lower than cyclical height for crops like coconut, tea, rubber, pepper, arecanut, cashewnut and tapioca. In the hypothesized 6 year cycle length, coefficients of cyclical peakness (Ap) was negative for rice, pepper, arecanut, banana and cashewnut and that of cyclical length (Bp) was negative for coconut, rubber, pepper, ginger, arecanut, banana, cashewnut, tapioca and sugarcane. Negative coefficients imply that they fall in the lower part of the cycle. Squared amplitude was greater than mean square amplitude for rice, oilseeds, rubber, pepper, arecanut, banana and sugarcane. Thus for these crops actual amplitude was greater than their average amplitude. For all other crops, the reverse happens. The production cycles of 6 years were found to be significant for all crops at 5% level using F-test. Hence, the observed ratio for a period of 6 years for production could have occurred by chance.

4.2.2. Agricultural Productivity

Table 4.7 presents Fourier coefficients, amplitude (squared), mean square amplitude and the ratio K of agricultural productivity. From the table it is visible that absolute value of Fourier coefficients using cosines was greater than the same coefficients using sines for crops like tea, pepper, ginger and banana. For all others the first was less than the second. Thus for most of the

Table 4.7

Fourier coefficients, amplitude (squared), mean square amplitude,and the ratio K for agricultural productivity (6 years) cycles

Category	Crops	Fourier Coefficients		Amplitude Squared Rp^2	Mean Square Amplitude Rm^2	Ratio K(= Rp/Rm)
		Ap	Bp			
Cereals	Rice	9.799	-17.11	388.7	1241.3	0.3132⊗
Oilseeds	Coconut	6.380	34.8	1252	10666	0.1173⊗
Plantation crops	Tea	27.880	2.730	784.8	1266.4	0.620⊗
	Rubber	25.410	-46.62	2819	2381.1	1.184⊗
Spices & condiments	Pepper	10.650	-0.600	113.8	29.864	3.809
	Ginger	138.24	-96.48	28419	22517	1.262⊗
	Arecanut	-7.400	-21.09	500	799	0.625⊗
	Turmeric	-22.41	-46.35	2651	8384	0.316⊗
Fruits& Vegetables	Banana	-425.1	96.960	190077	49877	3.811
	Tapioca	-22.07	45.710	2576	1968	1.309⊗
	Cashewnut	771.38	-1006	1607989	346446	4.641
Miscellaneous	Sugarcane	4453.2	-4549	40525760	6452275	6.281

⊗ significant at 5% level

Source : Estimated by the researcher.

selected crops (rice, coconut, rubber, arecanut, turmeric, cashewnut, tapioca and sugarcane) cyclical length was smaller than cyclical height. In the hypothesized 6-year cycle length, coefficients of cyclical peakness (Ap) was negative for arecanut, turmeric, banana and cashewnut. Similarly, coefficients of cyclical length (Bp) were negative for rice, rubber, pepper, ginger, arecanut, turmeric, tapioca and sugarcane. These crops having negative coefficients fall in the lower part of the cycle. Squared amplitude was greater than mean square amplitude for rubber, pepper, ginger, banana, cashewnut, tapioca and sugarcane. Here actual amplitude was greater than the average amplitude. For all others existing amplitude was smaller than mean amplitude. Productivity cycles of 6 years were found to be significant for cereals, oilseeds, plantation crops, spices and condiments (except pepper) and cashewnut. Hence, for these crops, the observed ratio for a period of 6 years could have occurred by chance. But for pepper, banana, tapioca and sugarcane F-test seems to be insignificant at 5% and 1% level. Therefore, our hypothesis of 6-year cycles of productivity was rejected for these 4 crops.

4.2.3. Farm Prices

Fourier coefficients, amplitude (squared), mean square amplitude and the ratio K for farm prices of agricultural commodities are presented in table 4.8. Table reveals that absolute value of Fourier coefficients using cosines was greater than those using sines for commodities like ginger and

Table 4.8

Fourier coefficients, amplitude (squared), mean square amplitude,and the ratio K for farm prices (6 years) cycles

Category	Crops	Fourier Coefficients		Amplitude Squared Rp^2	Mean Square Amplitude Rm^2	Ratio K(= Rp/Rm)
		Ap	Bp			
Cereals	Paddy	6.344	-26.28	730.604	570.341	1.4407⊗
Oilseeds	Coconut	-14.55	-126.8	16297.84	43142.9	0.378⊗
Spices &	Pepper	263.55	-277.5	146450.9	105306	1.3907⊗
condiments	Ginger	540.12	-118.0	305663.3	50515.9	6.051
	Arecanut	2.096	-12.83	168.958	370.604	0.456⊗
Fruits& Vegetables	Banana	3.807	-6.44	55.936	37.666	1.485⊗
	Tapioca	6.313	-10.95	159.664	140.964	1.133⊗
	Cashewnut	26.488	-147.1	22340.76	15129.4	1.477⊗
Miscellaneous	Sugarcane	26.106	-21.98	1164.629	589.887	1.974⊗

⊗ significant at 5% level

Source : Estimated by the researcher.

sugarcane. This implies that cyclical length was greater than cyclical height for these 2 crops and for others the reverse happens. In the hypothesized 6-year cycle length, coefficients of cyclical peakness (Ap) of coconut and cyclical lengths (Bp) of all crops were negative. Therefore, all crops had cycle lengths in the lower part of a cycle. Coconut had its cycle peakness too in the lower part of its cycle. Actual amplitudes of paddy, pepper, ginger, banana, tapioca, cashewnut and sugarcane were greater than their average amplitude which implies greater cycle amplitude for these 7 crops. But farm prices of coconut and arecanut have smaller amplitudes. Cycles of 6 years were found to be statistically significant for all crops except ginger. Therefore the hypothesized cycle length of 6 years can be accepted for the farm prices of paddy, pepper, coconut, arecanut, banana, tapioca, cashewnut and sugarcane. For ginger we can not accept the existence of 6-year cycle length.

4.2.4. Wholesale prices

Fourier coefficients, amplitude squared, mean square amplitude and the ratio K for wholesale prices of agricultural commodities are presented in table 4.9. Among the two Fourier coefficients, absolute value of cosine coefficients (Ap) was greater than that of sine's (Bp) for tea, rubber and ginger. For all others the opposite happens and thus their cyclical lengths were lower than cyclical heights. Cyclical length of all crops except that of turmeric lies in the upper part of the cycle. Similarly, cyclical peakness of all crops except that

Table 4.9

Fourier coefficients, amplitude (squared), mean square amplitude,and the ratio K for wholesale prices (6 years) cycles

Category	Crops	Fourier Coefficients		Amplitude Squared Rp^2	Mean Square Amplitude Rm^2	Ratio K (=Rp/Rm)
		Ap	Bp			
Oilseeds	Coconut	483.06	680.11	695897	39561.7	17.590
Plantation crops	Tea	2.330	-1.11	6.667	6.995	0.953⊗
	Rubber	180.90	124.6	48256	23660.24	2.039⊗
Spices & condiments	Pepper	379.61	-403.2	306695	82827.22	3.703
	Ginger	472.88	-182.9	257073	40671.86	6.321
	Turmeric	-56.34	-112.6	15960	13035.47	1.217⊗
	Arecanut	60.950	-135.6	22101	68359.78	0.3233⊗
Fruits& Vegetables	Banana	44.120	-65.54	6241.9	3426.683	1.822⊗
	Tapioca	4.970	-15.14	253.92	123.150	2.062⊗

`⊗ significant at 5% level

Source : Estimated by the researcher.

of coconut and rubber lies in the lower part of the cycle. Actual amplitude was greater than average amplitude for crops like coconut, rubber, pepper, ginger, turmeric, banana and tapioca. This implies that the amplitude of wholesale prices (except tea and arecanut) was greater compared to their mean amplitude. Cycles of 6 years were found to be significant for tea, rubber, turmeric, arecanut, banana and tapioca. We can not accept existence of 6-year cycles for the wholesale prices of coconut, pepper and ginger.

In nutshell, for most of the crops in our example, existence of 6-year cycle model was accepted.

4.3. Correlogram Analysis

In this part we distinguish moving averages, auto-regressive schemes and harmonic terms of cyclical series in the agricultural production, productivity and prices using correlogram analysis. Empirical results are given below.

4.3.1. Agricultural production

The calculated auto-correlation function with lag K (=0,1,2...35) of agricultural production is depicted in table 4.10.

Cereals

Correlogram analysis revealed that production swing of cereals was lowest during 1968-69 and highest during 1994-95. Cereal production had shown high fluctuation during middle years. Barlett test and Ljung-Box statistic showed that all auto-correlation coefficients were statistically significant. This favours significant swings in production series. Since the correlogram coefficients was continuously oscillating without any vanishing or dampening effects this series is harmonic in nature.

Oilseeds

The table implies that production swing of coconut was lowest during the earlier years and was increasing after 1989. Autocorrelation coefficients was lowest (indicating lower swings in production) during the period 1962-63 to 1963-64. Testing showed that all coefficients were significant and this series is also harmonic in nature.

Plantation crops

Production swings of tea and rubber were lower during earlier years and they increased after 1987. These swings were lowest in middle years and all auto-correlation coefficients were significant. Since correlogram is stagnant at some points for tea production its series is identified as semi-harmonic* type. But correlogram of rubber production reflects enough cyclical series and therefore its series is harmonic series.

* - By semi-harmonic series we meant the series oscillating cyclically throughout the lag-

Spices and condiments

Swings of pepper, ginger and arecanut production were smaller in the earlier years and greater in the later years. But that of turmeric was greater in the earlier years and smaller in the later years. During middle years all the 4 series had very low swings. Barlett test was significant for all these 4 series. LB statistic of pepper, ginger and arecanut were statistically significant but that of turmeric seems to be insignificant. Looking to the ups and downs of the series, production swings of pepper, ginger and arecanut follows semi-harmonic series and that of turmeric as auto-regressive type.

Fruits and vegetables

Production swings of banana was very little in the earlier years but it increased during 1976-77 to 1980-81 and 1989-90 to 1994-95. Cashewnut production swings was high in middle years. But that of tapioca was high in the first half of the selected period. Auto-correlation coefficients of banana were statistically significant by Barlett and LB statistic tests, but the latter test seems to be insignificant for both tapioca and cashewnut. Thus, cyclical swings of tapioca and cashewnut were significantly different from zero. Banana follows harmonic cycles and that of tapioca and cashewnut autoregressive cycles.

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length but at the some points they neither move upward nor downward. Here correlogram of tea production is same in the 7^{th} and 8^{th} lag length but on the whole the series is continuously oscillating without any dampening or vanishing effects. Hence we identified this series as semi-harmonic type.

Table 4.10

Sample Correlogram of Agricultural Production

K	Rice	Cocon	Tea	Rubbe	Pepper	Ginger	Arecan	Turmeri	Banana	Cashew	Tapioc	Sugar cane
1	0.0294	0.0129	0.0452	0.0365	0.0026	0.0502	0.0414	0.0855	(-)0.0175	0.0219	0.0834	0.0240
2	0.0225	0.0107	0.0338	0.0350	0.0049	0.0502	0.0336	0.0855	(-)0.0181	0.0080	0.0896	0.0149
3	0.0061	0.0104	0.0270	0.0327	0.0120	0.0502	0.0282	0.0855	0.0020	0.0032	0.0498	0.0053
4	0.0040	0.0110	0.0330	0.0299	0.0158	0.0502	0.0387	0.0532	0.0011	(-)0.000	0.0206	0.0033
5	0.0153	0.0103	0.0247	0.0269	0.0158	0.0502	0.0476	0.0130	(-)0.0001	0.0002	0.0099	0.0061
6	0.0258	0.0069	0.0111	0.0247	0.0102	0.0502	0.0279	0.0051	(-)0.000	0.0022	0.0025	(-)0.012
7	0.0074	0.0021	0.0130	0.0219	0.0065	0.0502	0.0138	0.0051	(-)0.0004	0.0107	(-)0.002	0.0042
8	-0.0180	(-)0.000	0.0130	0.0188	0.0065	0.0502	0.0040	0.0051	0.0012	0.0208	0.0055	0.0015
9	0.0147	0.0012	0.0182	0.0157	0.0077	0.0475	0.0011	0.0051	0.0034	0.0282	0.0101	0.0015
10	0.0080	0.0030	0.0315	0.0136	0.0120	0.0242	0.0003	-0.0020	0.0012	0.0447	0.0221	(-)0.006
11	0.0354	0.0043	0.0224	0.0117	0.0158	0.0089	0.0001	-0.0020	0.0001	0.0505	0.0384	0.0217
12	0.0578	0.0032	0.0156	0.0098	0.0158	0.0051	(-)0.000	0.0051	0.0000	0.0472	0.0803	0.0165
13	0.0268	(-)0.000	0.0043	0.0059	0.0102	0.0019	0.0004	-0.0020	(-)0.0000	0.0554	0.0906	(-)0.007
14	0.0212	0.0000	0.0006	0.0034	0.0077	0.0011	0.0013	-0.0020	0.0000	0.0675	0.0876	0.0058
15	0.0491	0.0001	0.0023	0.0025	0.0077	0.0006	(-)0.003	0.0130	0.0001	0.0874	0.0760	0.0045
16	0.0245	0.0057	0.0219	0.0014	0.0077	0.0006	0.0070	0.0532	0.0912	(-)0.032	0.0570	(-)0.005
17	0.0154	0.0135	(-)0.006	0.0011	0.0149	(-)0.001	0.0034	0.0209	0.1053	0.0136	0.0181	0.0178
18	0.0176	0.0175	0.0008	0.0019	0.0241	0.0014	0.0011	0.0051	0.0973	0.0186	0.0072	0.0250
19	0.0173	0.0180	0.0034	0.0018	0.0080	0.0014	0.0003	-0.0180	0.0955	0.0215	0.0053	(-)0.002
20	0.0186	0.0254	0.0127	0.0010	0.0011	0.0010	0.0001	0.0963	0.0187	0.0258	0.0041	-)0.0000
21	0.0261	0.0263	(-)0.002	0.0009	0.0008	0.0010	0.0003	0.0553	0.0026	0.0323	0.0011	-)0.0000
22	0.0352	0.0207	0.0006	0.0004	0.0024	0.0014	0.0003	0.0058	0.0044	0.0474	0.0005	0.0027
23	0.0071	0.0323	0.0017	0.0000	0.0083	0.0040	0.0021	0.0058	0.0080	0.0547	0.0014	0.3407
24	0.0044	0.0163	(-)0.015	(-)0.000	0.0251	0.0131	0.0180	0.0058	0.0023	0.0634	0.0004	(-)0.048
25	(-)0.000	0.0051	0.0065	0.0004	(-)0.007	0.0269	0.0062	0.0058	(-)0.0002	0.0536	(-)0.000	0.0062
26	0.0001	0.0103	(-)0.000	0.0017	0.0002	0.0339	0.0006	0.0223	0.00003	0.0159	0.0025	0.0082
27	0.0089	0.0017	(-)0.002	0.0041	0.0020	0.0296	(-)0.000	0.0223	0.0000	0.0146	0.0032	0.0089
28	0.0367	(-)0.001	0.0340	0.0079	0.0445	0.0316	0.0011	0.0206	0.0008	(-)0.026	0.0044	(-)0.008
29	0.0273	0.0161	0.0216	0.0164	0.0191	0.0362	0.0126	0.0191	0.0163	0.0198	0.0057	0.0086
30	0.0143	0.0264	0.0165	0.0313	0.0270	0.0404	0.0311	0.0176	0.0272	0.0112	0.0103	0.009
31	0.0162	0.0200	0.0700	0.0500	0.0724	0.0497	0.0288	0.0176	0.0424	0.0094	0.0159	0.0116
32	0.0166	0.0351	0.0336	0.0711	0.0852	0.0600	0.0384	0.0099	0.0441	(-)0.000	0.0192	-0.008
33	0.0247	0.1080	0.0334	0.0968	0.0823	0.0500	0.0877	0.0091	0.0505	0.0000	0.0221	0.0035
34	0.0585	0.1217	0.0979	0.1317	0.0921	0.0436	0.1409	0.0134	0.0777	0.0001	0.0233	0.0020
35	0.0760	0.1805	0.0868	0.1671	0.1397	0.0284	0.1854	0.0169	-0.0027	(-)0.000	0.0277	0.0008

Note : " 0.0000" and "(-)0.0000" denotes small values

Source : Estimated by the researcher.

Sugarcane

Swings in sugarcane production were very small in the years 1963-64 to 1970-71, 1973-74 to 1976-77, 1979-80 to 1982-83. Auto-correlation coefficients were statistically significant by Barlett and LB statistic tests and therefore its series is identified as auto-regressive series.

4.3.2. Agricultural productivity

The estimated auto-correlation function with lag K (= 0,1,2... 35) of agricultural productivity is presented in table 4.11. The table can be briefly explained as follows.

Cereals

In the table productivity swings of cereals were lowest during the middle years. Coefficients were high in later years indicating high swings. Barlett test and LB statistic test had shown that estimated auto-correlation coefficients were not significantly different from zero. Since correlogram was oscillating but was stagnant at some lags this series is identified as semi-harmonic in nature.

Oilseeds

Productivity swings of coconut was lower during 1962-63 to 1963-64. These swings were high during earlier, middle and upper quartiles.

Testing revealed that eventhough each coefficient was not significantly different from zero, there will be some non-zero coefficients in the series. Coconut productivity also follows semi-harmonic cycles.

Plantation crops

Productivity swings of both plantation crops (tea and rubber) was high in earlier and later years. But in middle years their swings was very low. Both tests revealed that all estimated auto-correlation coefficients were not equal to zero; atleast some of them were greater than zero. This reflects the fact that swings in the productivity of plantation crops were significant. The number of productivity swings of tea and rubber was very low and continuous and identified as semi-harmonic series.

Spices and condiments

There were regular ups and downs in the correlogram of pepper productivity. The highest swing was during 1984-85. For the correlogram of ginger productivity swings were constant in the early 7 years, low in the middle years and in arecanut productivity swings were low during 1961-62 to 1964-65 and 1977-78 to 1986-87. Ups in turmeric productivity were smaller during 1970-71 to 1976-77. Thus productivity swings of spices and condiments were different for different crops. Testing of correlogram indicates that ginger, arecanut and turmeric productivity coefficients were significantly different from zero but those for pepper lead us to the acceptance of null hypothesis. Ups and downs of the estimated coefficients favour pepper, ginger and arecanut as semi-harmonic series and turmeric as auto-regressive series.

Table 4.11

Sample Correlogram of Agricultural Productivity

K	Rice	Coconu	Tea	Rubbe	Peppe	Ginger	Arecan	Turmeri	Banana	Cashev	Tapioc	Sugar cane
1	0.0410	0.0909	0.0426	0.0813	0.0221	0.0577	0.0073	0.0860	0.0112	0.1474	0.1787	0.0395
2	0.0427	(-)0.147	0.0408	0.0761	0.0013	0.0577	0.0039	0.0860	0.0135	0.0455	0.1791	0.0307
3	0.0317	(-)0.095	0.0352	0.0657	(-)0.000	0.0577	0.0023	0.0860	0.0119	0.0142	0.0776	0.0270
4	0.0268	0.0318	0.0404	0.0537	0.0098	0.0577	0.0094	0.0682	0.0051	0.0151	0.0232	0.0316
5	0.0477	0.0174	0.0321	0.0408	0.0110	0.0577	0.0312	0.0258	0.0046	0.0160	0.0146	0.0287
6	0.0574	0.0111	0.0198	0.0329	0.0163	0.0577	0.0307	0.0123	0.0095	0.0163	0.0108	(-)0.001
7	0.0349	0.0111	0.0214	0.0254	0.0255	0.0577	0.0318	0.0123	0.0108	0.0168	0.0080	0.0001
8	0.0135	0.0105	0.0242	0.0182	0.0255	0.0540	0.0301	0.0123	0.0108	0.0167	0.0089	0.0006
9	0.0132	0.0096	0.0282	0.0112	0.0295	0.0505	0.0300	0.0123	0.0092	0.0163	0.0006	0.0007
10	0.0171	0.0084	0.0273	0.0078	0.0300	0.0228	0.0323	0.0039	0.0096	0.0161	0.0000	(-)0.003
11	0.0050	0.0077	0.0176	0.0056	0.0234	0.0056	0.0341	0.0039	0.0101	0.0159	(-)0.000	0.0181
12	0.0014	0.0018	0.0139	0.0041	0.0219	0.0021	0.0337	0.0123	0.0112	0.0155	0.0123	0.0140
13	0.0038	(-)0.001	0.0071	(-)0.001	0.0019	(-)0.000	0.0327	0.0039	0.0111	0.0161	0.0159	0.0109
14	0.0102	0.0024	0.0026	0.0011	0.0009	(-)0.000	0.0336	0.0039	0.0108	0.0166	0.0102	0.0068
15	0.0040	0.0025	0.0059	0.0021	0.0034	(-)0.000	0.0321	(-)0.004	(-)0.034	0.0160	0.0022	0.0031
16	0.0059	0.0044	0.0165	0.0047	0.0048	0.0015	0.0162	(-)0.004	0.1346	(-)0.011	(-)0.000	0.0011
17	0.0059	0.0134	(-)0.005	0.0040	0.0226	0.0032	(-)0.002	0.0123	0.1671	0.0146	0.0001	0.0018
18	0.0011	0.0104	0.0012	(-)0.000	(-)0.010	0.0027	0.0008	0.0123	0.1460	0.0298	0.0043	0.0049
19	(-)0.000	0.0098	0.0038	(-)0.000	0.0027	0.0027	0.0025	(-)0.012	0.1231	0.0386	0.0034	(-)0.000
20	(-)0.000	0.0218	0.0104	0.0003	0.0098	0.0020	0.0044	0.0223	0.0106	0.0433	(-)0.002	(-)0.000
21	(-)0.000	0.0239	(-)0.001	(-)0.000	0.0157	0.0020	0.0034	0.0368	0.0006	0.0463	(-)0.001	0.0000
22	0.0021	0.0175	(-)0.000	0.0000	0.0011	0.0027	0.0034	0.0174	0.0018	0.0525	(-)0.001	(-)0.001
23	0.0009	0.0356	(-)0.000	0.0000	(-)0.001	0.0027	(-)0.006	0.0174	0.0042	0.0566	0.0020	0.2457
24	0.0015	0.0124	(-)0.007	(-)0.000	0.0605	0.0061	(-)0.000	0.0174	0.0014	0.0575	0.0023	(-)0.039
25	0.0083	0.0035	0.0110	0.0000	(-)0.061	0.0146	0.0004	0.0174	(-)0.000	0.0518	(-)0.001	0.0057
26	0.0073	0.0152	0.0012	0.0006	(-)0.000	0.0147	0.0083	0.0368	0.0010	0.0340	(-)0.001	0.0074
27	0.0067	0.0368	0.0026	0.0019	(-)0.000	0.0160	0.0126	0.0368	0.0001	0.0250	0.0047	0.0079
28	0.0093	0.0010	0.0396	0.0041	0.0477	0.0223	0.0152	0.0349	0.0011	0.0049	0.0112	(-)0.006
29	0.0208	-)0.000	0.0286	0.0105	(-)0.009	0.0342	0.0323	0.0331	0.0070	0.0011	0.0192	0.0039
30	0.0511	0.0006	0.0229	0.0218	(-)0.012	0.0362	0.0537	0.0349	0.0077	0.0007	0.0222	0.004
31	0.0722	(-)0.002	0.0689	0.0325	0.0415	0.0387	0.0488	0.0389	0.0112	(-)0.000	0.0233	0.0065
32	0.0885	(-)0.007	0.0397	0.0496	0.0338	0.0395	0.0662	0.0366	0.0132	(-)0.000	0.0269	0.008
33	0.0931	0.0273	0.0387	0.0689	0.0232	0.0388	0.1032	0.0110	0.0144	0.0016	0.0318	0.0221
34	0.0692	0.0263	0.0876	0.1002	0.0139	0.0441	0.1097	0.0027	0.0184	(-)0.000	0.0586	0.0615
35	0.0776	0.0309	0.0777	0.1370	0.0342	0.0561	0.0668	0.0073	(-)0.035	(-)0.000	0.0646	0.0594

Note : " 0.0000" and "(-)0.0000" denotes small values

Source : Estimated by the researcher.

Fruits and vegetables

While the swings were greater and smaller regularly in both banana and tapioca that of cashewnut productivity was greater in earlier years and smaller in the later years. Tests reveal that estimated auto-correlation coefficients of tapioca and banana were significantly different from zero but that of cashewnut was not. Banana and tapioca series had semi-harmonic cycles and that of cashewnut was autoregressive in nature.

Sugarcane

Swings in the productivity of sugarcane were small during 1966-67 to 1971-72, 1979-80 to 1983-84 and 1988-89. Eventhough all the estimated auto-correlation coefficients lie in the accepted confidence interval of Barlett test, we have to reject the null hypothesis of LB statistic test. Thus all the estimated coefficients were significantly different from zero. This series is identified as semi-harmonic in nature.

4.3.3. Farm Prices

Estimated auto-correlation function with lag K (=0,1,2,3,...., 35) of farm prices is presented in table 4.12. Correlogram analysis is explained below with the help of this table.

Cereals

Swings of cereal farm prices were very low during middle years. Coefficients were negative 14th, 16th and 23rd lags indicating periods of negative swings. Testing also shows significant price swings of cereal prices and its series is harmonic type.

Oilseeds

Prices of coconut were oscillating and its swings were low in middle period. Sample correlogram was negative only with 23rd lag. But testing reveals that coefficients were not all significantly different from zero. The series is identified as semi-harmonic series.

Spices and condiments

Prices of spices and condiments (pepper, ginger and arecanut) were continuously oscillating with small ups and downs. But their swings were high in the later lags. Pepper swings were negative in 24th lag while ginger in 17th, 18th, 22nd, 26th and 27th lags and arecanut in 24th, 27th and 28th lags. Both tests were favourable to ginger and arecanut but price swings of pepper were not significant. Ginger and arecanut follows semi-harmonic cycles and pepper follows harmonic cycles.

Fruits and vegetables

Like cereals and oilseeds the farm prices of fruits and vegetables (banana, cashewnut and tapioca) were also oscillating with low swings in the middle period. All coefficients were significant and show that swings were negative in 22nd lag for banana, in 21st, 22nd and 24th lags for cashewnut and in 23rd lag for tapioca. In all other lags price swings were greater than zero. Since the coefficients were neither vanishing nor dampening,

Table 4.12

Sample Correlogram of Farm Prices

K	Paddy	Coconut	Pepper	Ginger	Arecanu	Banana	Cashewi	Tapioca	Sugarc
0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1	0.0436	0.0301	0.0185	0.0212	0.0140	0.0333	0.0217	0.0231	0.0295
2	0.0430	0.0295	0.0214	0.0208	0.0119	0.0318	0.0219	0.0223	0.0274
3	0.0436	0.0285	0.0228	0.0185	0.0122	0.0307	0.0226	0.0224	0.0257
4	0.0403	0.0285	0.0223	0.0157	0.0133	0.0293	0.0223	0.0218	0.0239
5	0.0299	0.0260	0.0208	0.0149	0.0108	0.0274	0.0213	0.0178	0.0220
6	0.0209	0.0230	0.0189	0.0162	0.0108	0.0254	0.0202	0.0163	0.0212
7	0.0126	0.0215	0.0202	0.0167	0.0116	0.0226	0.0195	0.0167	0.0201
8	0.0094	0.0204	0.0209	0.0144	0.0111	0.0184	0.0186	0.0141	0.0166
9	0.0123	0.0204	0.0196	0.0081	0.0107	0.0178	0.0179	0.0140	0.0145
10	0.0159	0.0170	0.0159	0.0079	0.0098	0.0173	0.0172	0.0153	0.0145
11	0.0177	0.0161	0.0140	0.0123	0.0103	0.0173	0.0167	0.0144	0.0138
12	0.0155	0.0192	0.0153	0.0146	0.0122	0.0163	0.0161	0.0132	0.0119
13	0.0047	0.0143	0.0154	0.0148	0.0135	0.0133	0.0139	0.0103	0.0105
14	-0.0021	0.0069	0.0102	0.0092	0.0128	0.0099	0.0096	0.0066	0.0080
15	0.0035	0.0067	0.0064	0.0070	0.0118	0.0063	0.0086	0.0049	0.0077
16	-0.0030	0.0084	0.0034	0.0008	0.0096	0.0034	0.0104	0.0046	0.0062
17	0.0031	0.0058	0.0012	0.000	0.0086	0.0027	0.0044	0.0060	0.0044
18	0.0065	0.0033	0.0006	0.000	0.0091	0.0025	0.0014	0.0079	0.0038
19	0.0073	0.0026	0.0009	0.0025	0.0063	0.0015	0.0023	0.0061	0.0035
20	0.0060	0.0006	0.0023	0.0113	0.0037	0.0007	0.0018	0.0041	0.0025
21	0.0012	0.0003	0.0035	0.0073	0.0014	0.0001	-0.0006	0.0038	-0.0009
22	0.0002	0.0005	0.0045	0.000	0.0007	-0.000036	-0.0001	0.0013	0.0003
23	-0.0008	-0.0011	0.0038	0.0001	0.0009	0.0010	0.0001	-0.0005	0.0002
24	0.0033	0.0117	-0.001	0.0298	-0.002	0.0046	-0.0016	0.0001	-0.0001
25	0.0025	0.0109	0.0041	0.0086	0.0003	0.0072	0.0014	0.0001	-0.0002
26	0.0033	0.0035	0.0462	-0.002	0.0002	0.0116	0.0034	0.0014	0.0032
27	0.0056	0.0128	0.0897	-0.001	0.000	0.0170	0.0180	0.0098	0.0089
28	0.0095	0.0351	0.0525	0.0011	0.000	0.0143	0.0189	0.0093	0.0158
29	0.0183	0.0209	0.0366	0.0042	0.0012	0.0125	0.0133	0.0122	0.0275
30	0.0204	0.0154	0.0245	0.0175	0.0051	0.0207	0.0160	0.0316	0.0409
31	0.0244	0.0453	0.0146	0.0275	0.0501	0.0309	0.0241	0.0511	0.0654
32	0.0583	0.1171	0.0104	0.0229	0.1186	0.0428	0.0657	0.0663	0.0600
33	0.0945	0.1332	0.0090	0.0253	0.1507	0.0719	0.1161	0.1033	0.0336
34	0.1090	0.0804	0.0374	0.0606	0.1474	0.1269	0.1229	0.1319	0.0634
35	0.1614	0.0613	0.1648	0.2349	0.1674	0.1807	0.1668	0.1724	0.2052

Note : " 0.0000" and "(-)0.0000" denotes small values

Source : Estimated by the researcher.

cashewnut price series follows the features of harmonic series and banana and tapioca follows semi-harmonic series.

Sugarcane

Sugarcane price swings were high in the first and last periods but was very low (and even negative in some lags) during middle years. Barlett test and LB statistic reveals that price swings were significant. This series also follows semi-harmonic features.

4.3.4. Wholesale Prices

The estimated auto-correlation function with lag K (= 0,1,2,3... 35) of wholesale prices of agricultural commodities was depicted in table 4.13. The table can be explained as follows.

Oilseeds

The table reveals that price swings of coconut was high during earlier and later years. During middle years its swings was very low. It satisfies Barlett test. Also LB statistic test follows the fact that price swings were significant. This series follows the properties of harmonic cycles.

Plantation crops

As in the case of coconut, here also price swings of rubber and tea were high in the earlier and later years and very low in the middle years. Price swing of tea was negative in 23^{rd} lag and that of rubber 21^{st} lag. Both crops satisfy Barlett test but the coefficient of LB statistic leads to the rejection of our null hypothesis. Therefore all the estimated auto-correlation coefficients were not

Table 4.13

Sample Correlogram of Wholesale Prices

K	Coconut	Tea	Rubber	Pepper	Ginger	Arecanut	Turmeri	Banana	Tapioca
1	0.0309	0.0215	0.0230	0.0172	0.0236	0.0115	0.0185	0.0322	0.0249
2	0.0304	0.0236	0.0242	0.0202	0.0234	0.0107	0.0172	0.0304	0.0247
3	0.0296	0.0233	0.0247	0.0218	0.0219	0.0110	0.0165	0.0291	0.0006
4	0.0293	0.0220	0.0246	0.0213	0.0189	0.0115	0.0167	0.0280	0.0006
5	0.0211	0.0220	0.0235	0.0195	0.0177	0.0099	0.0181	0.0262	0.0204
6	0.0153	0.0226	0.0171	0.0187	0.0189	0.0102	0.0202	0.0240	0.0180
7	0.0178	0.0230	0.0165	0.0194	0.0197	0.0111	0.0183	0.0216	0.0184
8	0.0212	0.0223	0.0203	0.0201	0.0180	0.0109	0.0123	0.0188	0.0157
9	0.0219	0.0209	0.0165	0.0190	0.0107	0.0104	0.0049	0.0173	0.0158
10	0.0183	0.0169	0.0153	0.0150	0.0042	0.0096	0.0024	0.0179	0.0172
11	0.0180	0.0168	0.0175	0.0126	0.0061	0.0099	0.0062	0.0181	0.0164
12	0.0156	0.0195	0.0179	0.0139	0.0169	0.0116	0.0161	0.0162	0.0151
13	0.0076	0.0188	0.0166	0.0141	0.0174	0.0123	0.0116	0.0126	0.0117
14	0.0072	0.0148	0.0091	0.0090	0.0110	0.0113	0.0077	0.0095	0.0087
15	0.0096	0.0097	0.0051	0.0053	0.0073	0.0109	0.0074	0.0058	0.0083
16	0.0087	0.0073	0.0072	0.0029	0.0021	0.0090	0.0080	0.0037	0.0058
17	0.0066	0.0019	0.0103	0.0006	(-)0.000	0.0086	0.0033	0.0046	0.0081
18	0.0041	0.0010	0.0057	0.0002	(-)0.000	0.0090	(-)0.000	0.0050	0.0097
19	0.0037	0.0024	0.0018	0.0005	0.0032	0.0070	(-)0.000	0.0037	0.0076
20	0.0010	0.0024	0.0003	0.0016	0.0127	0.0049	0.0038	0.0027	0.0054
21	0.0004	0.0019	(-)0.000	0.0025	0.0082	0.0034	0.0101	0.0011	0.0039
22	0.0000	0.0009	0.0012	0.0034	(-)0.001	0.0023	0.0042	(-)0.000	0.0004
23	(-)0.0000	(-)0.0010	0.0032	0.0028	0.0040	0.0004	(-)0.002	0.0013	(-)0.00003
24	0.0010	0.0054	0.0085	0.0016	0.0147	0.00002	0.0045	0.0099	0.0001
25	0.0031	0.0049	0.0087	(-)0.000	0.0084	0.00003	0.0053	0.0111	0.0009
26	0.0102	0.0054	0.0087	0.0033	0.0061	(-)0.000	0.0063	0.01380	0.0032
27	0.0248	0.0060	0.0086	0.0571	0.0023	0.00002	0.0066	0.0159	0.0091
28	0.0376	0.0059	0.0092	0.0626	0.0027	0.0001	0.0071	0.0141	0.0100
29	0.0231	0.0161	0.0138	0.0447	0.0092	0.0017	0.0053	0.0152	0.0124
30	0.0172	0.0662	0.0220	0.0317	0.0205	0.0122	0.0073	0.0251	0.0344
31	0.0491	0.0877	0.0219	0.0196	0.0302	0.0629	0.0021	0.0344	0.0446
32	0.1191	0.0809	0.0281	0.0140	0.0245	0.1559	0.0124	0.0468	0.0614
33	0.1397	0.1007	0.0436	0.0123	0.0268	0.1259	0.2290	0.0749	0.1061
34	0.0917	0.1032	0.0644	0.0468	0.0589	0.1199	0.0853	0.1282	0.1321
35	0.0713	0.1031	0.1863	0.1887	0.2160	0.1710	0.0607	0.1662	0.1678

Note : " 0.0000" and "(-)0.0000" denotes small values

Source : Estimated by the researcher.

zero, atleast some of them were non-zeroes (i.e. swings were significant). Tea and rubber follow the characteristics of semi-harmonic.

Spices and condiments

Table reveals that price swings of pepper, ginger, arecanut and turmeric was high during earlier and later years and was low during middle years. Swings were negative in some years (25^{th} lag for pepper, 17^{th}, 18^{th} and 22^{nd} lag for ginger, 26^{th} lag for arecanut and 18^{th}, 19^{th} and 23^{rd} lag for turmeric. All the 4 crops satisfy Barlett test. LB statistic test reveals that all the coefficients were not zeroes, some of them were non-zeroes. Pepper and arecanut follows harmonic and ginger and turmeric follows semi-harmonic cycles.

Fruits and vegetables

Price swings of tapioca and banana were high compared to other price swings. Swings were high in earlier and later years and were low in the middle years. Swings of tapioca were negative in 23^{rd} lag and that of banana was negative in 22^{nd} lag. Both satisfy Barlett test. LB statistic showed that all estimated auto-correlation coefficients were not zeroes. Tapioca price series follow the characteristics of semi-harmonic cycles and banana series follow harmonic feature.

To see the uniformity of sample correlogram of production, productivity and prices we compared them using figures 4.13 to 4.24. Figures reveal that most of the sample correlogram curves have greater height towards the ending of their lag length. Ups and downs of the curves of each commodity

Figure 4.13

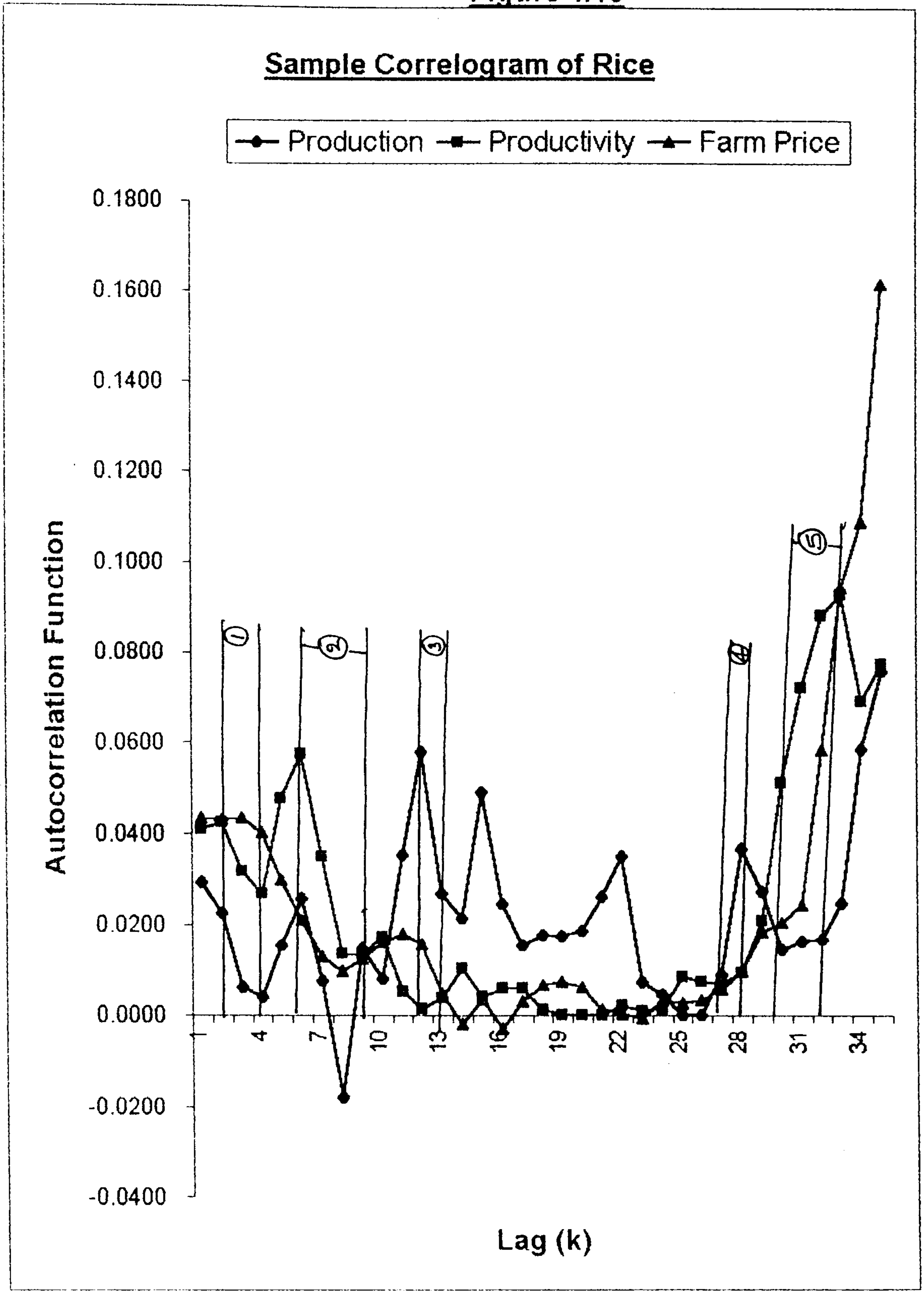

Sample Correlogram of Rice
Production
Productivity
Farm Price
0.1800
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
-0.0200
-0.0400
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.14

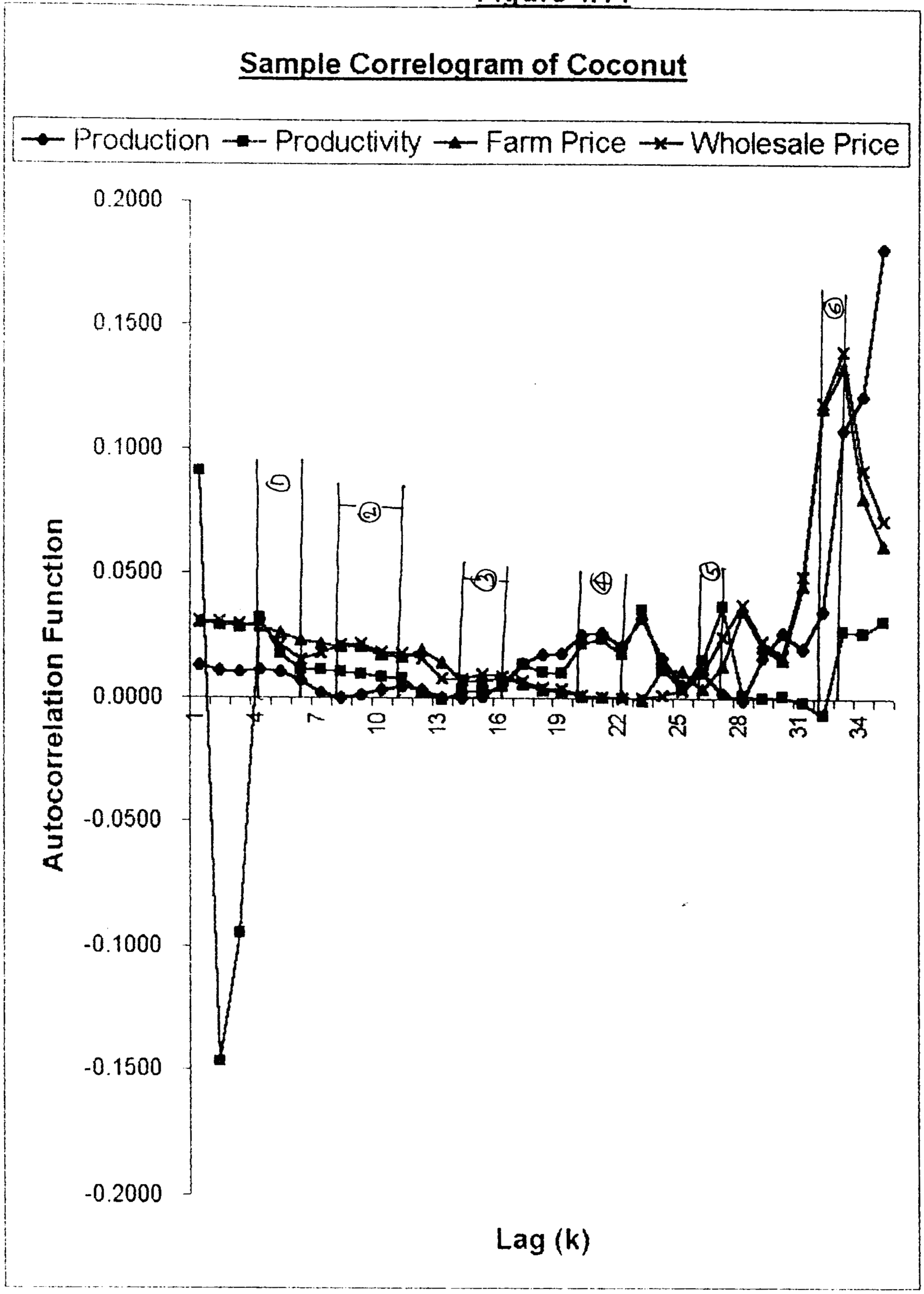

Sample Correlogram of Coconut
Production
Productivity
Farm Price
Wholesale Price
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
-0.1000
-0.1500
-0.2000
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.15

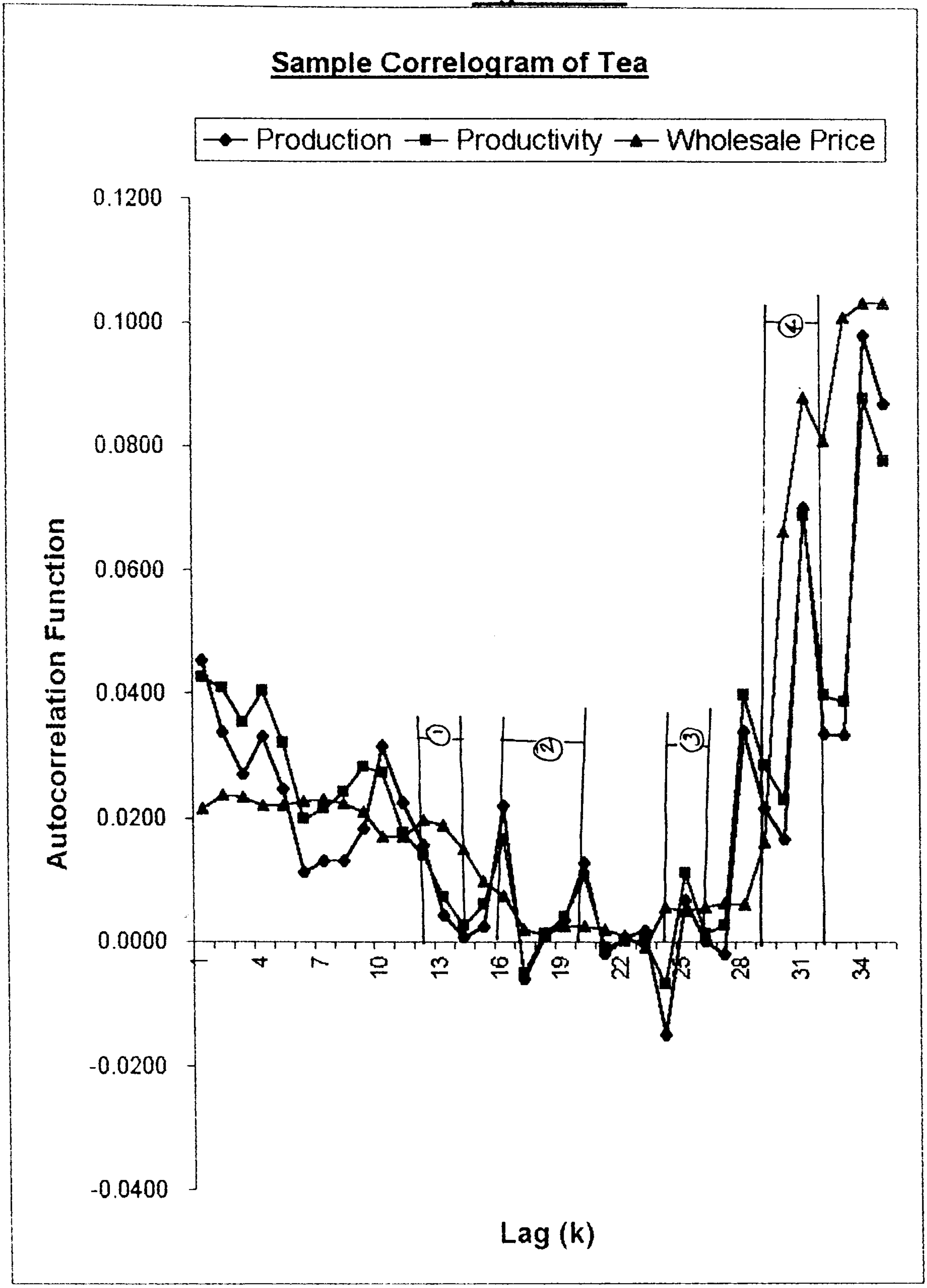

Sample Correlogram of Tea
Production
Productivity
Wholesale Price
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
-0.0200
-0.0400
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.16

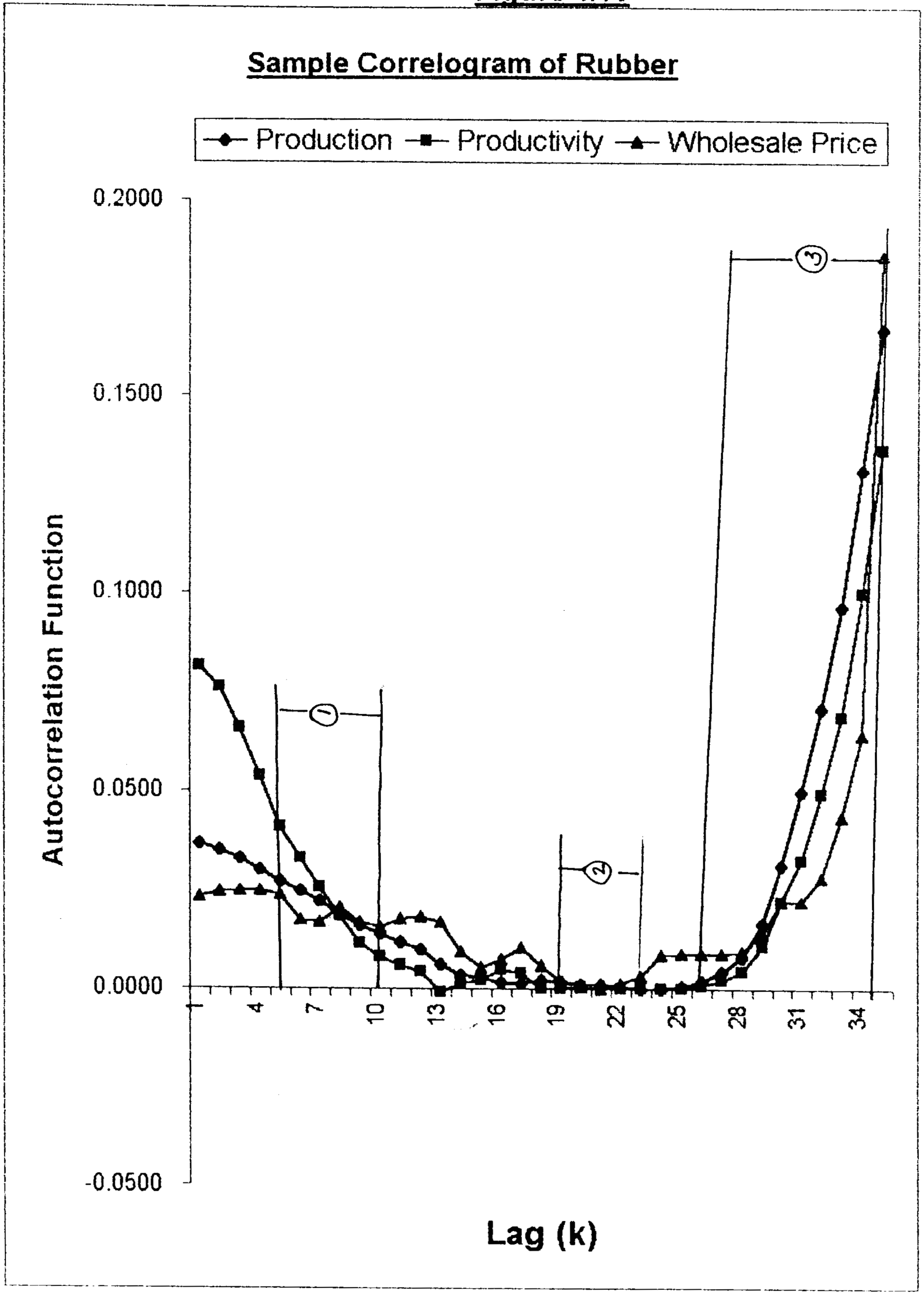

Sample Correlogram of Rubber
Production
Productivity
Wholesale Price
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.17

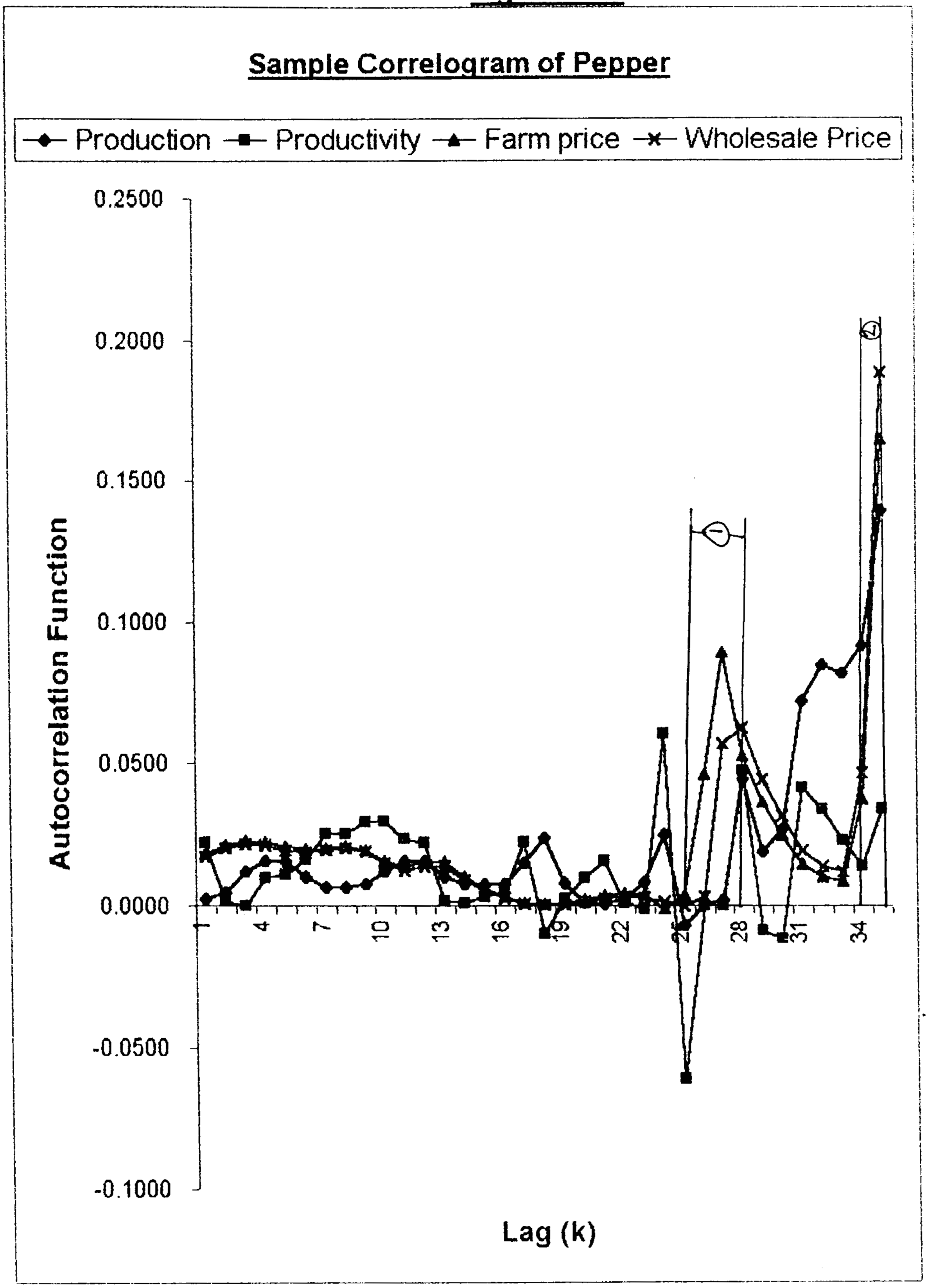

Sample Correlogram of Pepper
Production
Productivity
Farm price
Wholesale Price
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
-0.1000
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.18

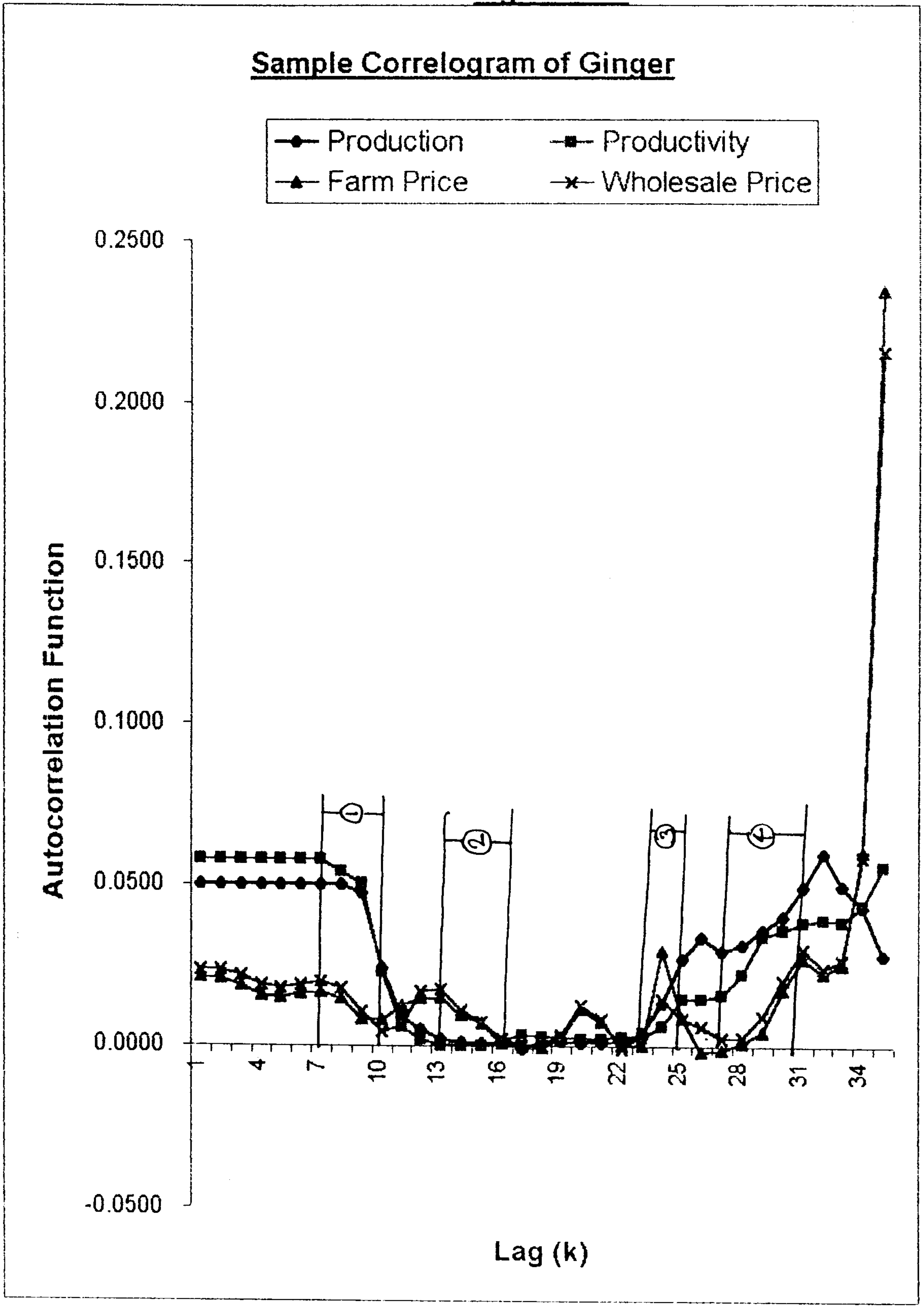

Sample Correlogram of Ginger
Production
Productivity
Farm Price
Wholesale Price
Autocorrelation Function
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.19

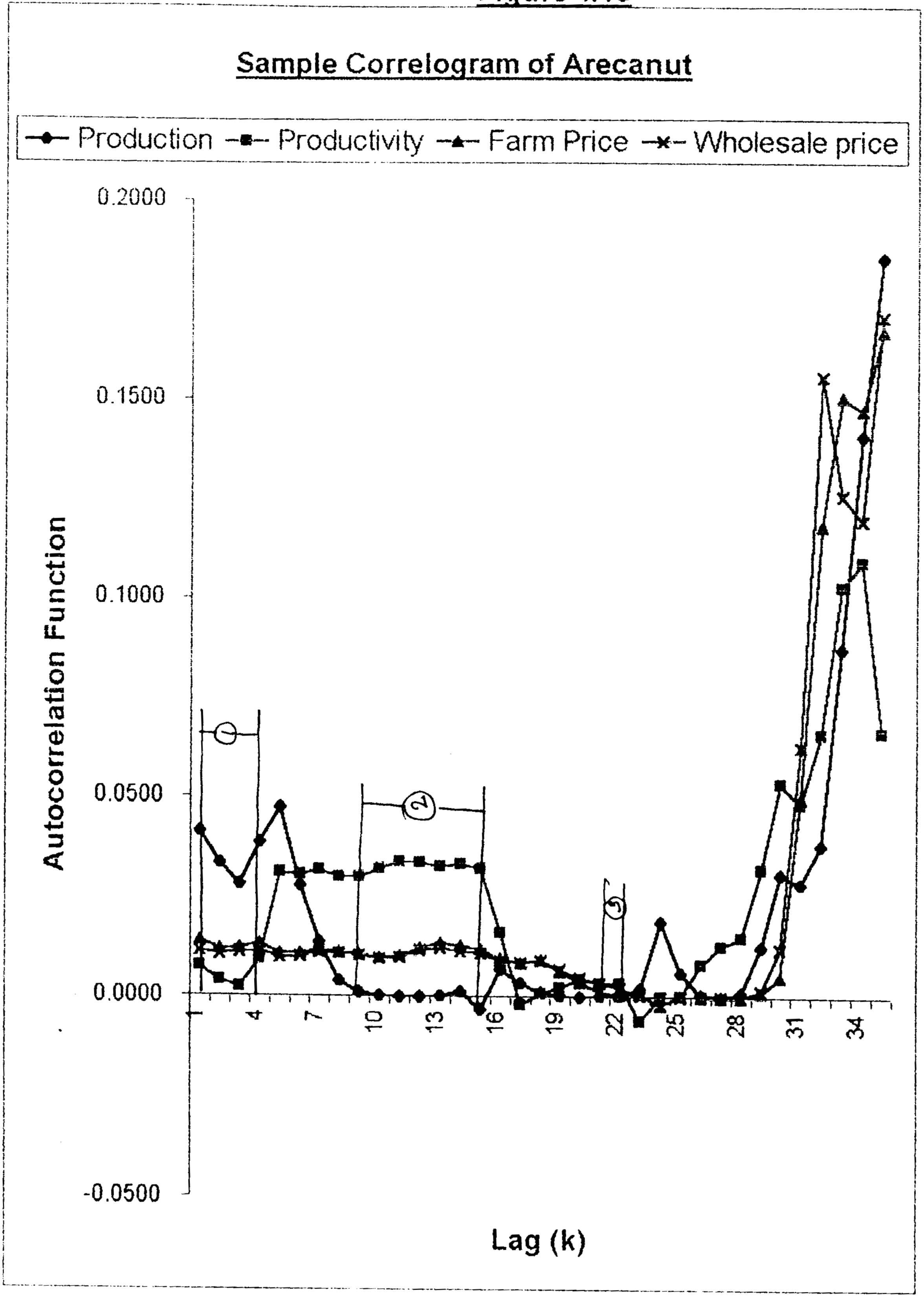

Sample Correlogram of Arecanut
Production
Productivity
Farm Price
Wholesale price
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.20

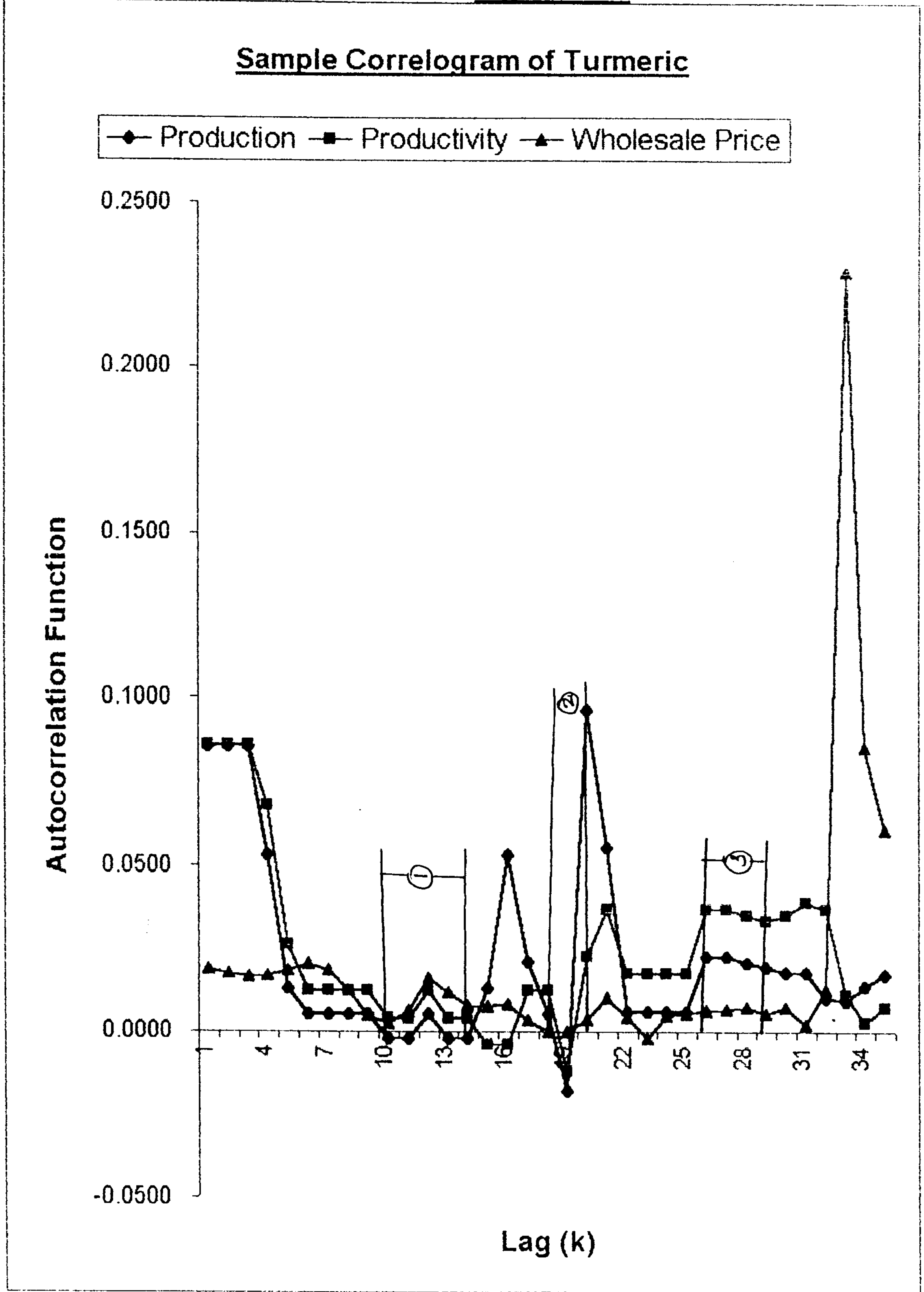

Sample Correlogram of Turmeric
Production
Productivity
Wholesale Price
Autocorrelation Function
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.21

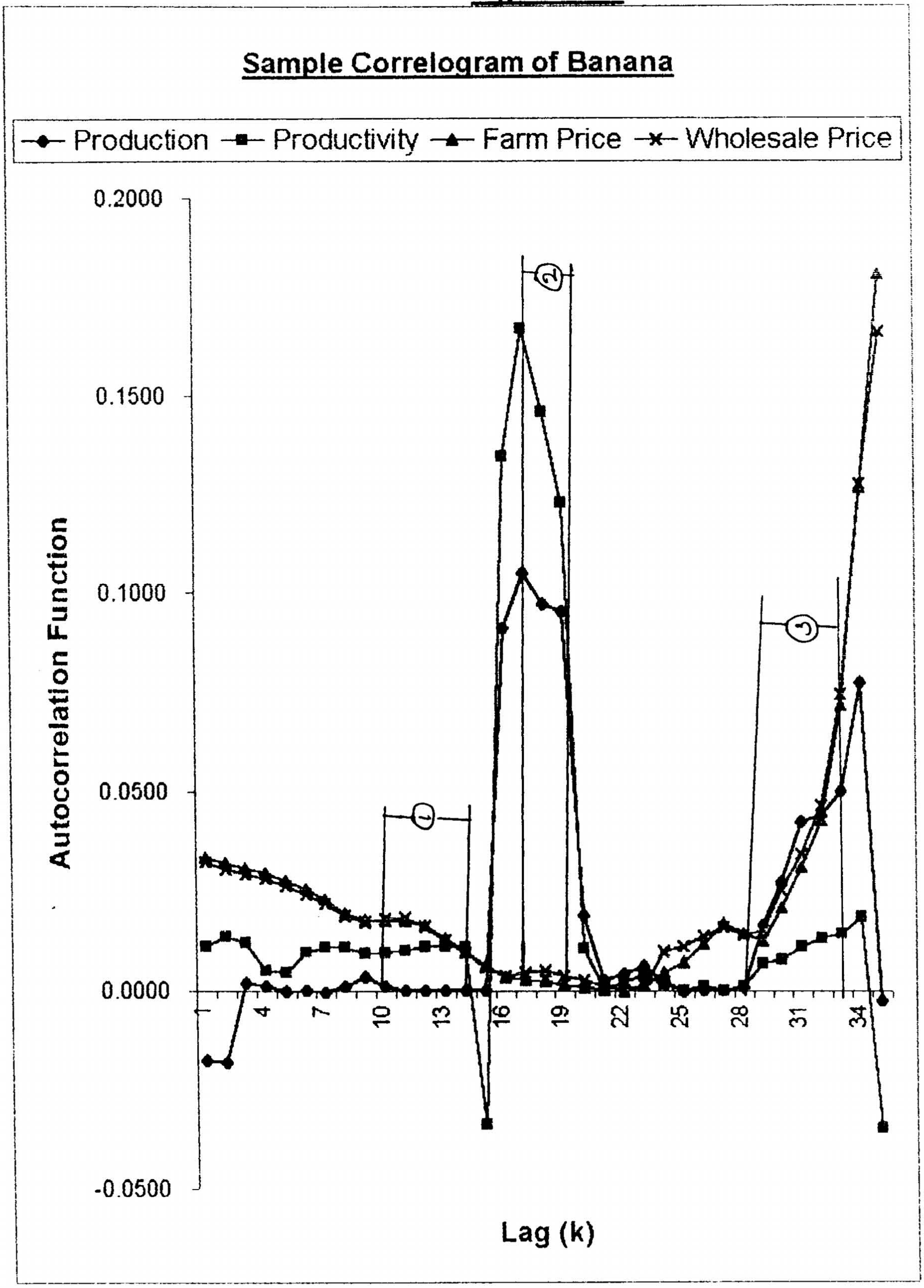

Sample Correlogram of Banana
Production
Productivity
Farm Price
Wholesale Price
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.22

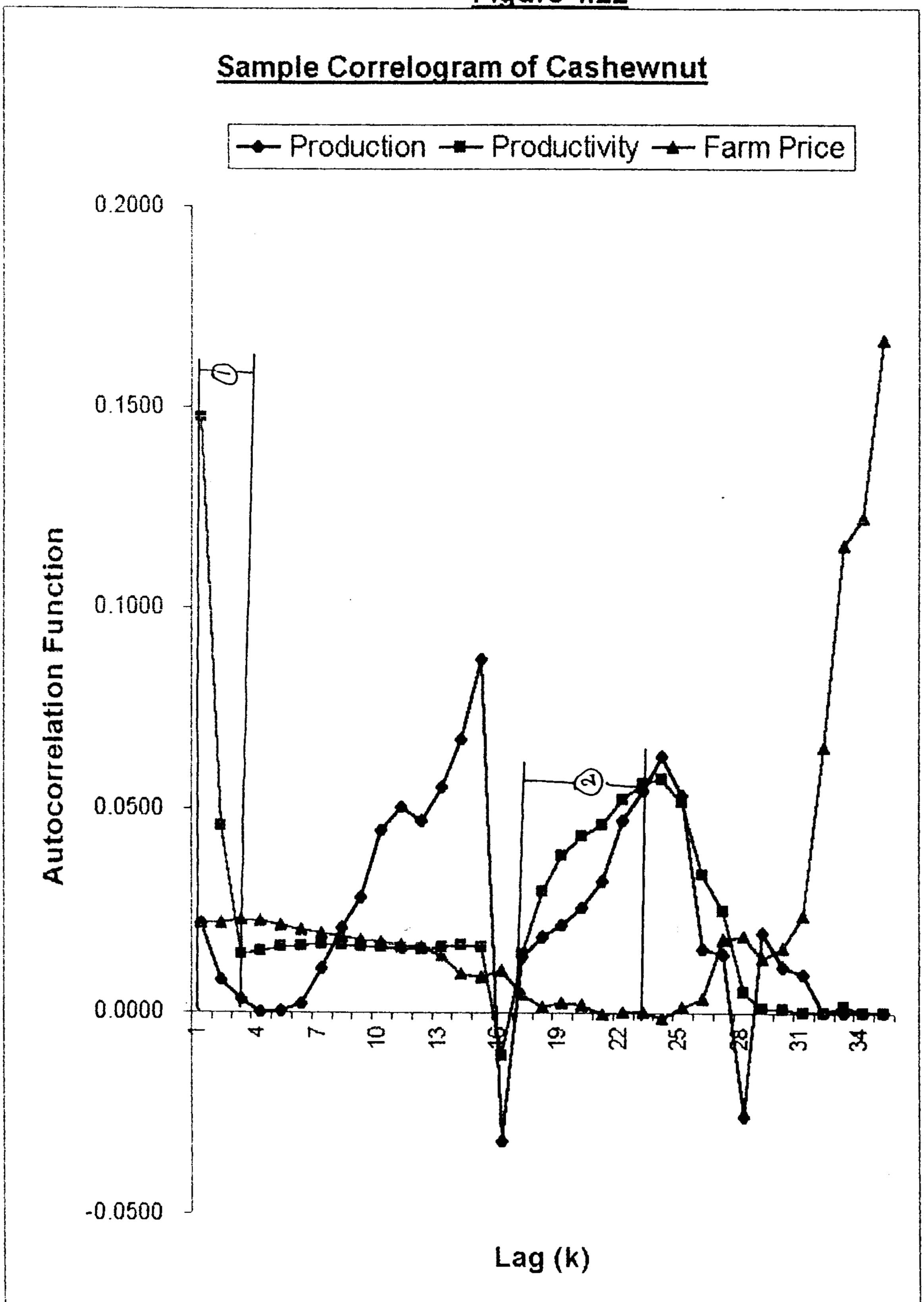
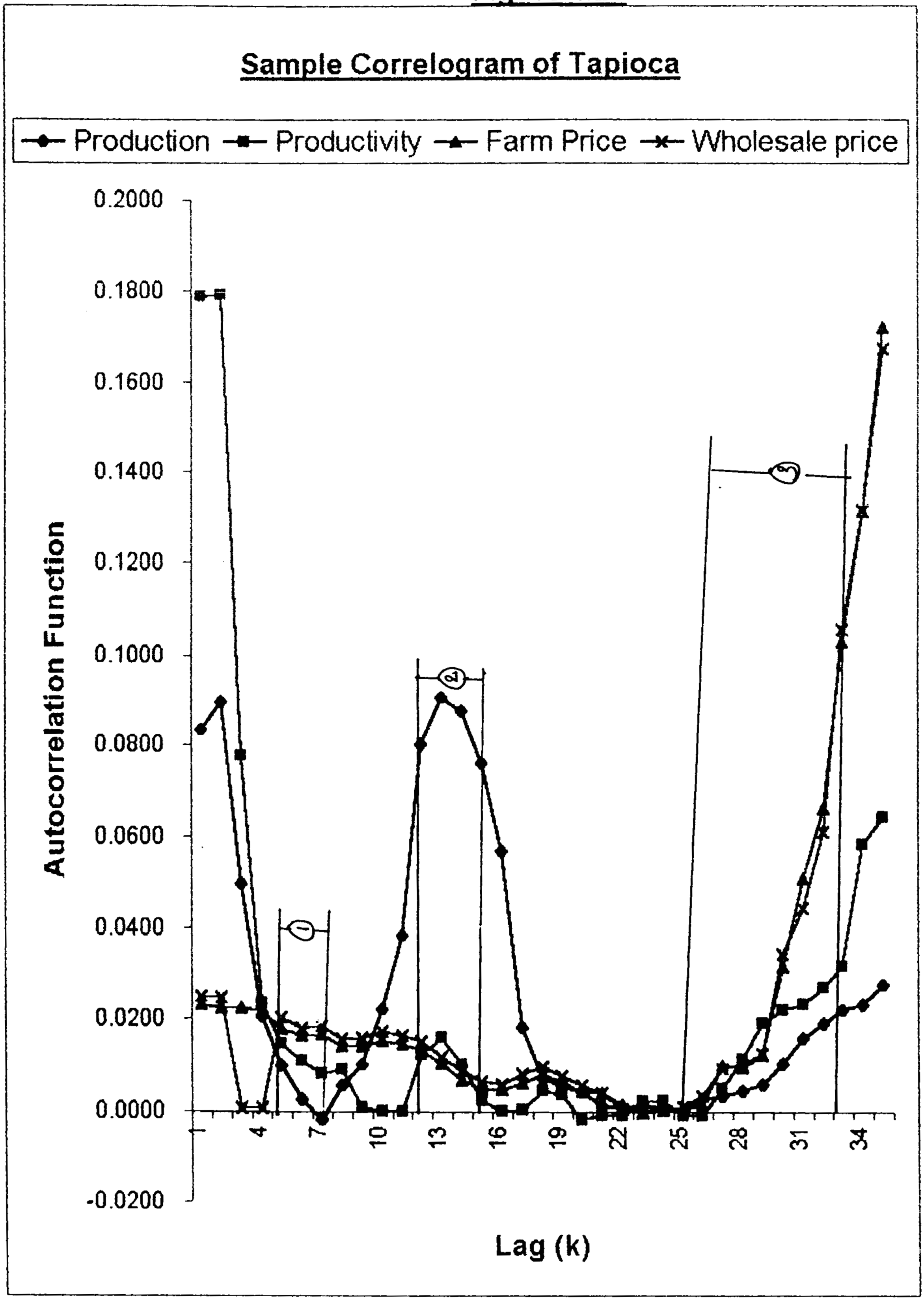

Sample Correlogram of Cashewnut
Production
Productivity
Farm Price
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

Figure 4.23


Sample Correlogram of Tapioca
Production
Productivity
Farm Price
Wholesale price
0.2000
0.1800
0.1600
0.1400
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
-0.0200
Autocorrelation Function
1
4
7
10
13
16
19
22
25
28
31
34
Lag (k)
1
2
3

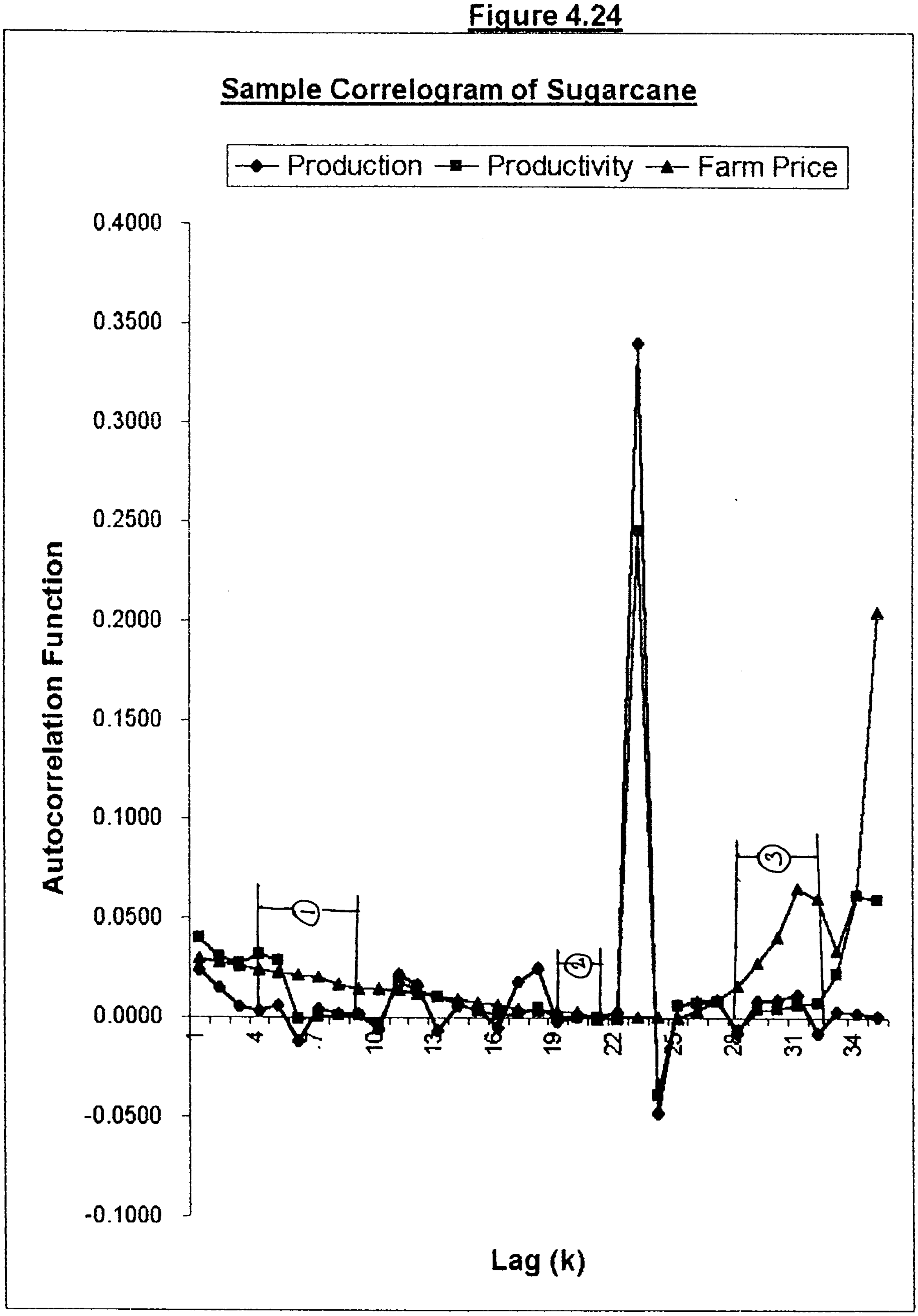


Figure 4.24
Sample Correlogram of Sugarcane
Production
Productivity
Farm Price
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
-0.0500
-0.1000
Autocorrelation Function
4
7
10
13
16
19
22
25
28
31
34
Lag (k)

were similar in most of the points and some of these points are marked by numbers. Thus movements of sample correlogram curves are another example of close relationships between production, productivity and prices of agricultural commodities of Kerala.

Conclusion

It is clear form the above analysis that cyclical fluctuations of agricultural commodities were a regular phenomenon in agricultural production, productivity and prices. These cyclical series can be categorised as in table 4.14.

Table 4.14

Type of cyclical series of agricultural commodities

Commodities	Production	Productivity	Farm prices	Wholesale prices
Rice	HS	SHS	HS	-
Coconut	HS	SHS	SHS	HS
Tea	SHS	SHS	-	SHS
Rubber	HS	SHS	-	SHS
Pepper	SHS	SHS	HS	HS
Ginger	SHS	SHS	SHS	SHS
Arecanut	SHS	SHS	SHS	HS
Turmeric	AR	AR	-	SHS
Banana	HS	SHS	SHS	HS
Cashewnut	AR	AR	HS	-
Tapioca	AR	SHS	SHS	SHS
Sugarcane	AR	SHS	SHS	-

AS – Auto-regressive series, HS – Harmonic series
SHS – Semi-Harmonic series
"-" - Denotes commodities not included in this study.
Source: Estimated by the researcher.

We observed that cyclical series existed in agriculture were mainly harmonic, semi-harmonic and autoregressive types. This leads us to the rejection of our null hypothesis – that moving average type of cyclical series exists in Kerala agriculture.

Our hypothesized length of cycle (6 – years) was satisfied by most of the crops (see table 4.15). Most of the commodities had existence of 6-year cycle length in the series. Agricultural production of all crops fluctuates

Table 4.15

Agricultural commodities with 6-year cycle length

Commodities	Production	Productivity	Farm prices	Wholesale prices
Rice	Y	Y	Y	-
Coconut	Y	Y	Y	N
Tea	Y	Y	-	Y
Rubber	Y	Y	-	Y
Pepper	Y	N	Y	N
Ginger	Y	Y	N	N
Arecanut	Y	Y	Y	Y
Turmeric	Y	Y	-	Y
Banana	Y	N	Y	Y
Cashewnut	Y	Y	Y	-
Tapioca	Y	N	Y	Y
Sugarcane	Y	N	Y	-

"Y" – Satisfies existence of 6-year length at 5% level
"N" – Does not satisfy existence of 6-year cycle length at 5% level
Source: Estimated by the researcher.

with 6-year cycle length. Cycle length of 6 years was violated mostly by the wholesale prices. Eventhough regular cycles of the given length were found to be significant for most crops, there were cycles of uneven length. Production, productivity and price cycles did not persist in uniform manner in agriculture.

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PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

By

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THESIS SUBMITTED TO THE UNIVERSITY OF CALICUT
FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
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August 1999

Chapter 5

INTER-RELATIONS IN AGRICULTURE

In the previous chapters we showed the distinct features of agricultural commodities of Kerala. These features were different for different crops. But movements of production, productivity and prices of the same crops showed similarity. In other words, there may be some inter-relationships between these three concepts. In this chapter we are trying to find out whether there exists any statistical inter-relations among them. The relations tested are:

1. Production = f (Productivity)
2. Productivity = f (Production)
3. Price = f (Production)
4. Production = f (Price)
5. Price = f (Productivity)
6. Productivity = f (Price)
7. Production = f (Price, Productivity)
8. Price = f (Production, Productivity)
9. Productivity = f (Production, Price)

Using Ordinary Least Squares (OLS) method, we estimated linear regressions of the form:

$$Y = a+bX+u$$

$$Y = a+bX+cZ+u.$$

Where,

'a', 'b' and 'c' refer to coefficients;

'X', 'Y' and 'Z' refer to variables and

'u' refers to the error term.

Overall fitness of these regressions is tested by coefficient of determination and significance of estimated coefficients by Student's t test. The empirical results of these 9 models are discussed below.

5. 1. Production as a function of Productivity

Relationship between production and productivity (production as a dependent variable) is shown in table 5.1. 7.9% to 97.8% of the changes in production was determined by productivity. Influence of productivity on production was high in plantation crops and spices and condiments and very low in rice, coconut, cashewnut and tapioca. In plantation crops this ranged from 89.4% to 97.8% and in spices and condiments from 58.6% to 94.7%.

Slope and intercept coefficients of all the selected commodities were statistically significant at standard levels. Production and productivity had direct and proportional relationships in all commodities except cereals. For a unit increment in productivity, increment in production was high in rubber (0.534), followed by coconut (0.503), pepper (0.266), tapioca (0.107), banana (0.063), arecanut (0.049), cashewnut (0.029), tea (0.029), ginger (0.015) and sugarcane (0.005). Without any change in productivity there may be some constant increments in the production of rice, coconut, tea, rubber, arecanut, cashewnut, tapioca and sugarcane.

Table 5.1

OLS estimates of Production as a function of Productivity

Crops	a	b	R^2	Remarks
Rice	1454.59⊗	(-)0.17⊗	0.079	Insignificant
Coconut	1084.79⊗⊗	0.5⊗	0.184	Insignificant
Tea	10.60⊗	0.03⊗	0.978	Significant
Rubber	432.83⊗	0.53⊗	0.894	Significant
Pepper	(-)33.68⊗	0.27⊗	0.605	Significant
Ginger	(-)3.34⊗⊗	0.02⊗	0.947	Significant
Arecanut	13.95⊗	0.05⊗	0.586	Significant
Banana	(-)76.43⊗⊗⊗	0.06⊗	0.678	Significant
Cashewnut	69.04⊗	0.03⊗	0.319	Insignificant
Tapioca	1921.33⊗	0.11⊗	0.112	Insignificant
Sugarcane	147.45⊗	0.01⊗	0.626	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

5. 2. Productivity as a function of Production

Increments of productivity due to changes in the mode of production are given in table 5.2. Since production and productivity were interrelated, coefficient of determination of productivity on production and that of production on productivity are same.

Slope coefficients of all commodities (except cereals) were positive and significant at 5% level. Thus production factors directly influence changes in productivity. This dependence of productivity was greater in sugarcane (114.68) followed by ginger (64.12), tea (34.05), arecanut (11.83), cashewnut (11.03), banana (10.72), pepper (2.27), rubber (1.67), tapioca (1.04) and coconut (0.37). Productivity curve starts from positive values for rice, coconut, rubber, pepper, ginger, arecanut, banana, tapioca and sugarcane and from negative points for tea and cashewnut.

5. 3. Price as a function of Production

a. Wholesale Prices

Wholesale price dependent on production is presented in table 5.3. Table revealed that production and its related factors determined about 15.6% to 75.2% of price changes. This determination was high in plantation crops and low in fruits and vegetables.

Table 5.2

OLS estimates of Productivity as a function of Production

Crops	a	b	R^2	Remarks
Rice	2142.03⊗	(-)0.453⊗	0.079	Insignificant
Coconut	3891.85⊗	0.37⊗	0.184	Insignificant
Tea	(-)331.24⊗	34.05⊗	0.978	Significant
Rubber	280.99⊗	1.67⊗	0.8939	Significant
Pepper	171.47⊗	2.272⊗	0.605	Significant
Ginger	331.12⊗⊗⊗	64.12⊗	0.947	Significant
Arecanut	166.74⊗⊗	11.83⊗	0.586	Significant
Banana	2985.66⊗	10.72⊗	0.678	Significant
Cashewnut	(-)136.18	11.03⊗	0.319	Insignificant
Tapioca	12123.52⊗	1.04⊗	0.112	Insignificant
Sugarcane	5628.56	114.68⊗	0.626	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

Table 5.3

OLS estimates of Price as a function of Production - Wholesale Prices

Crops	a	b	R^2	Remarks
Coconut	(-)2680.91⊗	1.117⊗	0.462	Insignificant
Tea	(-)60.639⊗	1.602⊗	0.738	Significant
Rubber	118.72	6.143⊗	0.659	Significant
Pepper	(-)2272.18⊗	133.39⊗	0.752	Significant
Ginger	(-)637.58⊗⊗⊗	65.25⊗	0.542	Significant
Turmeric	(-)303.268	20.89⊗	0.211	Insignificant
Arecanut	(-)4861.68⊗	114.59⊗	0.728	Significant
Tapioca	156.236⊗	(-)0.023⊗	0.157	Insignificant
Banana	23.059	1.227⊗	0.156	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

Slope coefficients of all selected commodities were positive (except tapioca) and significant. Thus price and production of most of the agricultural commodities had direct and proportional relationship. Being a staple food of the poor people, production of tapioca was inversely related to its price. For a unit increases in the production of tapioca, price decrease was 0.023 units. The increments in price due to increments in production were more than one in all other commodities. We can see highest increments in pepper (133.39) and lowest for coconut (1.12) for a one unit increments in its production. The price curve starts from negative points (when production is zero) for coconut, tea, pepper, ginger, turmeric and arecanut.

b. Farm Prices

The results of the analysis presented in table 5.4 revealed that the determination of farm price ranged from 2.5% to 72.5%. This determination was high in spices and condiments and very low in miscellaneous crops. In spices and condiments, this ranged from 47.8% to 72.59% and in all other commodities this was insignificant. Thus production plays an important role in the determination of farm prices only in the category of spices and condiments.

Slopes of all price curves were significant. Farm prices and production had direct and proportional relationships in coconut, pepper, ginger, arecanut, banana and sugarcane and indirect and proportional relationships in

Table 5.4

OLS estimates of Price as a function of Production - Farm Prices

Crops	a	b	R^2	Remarks
Rice	1255.99⊗	(-)0.424⊗	0.151	Insignificant
Coconut	3157.23⊗	0.403⊗	0.416	Insignificant
Pepper	20.74⊗	0.005⊗	0.674	Significant
Ginger	20.135⊗	0.007⊗	0.478	Insignificant
Arecanut	44.48⊗	0.091⊗	0.725	Significant
Tapioca	4058.271⊗	(-)6.601⊗	0.129	Insignificant
Banana	283.452⊗	1.561⊗	0.232	Insignificant
Cashewnut	97.942⊗	(-)0.003⊗⊗	0.029	Insignificant
Sugarcane	455.57⊗	0.124⊗⊗⊗	0.025	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

rice, tapioca and cashewnut. Changes in price as a result of one unit change in production was less than one for rice, coconut, pepper, ginger, arecanut, cashewnut and sugarcane. Even if changes in production was zero, there may be some constant and significant price change as an incentive to farmers, in all commodities. This incentive was high in tapioca (4058.27) followed by coconut (3157.23), rice (1255.99), sugarcane (455.57), banana (283.45), cashewnut (97.94), arecanut (44.48), pepper (20.74) and ginger (20.14).

5. 4. Production as a function of Price

a. Wholesale Prices

Influence of wholesale prices on production of agricultural commodities is presented in table 5.5. Since production and price are interrelated, the percentage of determination of price on production and production on price were same (comparison between tables 5.3 and 5.5). Thus, the percentage of determination was high in spices and condiments (except turmeric) and low in fruits and vegetables.

Both wholesale prices and production increase [illegible] direction (except in the case of tapioca). Unit increment in production as a result of one unit increment in price was less than one for all crops (except tapioca). This increment was high in tea (0.46) followed by banana (0.127), rubber (0.107), turmeric (0.101), coconut (0.077), ginger (0.008), pepper and arecanut (0.006).

Table 5.5

OLS estimates of
Production as a function of Price - Wholesale Prices

Crops	a	b	R^2	Remarks
Coconut	3116⊗	0.4133⊗	0.462	Insignificant
Tea	41.01⊗	0.46⊗	0.738	Significant
Rubber	42.66	0.107⊗	0.659	Significant
Pepper	20.36⊗	0.006⊗	0.752	Significant
Ginger	18.73⊗	0.008⊗	0.542	Significant
Turmeric	397.09⊗	0.101⊗	0.211	Insignificant
Arecanut	45.539⊗	0.006⊗	0.728	Significant
Tapioca	4112.99⊗	(-)6.735⊗	0.157	Insignificant
Banana	298.823⊗	0.127	0.156	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

Table also reveals that there will be some production for consumption purposes without the element of wholesale prices. Production with zero elements of prices was high in tapioca (4112.99) and low in ginger (18.73).

b. Farm Prices

Impact of farm prices on production is depicted in table 5.6. Percentage determination of farm price on production and that of production on farm price were same (comparison between tables 5.4 and 5.6). Thus determination of farm price on production was high in spices and condiments and low and insignificant in cereals, oilseeds, fruits and vegetables and sugarcane.

Production curve was increasing for coconut, pepper, ginger, arecanut, banana and sugarcane and decreasing for rice, tapioca and cashewnut. One unit increment in prices leads to more than one unit increments in production for coconut, pepper, ginger and arecanut. Slopes of all production curves were significant. Table also revealed that when slopes of production curves were zero, it starts from positive quadrant for all commodities except coconut, pepper, ginger, arecanut and banana. The absolute amount of production with zero farm prices was high for coconut followed by pepper, cashewnut, ginger, rice, arecanut, tapioca, sugarcane and banana.

Table 5.6

OLS estimates of Production as a function of Price- Farm Prices

Crops	a	b	R^2	Remarks
Rice	609.52⊗	(-)0.356⊗	0.151	Insignificant
Coconut	(-)2436.13⊗	1.034⊗	0.416	Insignificant
Pepper	(-)2056.06⊗	128.111⊗	0.674	Significant
Ginger	(-)628.39	62.62⊗	0.478	Insignificant
Arecanut	(-)326.95⊗	7.971⊗	0.725	Significant
Tapioca	136.44⊗	(-)0.019⊗	0.129	Insignificant
Banana	(-)9.866	0.149⊗	0.232	Insignificant
Cashewnut	1460.573⊗	(-)8.366⊗⊗⊗	0.029	Insignificant
Sugarcane	74.364	0.202⊗⊗⊗	0.025	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

5. 5. Price as a function of Productivity

a. Wholesale Prices

Effect of productivity on wholesale prices of agricultural commodities (see table 5.7) revealed that determination of productivity on price ranged from 0.004 to 78.9 percentage. This determination was high in plantation crops and very low in oilseeds and fruits and vegetables. Impact of productivity on wholesale prices was insignificant for coconut, pepper, turmeric, tapioca and banana.

Slope coefficients of all commodities (except banana) were positive. Thus price curve was upward slopping for coconut, tea, rubber, pepper, ginger, turmeric, arecanut and tapioca. The increments in price curve were more than one in rubber, pepper, ginger and arecanut. But for one unit increments in productivity, the absolute increments in wholesale price was less than one for coconut, tea, turmeric, tapioca and banana. Except for coconut and banana, increments in price curve seem to be statistically significant. There will be some positive change in the wholesale prices of coconut and banana even if changes in productivity were zeros. Intercept coefficients of rubber and turmeric were insignificant.

Table 5.7

OLS estimates of Price as a function of Productivity - Wholesale Prices

Crops	a	b	R^2	Remarks
Coconut	1425.457⊗⊗⊗	0.011	0.00004	Insignificant
Tea	(-)46.561⊗	0.048⊗	0.789	Significant
Rubber	(-)656.45	3.207⊗	0.563	Significant
Pepper	(-)6205.31⊗	33.227⊗	0.398	Insignificant
Ginger	(-)1022.02⊗⊗	1.039⊗	0.598	Significant
Turmeric	(-)294.04	0.704⊗	0.318	Insignificant
Arecanut	(-)4813.78	7.651⊗	0.684	Significant
Tapioca	(-)132.516⊗	0.013⊗	0.465	Insignificant
Banana	477.627⊗	(-)0.002	0.00008	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

b. Farm Prices

Impact of productivity on farm prices (see table 5.8) revealed that the coefficient of determination of productivity on farm prices ranged from 0.3% to 82.6%. This coefficient was high in cereals and low in oilseeds. Cropwise analysis reveals that the influence of productivity on farm prices was high in rice (0.826) followed by arecanut (0.706), ginger (0.545) etc. Except for rice, arecanut and ginger, all other commodities had insignificant productivity determination on farm prices.

Price curve of rice, pepper, ginger, arecanut, tapioca and sugarcane were upward slopping and that of cashewnut, banana and coconut was downward slopping. For a one-unit increment in productivity, the increment in price curve was less than one for rice, arecanut, tapioca and sugarcane and was greater than one for pepper and ginger. Except the case of banana, all other slopes were significant. With zero increments in productivity there will be positive increment in coconut, banana and cashewnut farm prices and negative increments in rice, pepper, ginger, arecanut, tapioca and sugarcane.

Table 5.8

OLS estimates of Price as a function of Productivity- Farm Prices

Crops	a	b	R^2	Remarks
Rice	637.695⊗	0.515⊗	0.826	Significant
Coconut	2943.657⊗	(-)0.29⊗⊗	0.024	Insignificant
Pepper	(-)5843.86⊗	31.955⊗	0.378	Insignificant
Ginger	(-)1037.60⊗⊗⊗	1.015⊗	0.545	Significant
Arecanut	(-)307.095⊗	0.508⊗	0.706	Significant
Tapioca	130.688⊗	0.012⊗	0.494	Insignificant
Banana	50.756⊗⊗	(-)0.001	0.003	Insignificant
Cashewnut	1624.45⊗	(-)1.049⊗	0.174	Insignificant
Sugarcane	(-)132.52⊗⊗⊗	0.005⊗	0.326	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

5. 6. Productivity as a function of Price

a. Wholesale Prices

Impact of wholesale prices on productivity is depicted in table 5.9. Since both are interrelated the coefficient of determination of wholesale prices on productivity and productivity on wholesale prices were the same (comparison between tables 5.7 and 5.9). Thus prices had significant impact on the productivity of tea, rubber, ginger and arecanut and insignificant impact on coconut, pepper, turmeric, tapioca and banana. Productivity curves of coconut, tea, rubber, pepper, ginger, turmeric, arecanut and tapioca are upward slopping out of which the slopes of tea, rubber, ginger, turmeric, arecanut and tapioca were significant. The productivity curve of banana was downward slopping and insignificant.

b. Farm Prices

Effect of changes in farm prices on productivity is shown in table 5.10. The inter-relationship between productivity and farm prices is reflected in the coefficient of determination. Coefficients of farm prices on productivity and productivity on farm prices were same (comparison between tables 5.8 and 5.10). Productivity curves was upward slopping for rice, pepper, ginger, arecanut, tapioca and sugarcane and downward slopping for others. This implies that for one unit change in price there is more than one unit change in the

Table 5.9

OLS estimates of Productivity as a function of Price- Wholesale Prices

Crops	a	b	R^2	Remarks
Coconut	5172.504⊗	0.004	0.00004	Insignificant
Tea	1051.001⊗	16.397⊗	0.789	Significant
Rubber	356.912⊗	0.175⊗	0.563	Significant
Pepper	219.223⊗	0.012	0.398	Insignificant
Ginger	1478.789⊗	0.575⊗	0.598	Significant
Turmeric	1064.72⊗	0.453⊗	0.318	Insignificant
Arecanut	683.359⊗	0.089⊗	0.684	Significant
Tapioca	13304.38⊗	36.159⊗	0.465	Insignificant
Banana	6741.582⊗	(-)0.035	0.00008	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

Table 5.10

OLS estimates of Productivity as a function of Price- Farm Prices

Crops	a	b	R^2	Remarks
Rice	1302.167⊗	1.603⊗	0.828	Significant
Coconut	5374.64⊗	(-)0.082⊗⊗⊗	0.024	Insignificant
Pepper	220.008⊗	0.011⊗	0.378	Insignificant
Ginger	1564.28⊗	0.537⊗	0.545	Significant
Arecanut	661.634⊗	1.387⊗	0.706	Significant
Tapioca	13284.61⊗	40.105⊗	0.494	Insignificant
Banana	6822.923⊗	(-)2.319	0.003	Insignificant
Cashewnut	1028.269⊗	(-)0.166⊗	0.174	Insignificant
Sugarcane	49331.19⊗	64.927⊗	0.326	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

productivity of rice, arecanut, tapioca, banana and sugarcane. Changes in all commodities (except banana) were statistically significant. The table also reveals that even if changes in prices were zero there was positive changes in the productivity of all agricultural commodities. This change was greater in sugarcane (49221.19) and lower in pepper (220.01).

5. 7. Production as a function of Price and Productivity

a. Wholesale Prices

Impact of changes of both wholesale price and productivity on production is shown in table 5.11. Analysis reveals that coefficient of determination of wholesale prices and productivity on production was significant for all agricultural commodities. This determination ranged from 66.8% to 98.0%. Influence of these two explanatory variables was high in tea (98.0%) followed by ginger (94.8%), rubber (89.4%), pepper (84.1%), tapioca (83.8%), banana (81.0%), turmeric (80.3%), arecanut (73.4%) and coconut (66.8%).

Production had direct and proportional relationships with the prices of coconut, rubber, pepper, arecanut and banana and indirect relationships with tea, ginger, turmeric and tapioca. For one unit increase in price there was more than one unit change in the production of rubber and tapioca. All price coefficients (except ginger) were statistically significant. Production and productivity had direct relationships (excluding rubber). But for one unit increment

Table 5.11

OLS estimates of Production as a function of Price and Productivity- Wholesale Prices

Crops	a	b	c	R^2	Remarks
Coconut	658.982⊗⊗	0.412⊗	0.475⊗	0.668	Significant
Tea	8.206⊗	(-)0.051⊗	0.031⊗	0.98	Significant
Rubber	282.391⊗	1.747⊗	(-)0.012	0.894	Significant
Pepper	(-)8.416⊗	0.004⊗	0.131⊗	0.841	Significant
Ginger	(-)3.788⊗⊗⊗	(-)0.0004	0.015⊗	0.948	Significant
Turmeric	12.477⊗	(-)0.001⊗⊗⊗	0.026⊗	0.803	Significant
Arecanut	39.13⊗	0.006⊗	0.009⊗⊗⊗	0.734	Significant
Tapioca	(-)707.217⊗⊗	(-)19.84⊗	0.362⊗	0.838	Significant
Banana	(-)160.857⊗	0.129⊗	0.068⊗	0.81	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

in productivity there was less than one unit increment in production for all commodities. Production curve possesses positive and significant intercepts for coconut, tea, rubber, turmeric and arecanut and negative and significant intercepts for all other commodities.

b. Farm Prices

Impact of changes in farm prices and productivity on production is shown in table 5.12. Analysis reveals that they had significant impact on production for coconut, pepper, ginger, arecanut, tapioca, banana and sugarcane and insignificant for rice and cashewnut. Influence of these two explanatory variables was high in banana (95.6%) followed by ginger (94.9%), tapioca (81.17%), pepper (80.2%), sugarcane (75.4%), arecanut (73.4%), coconut (70.3%) etc.

Production had significant and direct relationships with the farm prices of coconut, pepper, arecanut, banana and cashewnut and significant and indirect relationships with rice, ginger, tapioca and sugarcane. For one unit increment in price, the absolute increment in production was less than one for all commodities except for tapioca and banana. Production curve with farm prices and productivity as explanatory variables had positive intercepts for rice, arecanut, cashewnut and sugarcane. All intercepts except coconut seem to be significant.

Table 5.12

OLS estimates of Production as a function of Price and Productivity- Farm Prices

Crops	a	b	c	R^2	Remarks
Rice	920.568⊗	(-)0.837⊗	0.258⊗⊗⊗	0.181	Insignificant
Coconut	(-)255.375	0.455⊗	0.635⊗	0.703	Significant
Pepper	(-)12.896⊗	0.0036⊗	0.153⊗	0.802	Significant
Ginger	(-)4.033⊗⊗⊗	(-)0.0007⊗⊗⊗	0.015⊗	0.949	Significant
Arecanut	37.209⊗	0.076⊗	0.0109⊗⊗⊗	0.734	Significant
Tapioca	(-)893.64⊗	(-)21.539⊗	0.372⊗	0.8117	Significant
Banana	(-)163.381⊗	1.713⊗	0.065⊗	0.956	Significant
Cashewnut	66.426⊗	0.031⊗	0.0016	0.325	Insignificant
Sugarcane	102.137⊗	(-)0.342⊗	0.007⊗	0.754	Insignificant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

5. 8. Price as a function of Production and Productivity

a. Wholesale Prices

We know that price of a commodity is determined by demand for and supply of it. It may also be influenced by the prices of other commodities, market conditions etc. Here, we are intending to know whether production and productivity changes influence the price of an agricultural commodity. The results presented in table 5.13 reveal that coefficient of determination of production and productivity upon wholesale prices ranged from 32.8% to 90.3%. This determination was significant for coconut, tea, rubber, pepper, ginger, arecanut and tapioca, but insignificant for turmeric and banana.

Production was direct to the changes in prices of coconut, rubber, pepper, arecanut and banana and indirect for tea, ginger, turmeric and tapioca. Price change due to production was significant for coconut, tea, rubber, pepper, turmeric, arecanut, tapioca and banana. Price curve was upward bending for tea, ginger, turmeric, arecanut and tapioca. Productivity coefficients of all commodities (except rubber) were significant.

b. Farm Prices

Eventhough farm prices are fixed by the Government, Government changes the farm prices of agricultural commodities from time to

Table 5.13

OLS estimates of Price as a function of Production and Productivity- Wholesale Prices

Crops	a	b	c	R^2	Remarks
Coconut	328.389	1.408⊗	(-)0.664⊗	0.579	Significant
Tea	(-)28.163⊗	(-)1.736⊗	0.098⊗	0.809	Significant
Rubber	314.453	7.309⊗	(-)0.696	0.662	Significant
Pepper	(-)1267.84⊗⊗	146.7⊗	(-)5.857⊗⊗⊗	0.757	Significant
Ginger	(-)1109.1⊗⊗	(-)26.05	1.424⊗	0.602	Significant
Turmeric	(-)162.592	(-)10.188⊗⊗⊗	0.954⊗	0.328	Insignificant
Arecanut	(-)5713.27⊗	71.517⊗	3.962⊗	0.809	Significant
Tapioca	(-)53.269⊗	(-)0.041⊗	0.017⊗	0.903	Significant
Banana	830.756⊗	3.561⊗	(-)0.244⊗	0.46	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

time. This may be influenced by changes in agricultural conditions of the economy. Influence of farm prices by production and productivity presented in table 5.14 reveals that they influence farm prices of most of the selected commodities. This determination was significant for all commodities except cashewnut. Determination was high in tapioca (89.3%) followed by banana (86.5%), rice (84.5%), arecanut (81.08%), pepper (67.9%), coconut (64.5%), ginger (55.9%) and sugarcane (55.7%). Influence of production on price was direct to coconut, pepper, arecanut, banana and cashewnut and indirect to rice, ginger, tapioca and sugarcane. Table also shows that influence of productivity on price was significant for all commodities.

5. 9. Productivity as a function of Production and Price

a. Wholesale Prices

Productivity is not a direct function of either production or price. It is the result of new mode of cultivation adopting new methods like HYV seeds, fertilisers, irrigation etc. But inducement to increase productivity arises from the existence of high prices of the product. And to earn high prices the cultivator should increase production through increasing productivity. Thus these three concepts are interrelated. Price and production determine 38.3% to 98.4% of changes in productivity (see table 5.15). This determination was significant for commodities like tea, rubber, pepper, ginger, turmeric, arecanut, tapioca, banana etc. It was high in tea (98.4%) followed by ginger (95.4%), rubber (91.8%),

Table 5.14

OLS estimates of Price as a function of Production and Productivity- Farm Prices

Crops	a	b	c	R^2	Remarks
Rice	(-)444.992	(-)0.132⊗	0.492⊗	0.845	Significant
Coconut	1427.74⊗	1.397⊗	(-)0.993⊗	0.645	Significant
Pepper	(-)1110.29⊗⊗⊗	140.643⊗	5.516⊗⊗⊗	0.679	Significant
Ginger	(-)1194.96⊗⊗	(-)47.08⊗⊗⊗	1.711⊗	0.559	Significant
Arecanut	372.855⊗	4.715⊗	0.275⊗	0.8108	Significant
Tapioca	(-)60.398⊗	(-)0.037⊗	0.016⊗	0.893	Significant
Banana	89.319⊗	0.505⊗	(-)0.033⊗	0.865	Significant
Cashewnut	1299.12⊗	4.712	(-)1.186⊗	0.1799	Insignificant
Sugarcane	15.256	(-)1.002⊗	0.011⊗	0.557	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

Table 5.15

OLS estimates of Productivity as a function of Production and Price- Wholesale Prices

Crops	a	b	c	R^2	Remarks
Coconut	2657.685⊗	0.8071⊗	(-)0.3298⊗	0.383	Significant
Tea	(-)164.09⊗	29.629⊗	2.756⊗	0.984	Significant
Rubber	(-)112.512⊗	0.031⊗	0.435⊗	0.918	Significant
Pepper	163.822⊗	2.721⊗	(-)0.0034⊗⊗⊗	0.613	Significant
Ginger	389.147⊗	58.176⊗	0.091⊗	0.954	Significant
Turmeric	(-)100.362	28.339⊗	0.155⊗	0.8299	Significant
Arecanut	578.768⊗	2.291⊗⊗⊗	0.075⊗	0.691	Significant
Tapioca	4125.904⊗	2.232⊗	51.189⊗	0.898	Significant
Banana	3342.86⊗	11.374⊗	(-)1.477⊗	0.776	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

tapioca (89.8%), turmeric (82.9%), banana (77.6%), arecanut (69.1%) and pepper (61.3%).

Productivity of all commodities had direct and significant relationships with production. One unit increment in production (excluding coconut and rubber) results in more than one unit increment in productivity. Productivity curve starts from positive values for coconut, pepper, ginger, arecanut, tapioca and banana and negative for tea, rubber and turmeric.

b. Farm Prices

Influence of production and farm price on productivity of agricultural commodities is given in table 5.16. Both these explanatory variables had significant impact on the changes in productivity for all commodities except cashewnut. This impact was highest on ginger (95.6%) followed by banana (94.3%), tapioca (89.0%), rice (83.2%), sugarcane (83.0%), arecanut (71.5%), pepper (61.0%) and coconut (50.3%). Cashewnut had insignificant determination. Productivity and farm price coefficients were significant for all commodities. But their relationship was negative for coconut, pepper, banana and cashewnut. Even if changes in production and farm price was zero, there were positive changes in productivity for all commodities. This change was highest and significant in tapioca (4756.67) and lowest and insignificant in cashewnut.

Table 5.16

OLS estimates of Productivity as a function of Production and Price- Farm Prices

Crops	a	b	c	R^2	Remarks
Rice	1129.45⊗	0.138⊗⊗⊗	1.661⊗	0.832	Significant
Coconut	2931.54⊗	0.774⊗	(-)0.394⊗	0.503	Significant
Pepper	166.652⊗	2.572⊗	(-)0.002⊗⊗⊗	0.61	Significant
Ginger	388.571⊗	58.389⊗	0.091⊗	0.956	Significant
Arecanut	536.643⊗	2.81⊗⊗⊗	1.131⊗	0.715	Significant
Tapioca	4756.669⊗	2.104⊗	53.99⊗	0.89	Significant
Banana	2740.984⊗	14.401⊗	(-)24.803⊗	0.943	Significant
Cashewnut	55.337	9.934⊗	(-)0.131⊗	0.425	Insignificant
Sugarcane	1763.004	104.173⊗	51.981⊗	0.83	Significant

'⊗ - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗- Significant at 25% level

Conclusion

Eventhough production, productivity and prices of agricultural commodities were affected by a number of factors; this study found significant statistical relationships among the variables. Their relationships varied from commodity to commodity. Also two-way relations between them were insignificant for rice, coconut, pepper and ginger but the three terms had significant interrelations in all commodities except cashewnut.

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PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

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THESIS SUBMITTED TO THE UNIVERSITY OF CALICUT
FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
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August 1999

Chapter 6

AGRICULTURAL PRICES AND MACRO VARIABLES

In this chapter we analyse the effects of macroeconomic conditions on agricultural prices. Here the question is do macroeconomic conditions affect the variability of the structure of commodity prices within agriculture. Or, whether macroeconomic effects are neutral with respect to Kerala agriculture. Also, we determine the responses of individual commodity prices to relative price variability. In the second part we examine whether price levels and variability of agricultural commodities of Kerala have changed after 1991. The central hypothesis tested here is whether price variability of agricultural commodities increased after 1991 or not. An autoregressive conditionally heteroskedastic (ARCH) regression model is used to jointly investigate price levels and variability.

6.1. Relative Price Variability

We know that much of the observed variability in relative prices is caused by changes in weather, resource prices, technology etc. But several theoretical models imply a relationship between inflation and the variability of relative prices. Rational expectation models (Phelps[105] and

[105] Phelps, Edmund S (1970) "The new microeconomics in employment and inflation theory." Microeconomic foundations of employment and inflation theory. New York : W W Norton and Co.

Lucas[106]) say that as inflation becomes more variable, economic agents are less able to distinguish general price level movements from relative price changes. Rational expectations models in which economic agents are unable to distinguish temporary from permanent aggregate demand shocks can also generate a correlation between unexpected inflation and relative price variability. Empirical studies of Vining and Elwertowski[107] and Stockton[108] showed correlation of relative price variability with (a) changing average agricultural commodity prices, (b) changing economic activity and (c) the variance of aggregate inflation. Because rational expectation models focus on the role of unexpected inflation, Lapp and Smith[109] considered the effects of unexpected as well as expected inflation. Thus theoretical and empirical evidences support the relationship between relative price variability and other macroeconomic factors. Here we empirically test the relationship among these factors in Kerala.

Relative price variability is measured by constructing an index to show changes over time in relative prices among a commodity group.

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[106] Lucas, Robert E, Jr. (1973) "Some International evidence on output-inflation tradeoffs.", American Economic Review, Vol. 63, PP 326-34.
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[110] Engle, R (1982), "Autoregressive Conditional Heteroskedasticity with estimates of the variance of United Kingdom inflations", Econometrica, Vol. 50, July, PP 987-1008.
[111] Bollerslev, T (1986), " Generalised Autoregressive Conditional Heteroskedasticity", J. Econometrics, Vol. 31, June, PP 307-27.
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[113] Hamilton, J. D. (1994) Time series analysis, Princeton NJ: Princeton University Press.

A commodity's relative price is defined here as its nominal price divided by the average price of all commodities in the group. Relative price variability is defined as the variance, across that set of commodities, of the rates of change of individual nominal prices. If the prices of a set of commodities all change at the same rate, their relative prices do not change. However, relative prices must change if the prices in the set change at different rates. As the variance of the rates of nominal price change becomes greater, relative prices become more variable.

The price of each commodity can be decomposed into an aggregate and a relative price component, i.e.,

$$Pit = Pt + Zit \qquad \text{for } i=1,2,3,\ldots\ldots,N \qquad \_\_\_\_\_\_(1)$$

Where Pit is the natural log of the nominal price of commodity i in period t, Pt is the natural log of the average price across the n commodities in period t and Zit is the natural log of the relative price of commodity i in period t. Divisia price index, Pt (index used to measure relative price variability) is defined as

$$Pt = \Sigma\, Wit\ Pit \qquad \text{for } i = 1,2,3,\ldots\ldots,N \qquad \_\_\_\_\_\_(2)$$

Where the Wit's are price index weights that sum to one. Taking first differences of equation (1) and reordering terms yields

$$Zit - Zi,t\text{-}1 = (Pit - Pi,t\text{-}1) - (Pt - Pt\text{-}1) \qquad \_\_\_\_\_\_(3)$$

The left-hand side of equation (3) is the rate of change in the relative price of the i^{th} commodity. A weighted average of all relative price changes, i.e.,

$$\Sigma\, Wit\ (Zit - Zit\text{-}1) = 0.$$

The weighted sum of squares of the relative price changes, i.e.,

$$\Sigma\, Wit\, (Zit - Zi,t\text{-}1)^2 = \Sigma\, Wit\, [(Pit - Pi,t\text{-}1) - (Pt - Pt\text{-}1)]^2 > 0,$$

measures the variance of relative price changes from period t-1 to period t for the N commodities examined. Thus, the general expression for relative price variability Vt is

$$Vt = \Sigma\, Wit\, [(Pit - Pi,t\text{-}1) - (Pt - Pt\text{-}1)]^2.$$

6.1.1. Divisia price index and relative price variability

Divisia price index Pt, for farm prices and the associated index, Vt, of relative agricultural price variability were constructed from annual averages of monthly prices of agricultural commodities for the period 1960-61 to 1995-96. Since Wit's should reflect the relative importance of each commodity, we used income shares as weights.

The Vt series and the average rate of price change of Pt, Π ct, are presented in table 6.1. Vt series is plotted in figure 6.1. As figure illustrates, the variability of relative agricultural prices has changed overtime. Short-run fluctuations in relative price variability occurred throughout the selected period. . They were extremely volatile in the middle 1980s (particularly in 1984-85). Relative prices were more stable in the 1970s than in the 1960s and 1980s. Average rate of price change (Divisia price index) was maximum in 1984-85 and minimum during 1961-62. The rate of change was negative in the years 1964-65, 69-70, 71-72, 72-73, 75-76, 79-80, 81-82, 85-86, 89-90, 93-94 and 94-95.

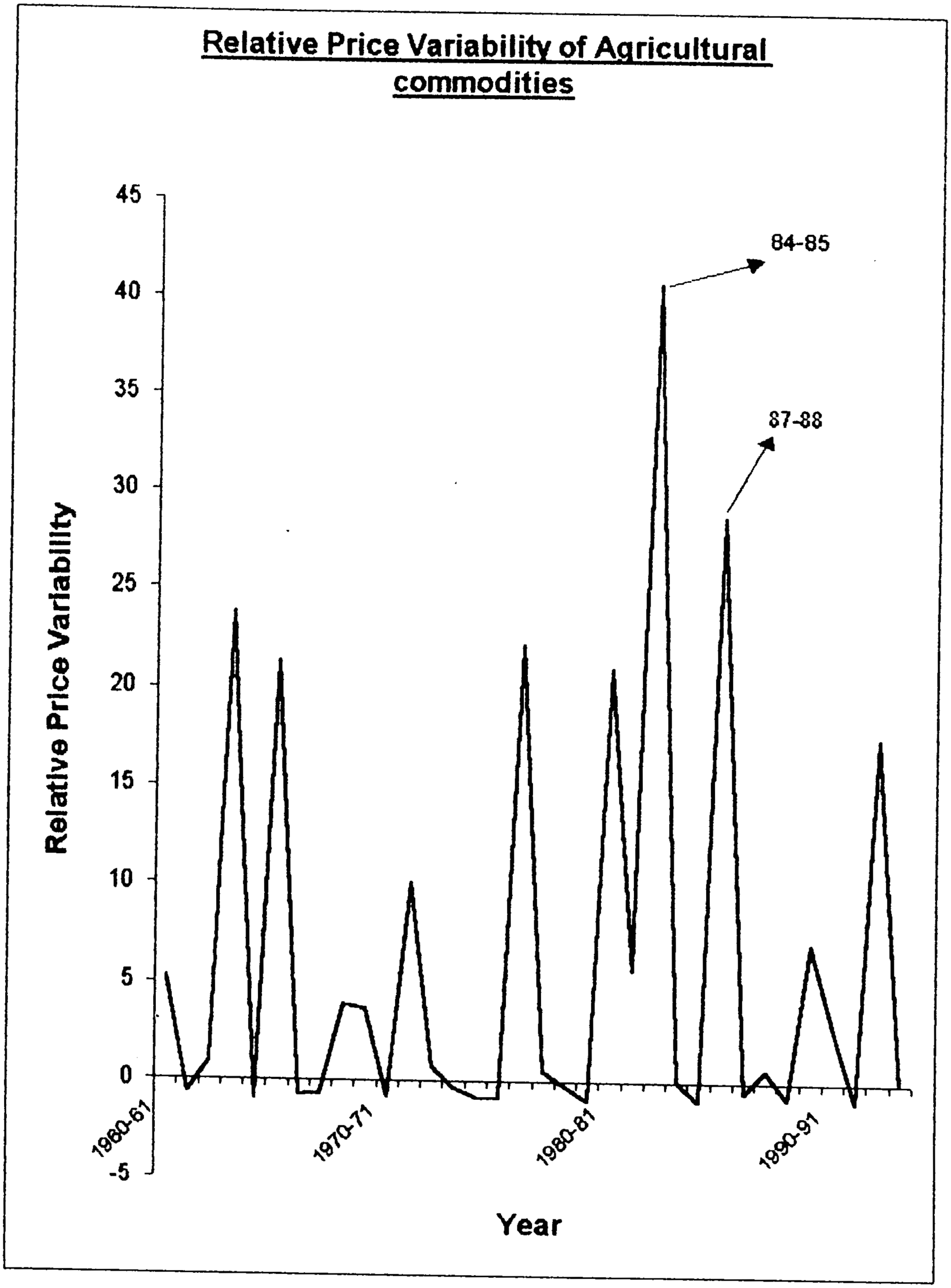
Table 6.1

Average rate of price change and relative price variability of selected agricultural commodities

Year	Divisia Price Index (rate of change in %	Variability of relative prices for agricultural commodities
1960-61	(-)	(-)
1961-62	0.0019	(-)
1962-63	0.1504	5.2267
1963-64	0.0739	-0.6797
1964-65	-0.0031	0.9009
1965-66	0.4746	23.8059
1966-67	0.0446	-0.9808
1967-68	0.2015	21.3324
1968-69	0.0792	-0.7766
1969-70	-0.0419	-0.6745
1970-71	0.0971	3.8905
1971-72	-0.1911	3.6947
1972-73	-0.1024	-0.8122
1973-74	0.3798	10.0619
1974-75	0.3633	0.7447
1975-76	-0.2144	-0.3526
1976-77	0.1061	-0.8487
1977-78	0.0331	-0.883
1978-79	0.1534	22.3032
1979-80	-0.1645	0.5349
1980-81	0.1747	-0.2175
1981-82	-0.0213	-0.9795
1982-83	0.1021	21.1353
1983-84	0.2407	5.7106
1984-85	1.2504	40.7113
1985-86	-0.5665	0.0398
1986-87	0.0643	-0.9976
1987-88	0.3295	28.8593
1988-89	0.1678	-0.5399
1989-90	-0.1866	0.6803
1990-91	0.0994	-0.8124
1991-92	0.2578	7.1179
1992-93	0.3943	2.7208
1993-94	-0.0419	-0.9782
1994-95	-0.1884	17.6591
1995-96	0.2342	0.0205

Source: Estimated by the researcher.

Figure 6.1


Relative Price Variability of Agricultural commodities
45
40
35
30
25
20
15
10
5
0
-5
Relative Price Variability
84-85
87-88
1960-61
1970-71
1980-81
1990-91
Year

6.1.2. Relative price variability and aggregate variables

Here we correlate relative price variability with

(1) Average rate of change of agricultural commodity prices (Π c,t)

(2) Aggregate rate of inflation measured by the annual rate of change of consumer price indices (Π t)

(3) Rate of change of annual average unemployment (Π u,t)

(4) Rate of annual real GNP growth (Π gt) and

(5) Unexpected inflation (P1U1) – calculated residuals from

Π ct = a0 + a1Mit-1 + a2Et-1 + et where

Mi refers to growth rate of money supply

E refers to exchange rate.

Treating the above 5 variables as explanatory variables we fit the regression

$$Vt = \alpha 0 + \Pi^2 ct + \Pi^2 t + \Pi^2 u,t + \Pi^2 gt + (P1U1)^2 + ut.$$

The above regression model examines the relationship between Vt and squared values of the explanatory variables. We adopted this approach because squaring of variables is consistent with the assumption that changes in the price level and aggregate activity, irrespective of direction, disturb relative prices. Using this model we test the null hypothesis that variances in economic activity affect relative price variability.

The Ordinary Least Squares (OLS) regressions for Vt and the selected explanatory variables are presented in table 6.2. Model 1 shows relative price variability changing with the squared rate of change of average agricultural commodity prices, $\Pi^2 c,t$. Model 2 adds squared inflation, $\Pi^2 t$, model 3 squared average unemployment rate, $\Pi^2 ut$, model 4 squared real GNP growth rate, $\Pi^2 gt$ and model 5 squared unexpected inflation, $(P1U1)^2$.

Table 6.2

Regression estimates for relative price variability

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	41.96 (189.15)	39.27 (191.95)	47.41 (194.51)	20.45 (195.52)	23.19 (198.15)
$\Pi^2 c,t$	-41.75 (121.95)	-43.38 (124.39)	-48.52 (126.82)	-49.51 (127.49)	-59.04 (131.10)
$\Pi^2 t$		260.12 (2005.46)	209.51 (2036.80)	-211.63 (2111.21)	1194.42 (3917.19)
$\Pi^2 u,t$			-240.84 (650.61)	-137.71 (666.05)	-154.47 (676.13)
$\Pi^2 g,t$				1521.81 (1861.06)	1223.61 (2010.35)
$(P1U1)^2$					-2601.18 (6070.33)
R^2	0.34	0.39	0.81	0.29	0.36

Figures in parentheses are standard errors.

Testing of these models lead us to the acceptance of our null hypothesis. Thus, variations in the selected economic activities affect relative price variability of agricultural commodities in Kerala. Average agricultural commodity prices were negatively related to the relative price variability of agricultural sector. But inflationary tendencies increase relative price variability (model 2). When unemployment rate increases, relative price variability significantly decreases (model 3). The changes in the rate of growth of real GNP were statistically significant with a positive sign. Unexpected inflation caused by changes in money supply and exchange rate inversely affects the relative variability of agricultural prices. Thus, we can say that changes in average agricultural commodity prices, average unemployment rate and unexpected inflation rate decrease the relative price variability of agricultural sector. Similarly, changes in inflation rate and real GNP growth rate increase relative price variability of agriculture. At best, the selected data suggest that relative price variability of agricultural commodity changes when economic activity is more variable.

6.1.3. Relative Price Variability and Prices of agricultural commodities

Evidence presented above strongly suggests that variations in economic activity affect relative price variability within the agricultural sector. In this section, we examine the responses of individual commodity prices to these conditions. To evaluate these, we estimated the following regression equation individually for the selected 9 commodities over the period under study.

$$Pit - Pi,t\text{-}1 = \alpha 0 + \alpha 1 \Pi\ ct + \alpha 2 \Pi\ t + \alpha 3\ \Pi\ ut + \alpha 4 \Pi gt + \alpha 5\ (P1U1) + et.$$

Paddy

Regression results shown in table 6.3 revealed that changes in paddy prices were affected by macro economic factors. 62.37% of changes in paddy prices were determined by rates of change of average agricultural commodity prices, inflation rate, unemployment rate, real GNP rate and unexpected inflation. Changes in average agricultural commodity prices itself was positively related to paddy farm prices but when other macro variables were included the first becomes negatively related to the second. An increase in the rate of inflation increases paddy farm prices. Models 3,4 and 5 reveal the fact that changes in the rates of unemployment, real GNP and unexpected inflation inversely affect farm prices of paddy.

Table 6.3

Regression estimates of paddy prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	10.79 (30.58)	-13.65 (20.63)	-9.56 (20.08)	-8.16 (20.38)	-22.25 (20.38)
Πct	21.54 (18.15)	-8.99 (13.13)	-10.02 (12.79)	-9.01 (13.39)	-10.78 (13.51)
Πt		348.92 (54.05)	356.11 (52.79)	361.67 (56.59)	535.20 (182.78)
Πut			-42.14 (25.09)	-42.06 (25.46)	-39.74 (25.57)
Πgt				-16.58 (54.54)	-14.14 (54.59)
PIUI					-186.99 (187.29)
R^2	0.04	0.58	0.61	0.61	0.62

Figures in parentheses are standard errors

Coconut

Estimated results shown in table 6.4 reveal that 73.54% of the variations in coconut farm prices were determined by the selected 5 aggregate variables. Intercept term was always negative which implies that when all the selected explanatory variables were zero the change in coconut farm price will be less than zero. But since the constant term was insignificant we can ignore it. The table also says that an increase in average agricultural commodity prices, unemployment rate and real GNP growth rate increases increments of coconut farm prices and a decrease in these variables decreases it. On the contrary an increase in the inflation rate and unexpected inflation rate decrease its price changes.

Table 6.4

Regression estimates of coconut prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	-52.59 (250.72)	-41.31 (254.26)	-71.23 (254.49)	-118.19 (255.84)	-403.12 (248.98)
Πct	1312.88 (148.83)	1326.97 (161.79)	1334.53 (162.12)	1300.65 (168.19)	1264.79 (165.12)
Πt		-161.06 (666.01)	-213.73 (668.82)	-400.72 (710.42)	3108.18 (2232.99)
Πut			308.41 (317.98)	305.68 (319.67)	352.52 (312.39)
Πgt				558.05 (684.66)	607.35 (666.97)
PIUI					-3781.19 (2288.03)
R^2	0.70	0.70	0.70	0.71	0.71

Figures in parentheses are standard errors

Pepper

Price behaviour of pepper farm prices to various macroeconomic variables are shown in table 6.5. Positive intercept term implies that if changes in all the selected explanatory variables were zero, there would be some increment in the farm prices of pepper. But these changes would be insignificant. An increase in average agricultural commodity prices, unemployment rate and real GNP growth rate decreases its variability.

Table 6.5

Regression estimates of pepper prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	213.81 (2723.82)	-77.77 (723.29)	143.79 (728.16)	245.44 (735.36)	782.66 (733.98)
Π ct	-247.71 (429.67)	-417.61 (460.23)	-413.29 (463.87)	-360.97 (483.45)	-293.35 (486.76)
Π t		1942.02 (1894.52)	2058.23 (1913.62)	2462.89 (2041.93)	-4153.13 (6582.56)
Π ut			-680.48 (909.79)	-674.57 (918.83)	-762.88 (920.89)
Π gt				-1207.7 (1967.89)	-1300.66 (1966.1)
PIUI					7129.44 (6744.81)
R^2	**0.01**	**0.04**	**0.06**	**0.07**	**0.10**

Figures in parentheses are standard errors

Ginger

Price behaviour of ginger farm prices to changes in aggregate variables is explained with the help of table 6.6. Constant term was always positive. Thus there will be some increment in the prices if changes in all the explanatory variables were zero. Changes in the average agricultural commodity prices, inflation rates and unexpected inflation rate increases the rate of change of ginger farm prices. But increments in the unemployment rate and real GNP growth rate decrease it.

Table 6.6

Regression estimates of ginger prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	97.44	61.18	140.31	199.19	491.14
	(558.9)	(566.26)	(563.35)	(570.43)	(574.73)
Π ct	636.15	590.86	570.864	613.34	650.09
	(331.77)	(360.31)	(358.87)	(375.02)	(381.15)
Π t		517.67	656.96	891.41	-2703.95
		(1483.23)	(1480.48)	(1583.96)	(5154.39)
Π ut			-815.57	-812.14	-860.14
			(703.86)	(712.75)	(721.09)
Πgt				-699.70	-750.22
				(1526.52)	(1539.56)
PIUI					3874.37
					(5284.44)
R^2	**0.10**	**0.10**	**0.14**	**0.14**	**0.16**

Figures in parentheses are standard errors

Arecanut

Effect of macro economic factors on changes in arecanut farm prices is given in table 6.7. Average agricultural commodity prices and real GNP growth rate increases the rate of change of arecanut farm prices. But inflation rate, unemployment rate (both in the absence of unexpected inflation, models 2 and 3) and unexpected inflation (model 5) lead to a decrement in the rate of change of these prices.

Table 6.7

Regression estimates of arecanut prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	5.288 (23.18)	6.305 (23.51)	6.56 (23.87)	16.27 (24.25)	-23.22 (23.39)
Πct	42.85 (13.79)	44.22 (14.96)	44.16 (15.21)	43.95 (15.95)	40.24 (15.52)
Πt		-14.51 (61.58)	-14.07 (62.74)	-15.22 (67.35)	347.94 (209.82)
Πut			-2.63 (29.83)	-2.65 (30.30)	2.199 (29.35)
Πgt				3.44 (64.90)	8.54 (62.67)
PIUI					-391.34 (214.99)
R^2	**0.22**	**0.22**	**0.22**	**0.22**	**0.30**

Figures in parentheses are standard errors

Cashewnut

Effect of aggregate variables on farm prices of cashewnut is depicted in table 6.8. Its price increases even if changes in all selected variables were zero. Changes in average agricultural commodity prices and inflation rate lead to a positive rate of change in the farm price of cashewnut. But increments in the unemployment, real GNP growth and unexpected inflation decreases the changes in the price of cashewnut.

Table 6.8

Regression estimates of cashewnut prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	41.18 (157.73)	16.08 (158.32)	19.86 (160.68)	63.39 (159.58)	-5.19 (161.14)
Π ct	242.95 (93.63)	211.61 (100.74)	210.65 (102.36)	242.05 (104.87)	233.42 (106.87)
Π t		358.34 (414.69)	365.0 (422.27)	538.32 (442.94)	1382.93 (1445.18)
Π ut			-38.98 (200.76)	-36.45 (199.31)	-25.17 (202.18)
Πgt				-517.27 (426.88)	-505.39 (431.66)
PIUI					-910.15 (1480.80)
R^2	0.17	0.18	0.18	0.22	0.23

Figures in parentheses are standard errors

Banana

Effect of changes in macroeconomic variables on banana farm prices is depicted in table 6.9. Table revealed that there would be some increments in the farm prices of banana without any changes in aggregate variables. Increments in average agricultural commodity prices and unemployment rate lead to an decrease in the rate of change of banana price. But inflation, real GNP and unexpected inflation directly affect its prices.

Table 6.9

Regression estimates of banana prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	3.45 (4.58)	1.86 (4.39)	2.34 (4.41)	1.43 (4.42)	2.69 (4.48)
Π ct	-1.35 (2.72)	-3.34 (2.79)	-3.46 (2.81)	-4.11 (2.91)	-3.95 (2.97)
Π t		22.65 (11.51)	23.48 (11.59)	19.89 (12.28)	4.38 (40.21)
Π ut			-4.89 (5.51)	-4.94 (5.53)	-5.15 (5.63)
Πgt				10.71 (11.83)	10.49 (12.01)
PIUI					16.72 (41.19)
R^2	**0.01**	**0.11**	**0.13**	**0.16**	**0.16**

Figures in parentheses are standard errors.

Tapioca

Influence of aggregate economic variables on the farm prices of tapioca is given in table 6.10. Without any change in the selected 5 dependent variables, there may be some increments in the farm prices of tapioca. As in the case of banana, here also increments in average agricultural commodity price and unemployment rate decreases and rates of inflation, real GNP growth and unexpected inflation increases the rate of increments of farm prices of tapioca.

Table 6.10

Regression estimates of banana prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	8.82 (11.39)	3.39 (11.14)	4.59 (11.18)	1.52 (11.09)	4.71 (11.24)
Π ct	-1.74 (6.76)	-5.77 (7.09)	-6.08 (7.12)	-8.29 (7.29)	-7.89 (7.46)
Π t		46.59 (29.18)	48.18 (29.38)	35.95 (30.8)	-3.44 (100.84)
Π ut			-12.33 (13.97)	-12.51 (13.86)	-13.03 (14.11)
Πgt				36.49 (29.68)	35.94 (30.12)
PIUI					42.44 (103.33)
R^2	0.02	0.07	0.09	0.14	0.14

Figures in parentheses are standard errors

Sugarcane

Dependence of sugarcane farm price on aggregate economic variables is indicated in table 6.11. Table revealed that without any change in the macroeconomic variables, there might be some increments in the prices of sugarcane. Changes in the average agricultural commodity prices, unemployment rate and real GNP growth rate lead to a negative and change in inflation rate and unexpected inflation rate lead to a positive effect in the farm prices of sugarcane.

Table 6.11

Regression estimates of sugarcane prices and macro Economic variables

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	18.68 (40.72)	13.17 (41.00)	19.13 (40.72)	24.39 (41.16)	42.89 (41.56)
∏ct	-36.56 (24.17)	-43.44 (26.09)	-44.95 (25.94)	-41.15 (27.06)	-38.82 (27.56)
∏t		78.69 (107.40)	89.17 (107.02)	110.12 (114.29)	-117.85 (372.69)
∏ut			-61.41 (50.88)	-61.11 (51.43)	- 64.15 (52.14)
∏gt				-62.49 (110.15)	-65.70 (111.32)
PIUI					245.65 (381.87)
R^2	0.06	0.08	0.12	0.13	0.14

Figures in parentheses are standard errors

6.2. Variability of agricultural prices after 1991

6.2.1. ARCH Model

The ARCH model was introduced by Engle[110] and generalised by Bollerslev[111]. A number of extensions to Engle's basic model have been made: reviews are provided by Bollerslev, Chou and Kroner[112] and by Hamilton[113]. The ARCH model posits an error structure in which the sign of the disturbance term is not predictable, but in which the size of the forecast error may be. In particular, unconditional variance is homoskedastic, but variance at any time t, conditional on prior period information, is heteroskedastic. To be more specific, let us take a k-variable regression model:

$$Yt = \beta_1 + \beta_2 X_{2t} + \ldots\ldots\ldots\ldots + \beta_k X_{kt} + u_t \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

And assume that conditional on the information available at time (t-1), the disturbance term is distributed as

$$u_t \sim N\,[0, (\alpha 0 + \alpha 1\, u^2{}_{t-1})] \quad \ldots\ldots\ldots\ldots(2)$$

that is, u_t is normally distributed with zero mean and variance of $(\alpha 0 + \alpha 1\, u^2{}_{t-1})$. Since in this equation the variance of u_t depends on the squared disturbance term in the previous time period, it is called an ARCH(1) process. But we can generalise it easily. Thus, an ARCH(p) process can be written as

$$Var.(u_t) = \sigma^2{}_t = \alpha_0 + \alpha_1\, u^2{}_{t-1} + \alpha_2\, u^2{}_{t-2} + \ldots\ldots\ldots + \alpha_p u^2{}_{t-p} \quad \ldots\ldots(3)$$

If there is no autocorrelation in the error variance, we have H0 :

$\alpha_1 = \alpha_2 = \ldots\ldots\ldots\ldots = \alpha_p = 0$, in which case Var.(ut) = α_0, and we have the case of homoskedastic error variance.

As Engle has shown, a test of the proceeding null hypothesis can be easily made by running the following regression:

$$u^2_t = \alpha_0 + \alpha_1 u^2_{t-1} + \alpha_2 u^2_{t-2} + \ldots\ldots\ldots + \alpha_p u^2_{t-p} \quad \ldots\ldots(4)$$

where u , as usual, denote the ordinary least squares residuals estimated from the original regression model (1).

One can test the null hypothesis H_0 by the usual t test or, alternatively by LaGrange multiplier (White's general heteroskedasticity) test (see appendix 10).

In this study, the dependent variable, price, is treated as a second order autoregressive process around a deterministic time trend. This linear, unit step trend is used to find out the trend value of price. Seasonality index (calculated by the method shown in appendix 11) was used for seasonal adjustment of the data. Dummy variables are defined over the periods coincident with the year 1991 as D^0 and the periods following 1991 as D^+. That is, D^0 =1 for months during the year 1991 and 0 otherwise and D^+ =1 for all months subsequent to the year 1991 and 0 otherwise. Specifically, the form of the ARCH model implemented below can be written as equation (5) and (6).

$$Pt = \beta_0 + \Sigma\beta i P_{t-i} + \gamma_1 D^0_t + \gamma_2 D^+_t + \gamma_3 T_t + \gamma_4 S_t + e_t \ldots\ldots\ldots\ldots(5)$$

$$e^2_t = \alpha_0 + \Sigma\, \alpha_j e_{t-j} + \lambda_1 D^0_t + \lambda_2 D^+_t + \lambda_3 P_{t-1} + v_t \ldots\ldots\ldots\ldots (6)$$

where Pt = deflated prices of agricultural commodities

P_{t-1} = lagged values of deflated prices

D^0 and D^+ = dummy variables

T = trend values of prices

S = seasonally adjusted prices

e_t and v_t = error terms

t = time period and i = j = 1,2.

A positive coefficient for D^+ in the variance regression ($\lambda_2 > 0$) is consistent with the year 1991 inducing greater price volatility. Conversely, a negative coefficient for D^+ in the variance regression ($\lambda_2 < 0$) indicates that price variability fell after reducing government interventions in agricultural markets. Similarly a positive coefficient for D^0 in the variance regression ($\lambda_1 > 0$) indicates greater price volatility during 1991 and a negative coefficient for D^0 ($\lambda_2 < 0$) indicates that price variability decreased during 1991.

Based on diagnostic tests of residual autocorrelation, the conditional variance equation (6) was estimated as both a first order and second order autoregressive process. Two possible pathways were used to test for ARCH effects. First, a least squares regression of equation (5) was performed, the residuals were retained and squared and t tests were applied to estimates of the population parameters a_1 and a_2 from regressions of the form in equation (7)

$$E(e^2_t) = a_0 + a_1 e^2_{t-1} + a_2 e^2_{t-2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Based on these tests, the null hypothesis of homoskedastic conditional variance was tested at standard significance levels. If it could not be rejected White's heteroskedasticity test was applied. Based on this we test whether the null hypothesis of homoskedastic conditional variance was rejected or not. If it is rejected we apply ARCH(2) model. Given the presence of ARCH effects, least squares method was used to estimate equations (5) and (6).

Data analysed here includes uninterrupted sets of monthly wholesale prices from January 1987 to December 1996. Prices are expressed in rupees per quintal for all commodities (except for coconut). For coconut it is expressed as rupees per thousand nuts. These prices are deflated by consumer price indices.

6.2.2. Price levels and variability of Cereals

Estimated regression results of price levels and variability of cereals are reported in table 6.12. With few exceptions, the point estimates in the mean and variance regressions were individually significant. Using the most parsimonious specification possible, models 1 and 2 establishes the basic ARCH results. First, the slope estimate for the first order autoregressive process indicates serially correlated prices. Second, the coefficient on the lagged variance term is positive and significant, indicating presence of conditional heteroskedasticity in error terms of the mean equation; this justifies the use of the ARCH model and indicates that using an autoregressive (AR) process alone for statistical inference in the mean equation would be inefficient. Also lagged price (1-period) was negative for model 1 which indicates the negative relationship of price to its lagged value.

Model 2 adds two period lagged price to model 1 and this reduces coefficients of one period lagged price and constant term of model 1. Eventhough one period lag was negative to price, two period lag was positive in both mean and variance equation. Two period lagged variance was greater and significant which implies that it increased variability of rice prices.

The coefficient of 1991 dummy (model 3) showed a two fold increase in price levels and a four fold decrease in price variance during that year. Coefficient estimates of lagged prices in the mean equation were not significantly different from zero indicates their low importance in the price levels.

Post 1991 dummy reveals a two fold increase in price levels and a decrease in price variance (model 4). Thus, after 1991, price variance fell. The hypothesis set out earlier – namely price variability increased after 1991– was rejected in the case of rice. Or, in other words, we can say that during the post 1991 period, rice price level was increasing and price variance was decreasing.

Table 6.12

OLS estimates of ARCH models of Rice

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	60.83⊗	60.80⊗	60.52⊗	59.09⊗	55.96⊗	55.17⊗
Lagged(I-period)price	(-)0.02	(-)0.03	(-)0.03	(-)0.01	0.040	(-)0.04
Lagged (2-period)price		0.05 ⊗⊗⊗	0.05⊗⊗	0.064⊗⊗⊗	0.073⊗⊗⊗	0.007
1991 Dummy (D0)			2.88⊗	1.45⊗⊗⊗	2.652⊗⊗	3.47⊗
Post 1991 Dummy(D+)				2.809⊗	0.370	(-)0.64
Trend					0.007⊗⊗	(-)0.022⊗
Seasonally Adjusted Price						0.03⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	10.560	4.899	5.345	5.617	5.580	
Lagged(I-period)variance	0.868⊗⊗⊗	(-)0.822⊗⊗	0.117	0.117	0.082	
Lagged(2-period)variance		0.81⊗	0.799⊗	0.798⊗	0.799⊗	
1991 Dummy (D0)			(-)4.782⊗⊗	(-)4.53⊗⊗⊗	(-)4.54⊗⊗⊗	
Post 1991 Dummy(D+)				(-)0.514	(-)0.458	
Lagged (1-period) price					0.050	
R^2						32.11

"⊗" - Significant at 5% level
"⊗⊗" - Significant at 10% level
"⊗⊗⊗" - Significant at 25% level

Results from model 5 of mean equation indicate a slight upward increase in price levels due to time trend. This trend reduced increase in price level due to post 1991 dummy and increased the influence of 1991 dummy. Seasonal adjustment reduced (model 6) the lagged effects and increased the importance of 1991 dummy on price levels. With the presence of seasonally adjusted component, the time trend and post 1991 dummy became inversely related to mean price level.

6.2.3. Price levels and variability of Oilseeds

Table 6.13 explains the price levels and variability of coconut. Most of the point estimates in mean and variance equations of coconut were statistically significant. Models 1 and 2 of the variance equations establish the basic ARCH results. Lagged values have direct and significant influence in explaining the price levels and variance of coconut. Inclusion of second period lag reduced the influence of mean price level and variance of the first period lag. Model 3 which includes 1991 dummy says during 1991 average price level of coconut increased, but its variance decreased. Coefficient of post 1991 dummy was negative for both mean and variance equations. That means price level and variance of coconut decreased after 1991. Thus null hypothesis of increased price variance after 1991 is rejected. Influence of trend values on price level was significant but negative. Increase in price levels of coconut because of seasonalisation was very small but significant. Seasonality was inversely related

Table 6.13

OLS estimates of ARCH models of Coconut

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	340.51⊗	340.39⊗	329.59⊗	350.25⊗	696.25⊗	494.31⊗
Lagged(l-period)price	0.506⊗	0.237⊗⊗⊗	0.256⊗⊗	0.257⊗⊗	0.276⊗	-0.040
Lagged (2-period)price		0.385⊗	0.344⊗	0.323⊗	0.406⊗	0.229⊗
1991 Dummy (D0)			108.17⊗	128.94⊗	60.54⊗	21.71⊗
Post 1991 Dummy(D+)				(-)41.31⊗	94.54⊗	(-)5.97
Trend					(-)0.117⊗	(-)0.13⊗
Seasonally Adjusted Price						0.09⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	543.73⊗⊗⊗	502.910	505.260	524.390	524.500	
Lagged(l-period)variance	0.343⊗	0.132⊗	0.143	0.146	0.147	
Lagged(2-period)variance		0.175⊗⊗	0.178⊗⊗	0.183⊗⊗	0.182⊗⊗	
1991 Dummy (D0)			(-)67.63	(-)49.87	(-)49.86	
Post 1991 Dummy(D+)				(-)44.58	(-)44.03	
Lagged (1-period) price					0.118	
R^2						88.24

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

to its lagged and trend values. Lagged prices increased the influence of dummy variables (both 1991 and post 1991 dummy) on price variance. Also, lagged, dummy, trend and seasonality affect mean price levels significantly in most of the models.

6.2.4. price levels and variability of plantation crops

Rubber

Price levels and variability of rubber is given in table 6.14. All point estimates in mean equations and most of them in variance equations were statistically significant at 5% level. Lagged values have positive and significant influence in the determination of mean and variance of rubber prices. But model 2 implies that second period lag was more important than first period lag. Results say that average price and variability decreased during 1991, but was increasing after 1991. Trend and seasonal factors were in direct relation with price level. In the presence of these factors average prices of rubber increased during 1991 and decreased after that year. Lagged (both periods) variance influenced variance of rubber positively and significantly. During 1991, variance decreased but after that its variance increased. Influence of lagged price on price variance was low but negative and significant.

Table 6.14

OLS estimates of ARCH models of Rubber

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	241.76⊗	241.58⊗	245.71⊗	239.01⊗	175.78⊗	178.46⊗
Lagged(l-period)price	0.496⊗	(-)0.52⊗⊗	(-)0.501⊗⊗	(-)0.49⊗⊗	(-)0.44⊗⊗	(-)0.12⊗⊗⊗
Lagged (2-period)price		0.763⊗	0.758⊗	0.75⊗	0.73⊗	0.278⊗
1991 Dummy (D0)			(-)41.236⊗	(-)47.93⊗	(-)17.71⊗⊗	8.806⊗⊗
Post 1991 Dummy(D+)				13.397⊗	(-)45.56⊗	(-)36.76⊗
Trend					0.035⊗	(-)0.020⊗
Seasonally Adjusted Price						0.052⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	160.950	127.710	135.440	122.080	121.210	
Lagged(l-period)variance	0.327⊗	0.179⊗	0.174⊗	0.176⊗	0.174⊗	
Lagged(2-period)variance		0.295⊗	0.300⊗	0.301⊗	0.307⊗	
1991 Dummy (D0)			(-)80.24⊗⊗	(-)93.153⊗⊗	(-)92.50⊗⊗⊗	
Post 1991 Dummy(D+)				25.940	26.330	
Lagged (1-period) price					(-)0.86⊗⊗⊗	
R^2						88.78

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

Tea

Almost all the point estimates in mean and variance equations (table 6.15) are statistically significant. Lagged price was significant and positive to deflated price of tea. Mean price was directly related to its second period lag and inversely related to its first period lag. During the year 1991 average price of tea increased but after that it was decreasing. Trend and seasonally adjusted variable on price was positive and significant but very low. In all the models 1991 dummy variable was positive and post 1991 dummy was negative (in mean equations). Trend and seasonal factor influence on these variables was very low. This strongly supports the view that during 1991 mean price level increased and after that year it decreased. Tea price variance was positively related to its second lag. Models 4 and 5 of variance equations says that price variance decreased during 1991 and after that its volatility increased. Also, lagged price influence on price variance was very low and insignificant.

6.2.5. Price levels and variability of Spices and condiments

Pepper

Regression results of price levels and variability of pepper are presented in table 6.16. With few exceptions, the point estimates in both equations were individually significant. Slope coefficients of first and second order autoregressive process (models 1 and 2) indicates serially correlated

Table 6.15

OLS estimates of ARCH models of Tea

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	3.67⊗	3.67⊗	3.66⊗	4.10⊗	1.72⊗	4.35⊗
Lagged(l-period)price	0.58⊗	(-)0.31⊗⊗⊗	(-)0.31⊗⊗	0.28⊗⊗⊗	(-)0.30⊗⊗⊗	(-)0.11⊗⊗⊗
Lagged (2-period)price		0.71⊗	0.71⊗	0.62⊗	0.60⊗	0.16⊗⊗
1991 Dummy (D0)			0.15⊗⊗⊗	0.56⊗	1.02⊗	0.36⊗
Post 1991 Dummy(D+)				(-)0.88⊗	(-)1.82⊗	(-)0.53⊗
Trend					0.08⊗	(-)0.13⊗
Seasonally Adjusted Price						0.114⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	0.10⊗⊗⊗	0.101⊗⊗⊗	0.11⊗⊗⊗	0.086⊗	5.580	
Lagged(l-period)variance	(-)0.25⊗⊗⊗	(-)0.389⊗⊗	(-)0.38⊗⊗	(-)0.43⊗	0.082	
Lagged(2-period)variance		0.103⊗⊗⊗	0.099⊗⊗⊗	0.08⊗	0.799⊗	
1991 Dummy (D0)			(-)0.07⊗	(-)0.09⊗	(-)4.54⊗⊗⊗	
Post 1991 Dummy(D+)				0.05⊗	-0.458	
Lagged (1-period) price					0.050	
R^2						88.01

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

Table 6.16

OLS estimates of ARCH models of Pepper

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	445.47⊗	446.04⊗	461.31⊗	529.25⊗	689.82⊗	806.61⊗
Lagged(l-period)price	0.031⊗⊗⊗	(-)0.487⊗⊗	-)0.504⊗⊗	(-)0.488⊗⊗	(-)0.48⊗⊗⊗	(-)0.2534⊗
Lagged (2-period)price		0.407⊗⊗⊗	0.308⊗⊗⊗	0.59⊗⊗	0.601⊗	0.350⊗
1991 Dummy (D0)			(-)157.41⊗	(-)84.37⊗	(-)120.63⊗	(-)21.57⊗
Post 1991 Dummy(D+)				134.49⊗	(-)61.360⊗⊗	27.83⊗
Trend					(-)0.042⊗⊗	(-)0.163⊗
Seasonally Adjusted Price						0.082⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	822.870	816.070	879.280	1039.62⊗⊗	970.050	
Lagged(l-period)variance	8.93⊗⊗	(-)8.160⊗⊗	(-)8.31⊗⊗	(-)8.41⊗⊗⊗	(-)5.19⊗⊗⊗	
Lagged(2-period)variance		16.89⊗	16.74⊗	16.83⊗	18.33⊗	
1991 Dummy (D0)			(-)631.31⊗	-)470.85⊗⊗	(-)605.88⊗⊗	
Post 1991 Dummy(D+)				(-)320.77⊗⊗	(-)209.34⊗⊗⊗	
Lagged (1-period) price					(-)8.928⊗	
R^2						96.00

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

prices. Secondly, the coefficients on the lagged variance term are significant, indicating presence of conditional heteroskedasticity in error terms of the mean equations and this justifies the use of ARCH model. Inclusion of second period lags in both mean and variance equation changes the sign of first period lag significantly. The table indicates that during and after 1991 mean and variance of pepper prices decreased. Influence of trend on average price level was negative and significant (model 5). Seasonality influenced mean prices positively but it changed the sign of post reform dummy. Also, lagged deflated prices adversely affected the price variance of this commodity.

Ginger

Changes in price levels and variability of ginger before and after 1991 is given in table 6.17. Model 1 supports the characteristic features of ARCH effects. Lagged price was positive and significant to average price level. During 1991 average ginger price decreased but since then it increased significantly. Trend and seasonal factors affected ginger price level significantly. Influence of lagged variance (especially first period) on price volatility was significant. Also lagged prices decreased price variance. Analyses revealed that during and after 1991 variance of ginger prices decreased, but their influence seems to be insignificant.

Table 6.17

OLS estimates of ARCH models of Ginger

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	279.81⊗	279.52⊗	284.69⊗	263.131⊗	129.33⊗	159.775⊗
Lagged(l-period)price	0.467⊗	(-)0.355⊗⊗	(-)0.359⊗⊗	(-)0.3[illegible]⊗	(-)0.286⊗⊗⊗	(-)0.234⊗⊗
Lagged (2-period)price		0.658⊗	0.616⊗	0.616⊗	0.669⊗	0.415⊗
1991 Dummy (D0)			(-)51.16⊗	(-)72.84⊗	11.084⊗⊗⊗	28.366⊗
Post 1991 Dummy(D+)				43.15⊗	(-)121.308⊗	(-)58.885⊗
Trend					0.069⊗	(-)0.009⊗⊗
Seasonally Adjusted Price						0.059⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	868.93⊗⊗⊗	859.94⊗⊗⊗	869.74⊗⊗	905.13⊗⊗⊗	908.28⊗⊗⊗	
Lagged(l-period)variance	(-)0.216⊗⊗⊗	(-)0.257⊗⊗	(-)0.263⊗⊗	(-)0.28⊗⊗⊗	(-)0.28⊗⊗⊗	
Lagged(2-period)variance		0.037	0.039	0.050	0.050	
1991 Dummy (D0)			(-)92.47	(-)55.24	(-)67.110	
Post 1991 Dummy(D+)				(-)77.07	(-)76.16	
Lagged (1-period) price					(-)1.22	
R^2						84.46

'⊗' - Significant at 5% level
'⊗⊗' - Significant at 10% level
'⊗⊗⊗' - Significant at 25% level

Arecanut

Most of the point estimates in mean and variance equations of arecanut (table 6.18) are significant. Lagged values have direct and significant influence in explaining the changes in average price and variance of arecanut. Model 3 which includes 1991 dummy reflects the fact that price level of arecanut increased significantly. But during 1991 its price variance decreased significantly. Model 4 says that after 1991 price level and variance conditional on post 1991 dummy increased. Thus null hypothesis of increased price variance was accepted. Also lagged deflated price influence on price variance was inverse.

Turmeric

We know that model 1 (table 6.19) favours ARCH (1) and model 2 ARCH (2) model of turmeric. Most of the point estimates were significant at standard levels. Average price and its variance was much influenced by their lagged values. Eventhough inclusion of second period lagged variance reduced the coefficient value of first period variance, both of them had significant influence on price variance of turmeric. Changes in the price level during and after 1991 were positive and significant. During the year 1991 variance decreased but after that its variance increased significantly. Seasonal factors reduced average prices and lagged deflated prices reduced price variance after 1991.

Table 6.18

OLS estimates of ARCH models of Arecanut

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	335.35⊗	335.08⊗	314.503⊗	268.25⊗	211.93⊗	163.55⊗
Lagged(l-period)price	0.484⊗⊗	0.030	0.103	0.109	0.111	0.046
Lagged (2-period)price		0.463⊗⊗	0.581⊗	0.805⊗	0.701⊗	(-)0.048
1991 Dummy (D0)			204.52⊗	161.91⊗	190.12⊗	21.53⊗
Post 1991 Dummy(D+)				91.49⊗	32.23⊗⊗⊗	(-)70.29⊗
Trend					0.023⊗	(-)0.088⊗
Seasonally Adjusted Price						0.122⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	648.143⊗⊗	633.966⊗⊗	643.713	527.86⊗⊗	549.886⊗⊗⊗	
Lagged(l-period)variance	0.300⊗	0.056	0.070	0.023	(-)0.010	
Lagged(2-period)variance		0.132⊗⊗	0.133⊗⊗	0.116⊗⊗	0.136⊗⊗	
1991 Dummy (D0)			(-)137.35⊗⊗	(-)245.18⊗⊗	(-)261.60⊗⊗⊗	
Post 1991 Dummy(D+)				269.127⊗	227.807⊗⊗	
Lagged (1-period) price					(-)4.004⊗	
R^2						94.00

*⊗ - Significant at 5% level
*⊗⊗ - Significant at 10% level
*⊗⊗⊗ - Significant at 25% level

Table 6.19

OLS estimates of ARCH models of Turmeric

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	188.215⊗	188.014⊗	168.716⊗	157.048⊗	193.44⊗	148.098⊗
Lagged(l-period)price	0.489⊗	(-)0.032	0.153⊗⊗⊗	0.141	0.128	(-)0.051
Lagged (2-period)price		0.506⊗	0.298⊗	0.329⊗	0.354⊗	0.157⊗
1991 Dummy (D0)			193.914⊗	181.764⊗	169.156⊗	19.336⊗
Post 1991 Dummy(D+)				23.387⊗	47.927⊗	(-)6.418
Trend					(-)0.024⊗⊗⊗	(-)0.071⊗
Seasonally Adjusted Price						0.093⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	375.690	345.423	347.791	308.109	312.945	
Lagged(l-period)variance	0.378⊗	0.169⊗	0.172⊗	0.167⊗	0.179⊗	
Lagged(2-period)variance		0.183⊗	0.183⊗	0.177⊗	0163⊗	
1991 Dummy (D0)			(-)31.307	(-)69.932	(-)65.5	
Post 1991 Dummy(D+)				88.063⊗⊗⊗	86.05⊗⊗⊗	
Lagged (1-period) price					(-)1.416⊗⊗⊗	
R^2						92.56

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

6.2.6. Price levels and variability of Fruits and vegetables

Banana

Regression results showing price levels and variability of banana is shown in table 6.20. Models 1 and 2 favour heteroskedastic conditional variance in banana price series. Average prices and variance were directly and significantly influenced by their lagged values. Price levels and variance decreased during 1991. But after that prices varied significantly. Influence of trend factors on average prices was very low but positive and significant. Seasonality effect was indirect to average banana price. Also lagged deflated price increased variance insignificantly.

Tapioca

Most of the regression coefficients of tapioca in table 6.21 were statistically significant. ARCH effect was reflected in models 1 and 2. Lagged prices increased both mean and variance of tapioca prices. Year 1991 were favourable and insignificant to its average prices but indirect and significant to price variance. In the year 1991 tapioca mean prices increased and variance decreased. Table also implies that trend factors decreased mean price level. Seasonality increased average prices significantly. Price variance increased due to lagged price effect but its effect was insignificant.

Table 6.20

OLS estimates of ARCH models of Banana

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	88.529⊗	88.639⊗	89.562⊗	93.335⊗	45.138⊗	48.322⊗
Lagged(I-period)price	0.508	0.263⊗	0.266⊗	0.267⊗	0.112⊗	0.132⊗
Lagged (2-period)price		0.38⊗	0.379⊗	0.378⊗	0.166⊗	0.155⊗
1991 Dummy (D0)			(-)9.231⊗	(-)5.459⊗⊗	13.119⊗	10.679⊗
Post 1991 Dummy(D+)				(-)7.546⊗	(-)30.351⊗	(-)27.401⊗
Trend					0.009⊗	0.011⊗
Seasonally Adjusted Price						(-)0.024⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	58.464	47.843	53.851	18.668	18.926	
Lagged(I-period)variance	0.615⊗	0.249⊗⊗	0.247⊗⊗	0.281⊗	0.28⊗	
Lagged(2-period)variance		0.397⊗	0.403⊗	0.360⊗	0.355⊗	
1991 Dummy (D0)			(-)62.093⊗	(-)98.286⊗	(-)98.386⊗	
Post 1991 Dummy(D+)				72.883⊗	72.969⊗	
Lagged (1-period) price					0.092	
R^2						74.01

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

Table 6.21

OLS estimates of ARCH models of Tapioca

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	16.546⊗	16.532⊗	16.494⊗	16.063⊗	27.515⊗	1.754⊗⊗⊗
Lagged(l-period)price	0.507⊗	(-)0.227⊗⊗	(-)0.220⊗⊗	(-)0.224⊗⊗	(-)0.164⊗⊗⊗	(-)0.205⊗⊗⊗
Lagged (2-period)price		0.623⊗	0.622⊗	0.619⊗	0.589⊗	0.492⊗
1991 Dummy (D0)			0.38	(-)0.053	2.625⊗	2.206⊗
Post 1991 Dummy(D+)				0.863⊗	(-)4.586⊗	(-)2.509⊗
Trend					(-)0.049⊗	0.028⊗
Seasonally Adjusted Price						0.062⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	3.218⊗⊗⊗	2.799⊗⊗⊗	3.238⊗⊗⊗	3.63⊗⊗⊗	3.629⊗⊗⊗	
Lagged(l-period)variance	0.210⊗⊗⊗	(-)0.172⊗⊗	(-)0.209⊗⊗	(-)0.208⊗⊗	(-)0.202⊗⊗⊗	
Lagged(2-period)variance		0.425⊗	0.374⊗	0.419⊗	0.416⊗	
1991 Dummy (D0)			(-)3.191⊗	(-)2.657⊗	(-)2.646⊗	
Post 1991 Dummy(D+)				(-)0.955⊗⊗	(-)0.956⊗⊗	
Lagged (1-period) price					0.033	
R^2						56.07

'⊗' - Significant at 5% level
'⊗⊗ - Significant at 10% level
'⊗⊗⊗ - Significant at 25% level

6.2.7. Price levels and variability of Sugar

In the table 6.22 most of the estimates of price levels and variability of sugar are significant and the presence of ARCH effect reveals the following facts about sugar prices. Average prices and its volatility depend significantly upon its past values. But if one more lagged value were present, the second lagged value had more influence than the first period lagged value. Year 1991 had significant influence on sugar prices and its variance (models 3 and 4). Therefore our null hypothesis – increased price variability after 1991 – was rejected. Trend and seasonal factors had low, insignificant but direct influence on average prices. The presence of seasonality affects the 1991 dummy to be positive with changes in mean prices. All other factors influencing price levels were robust in their signs. Also, lagged price deflated by consumer price indices had inverse relation with conditional variance.

Conclusion

The foregoing analysis has shown that variability of relative prices in agriculture has not been stable over the last 36 years. The result supports the hypothesis that variability of relative prices in agriculture is related to (a) the average rate of nominal price change among agricultural commodities, (b) actual and unexpected inflation and (c) other economic variables like changes in real GNP growth rate.

Table 6.22

OLS estimates of ARCH models of Sugar

Mean Equation : Dependent variable is deflated Price						
Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	90.376⊗	90.402⊗	90.924⊗	92.418⊗	90.275⊗	83.286⊗
Lagged(I-period)price	0.531⊗	0.036	0.012	0.010	0.010	0.051
Lagged (2-period)price		0.507⊗	0.508⊗	0.500⊗	0.504⊗	0.18⊗⊗
1991 Dummy (D0)			(-)5.238⊗	(-)3.753⊗⊗	(-)3.087⊗⊗⊗	6.711⊗
Post 1991 Dummy(D+)				(-)2.987⊗	(-)4.352⊗⊗⊗	(-)9.781⊗
Trend					0.003	(-)0.058⊗
Seasonally Adjusted Price						0.070⊗
Variance Equation : Dependent variable is conditional variance in Price						
Constant	35.846⊗⊗⊗	32.968⊗⊗⊗	35.529⊗⊗	41.088⊗⊗⊗	40.355⊗⊗⊗	
Lagged(I-period)variance	0.281⊗⊗⊗	(-)0.267	(-)0.238	(-)0.197	(-)0.103	
Lagged(2-period)variance		0.441⊗	0.446⊗	0.467⊗	0.520⊗	
1991 Dummy (D0)			(-)27.594⊗	(-)21.656⊗	(-)22.594⊗	
Post 1991 Dummy(D+)				(-)11.997⊗	(-)12.613⊗	
Lagged (1-period) price					(-)1.139⊗	
R^2						56.12

'⊗' - Significant at 5% level
'⊗⊗' - Significant at 10% level
'⊗⊗⊗' - Significant at 25% level

Average rate of nominal price change among agricultural commodities had positive relationship with farm prices of coconut, ginger, arecanut and cashewnut. Eventhough this variable had negative relation with paddy prices, it becomes positive in the presence of other aggregate variables. Actual inflation rate was positively related to farm prices of paddy, coconut, arecanut, cashewnut and banana and negative to pepper, ginger, tapioca and sugarcane. But the presence of unexpected inflation changes the direction of relationships of coconut, pepper, ginger, arecanut, tapioca and sugarcane. Changes in real GNP had direct effect on coconut, arecanut, banana and tapioca prices. All other farm prices were inversely related to it.

Eventhough these relationships can be derived, the coefficient of determination of aggregate economic variables upon the farm prices of all commodities (except paddy and coconut) seems to be very low. But this study support the hypothesis that farm prices are related to macroeconomic variables because most of the point estimates were statistically significant at standard levels of significance.

Application of ARCH models to agricultural price reveals that coefficient of determination of mean equations of all commodities except rice was highly significant. Thus results confirm that in the year 1991, price variability in all the selected agricultural commodities was less. But after 1991 price variability was greater for plantation crops, spices and condiments (arecanut and turmeric) and fruits and vegetables (banana). And price volatility decreased for cereals, oilseeds, pepper, ginger and sugar. These changes in price variability were evident, even when lagged price effects were incorporated as explanatory variable.

Mean price levels of agricultural commodities like rice, coconut, tea, arecanut and turmeric showed increasing trend during 1991. The average prices of rice, rubber, ginger, arecanut, turmeric and tapioca continued to increase after 1991 year also. When trend and seasonality factors were incorporated as explanatory variables mean price levels increased for all commodities (except pepper) after 1991. Thus, we can accept the fact that if trend and seasonality factors were significant, then mean price levels decreased (except pepper) after 1991.

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PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

By

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THESIS SUBMITTED TO THE UNIVERSITY OF CALICUT
FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
UNIVERSITY OF CALICUT
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August 1999

Chapter 7

7. Inter – district Price Integration

7.1. Market integration of Cereals

7.2. Market integration of oilseeds

7.3. Market integration of Plantation crops

7.4. Market integration of spices and condiments

7.5. Market integration of Fruits and Vegetables

7.6. Market integration of Sugarcane

INTER – DISTRICT PRICE INTEGRATION

Price efficiency is very much important to indicate overall market performance of commodities. It helps to see the spatial price relationships. Usually integrated markets are those where prices are determined interdependently. This has generally been assumed to mean that price changes in one market will be fully transmitted to other markets. Markets that are not integrated may convey inaccurate price information that might distort marketing decisions and contribute to inefficient product movements.

In this chapter, price efficiency of the selected agricultural commodities between different districts has been examined. Monthly averages of wholesale price data for the commodities from January 1987 to December 1996 are taken. On the whole there are 120 observations.

The specification of an econometric model of spatial price differentials will depend, in part, on assumptions about spatial market structure. Here we shall assume that there exists a group of local markets and a single central market. While there may be some trade among the local markets, it is trade with the central market, which dominates local price formation. Depending on the number of local markets and their sizes, one can also posit that the central market price is influenced by various local prices. Thiruvananthapuram, being the capital of Kerala, is considered as the central market and others as local markets. When data for Thiruvananthapuram market are not available, Ernakulam market is taken as central market.

Thus, the static pattern of price formation among N markets, where market 1 is the central market, may be summarised by a model of the form

$$P_1 = f_1 (P_2, P_3, P_4, \ldots\ldots\ldots) \text{ -------------(1)}$$

$$P_i = f_i (P_1) \text{ -------------(2)}$$

The functions f_i ($i = 1,2,3, \ldots\ldots\ldots N$) can be thought of as solutions of the appropriate conditions for market equilibrium taking account of the main spatial choices and costs of adjustment facing traders when deciding where to sell.

Ravallion (1986)[114] has given a dynamic structure to the above model. To him dynamic effects can arise from a number of conditions in the underlying behavioural relations including expectation formation and adjustment costs. By permitting each local price series to have its own dynamic structure as well as an inter linkage with other local markets, the main inferential dangers of the simpler bivariate model can be avoided. Most important, the alternative hypothesis of market integration and market segmentation can then be encompassed within a more general model and so tested as restricted forms.

114 Ravallion, M, (1986), "Testing market integration", American Journal of Agricultural Economics, Vol. LXXV111, No. 1, PP 102-109.

A dynamic model also has the advantage that one can distinguish between the concepts of instantaneous market integration and the less restrictive idea of integration as a long-run target of the short-run dynamic adjustment process. In many settings it will be implausible that trade adjusts instantaneously to spatial price differentials, and so one would be reluctant to accept short-run market integration as an equilibrium concept. But, given enough time, the short-run adjustments might exhibit a pattern, which converges to such an equilibrium. If short-run integration is rejected, then it would be nice to know if there is any long-run tendency toward market integration.

Combining these considerations, the following econometric model of a T-period series of prices for N regions (with a slight difference from the model of Ravallion, 1986) is assumed for the present study.

$$P_{1t} = \Sigma_j a_{ij} P_{1t-j} + \Sigma_k \Sigma_j b_1{}^k{}_j P_{kt-j} + e_{1t} \quad \text{-----------------(3)}$$

$$P_{it} = \Sigma_j a_{ij} P_{it-j} + \Sigma_j b_{ij} P_{1t-j} + e_{it} \quad \text{-----------------(4)}$$

Where i, k = 2,3,4, ...,N,

j=0,1,2, ...,N,

e's are appropriate error processes and

a's and b's are fixed coefficients.

In terms of the parameters of equation (4), the following hypothesis will usually be testable.

(a) Market segmentation :- Central market prices do not influence prices in the i^{th} local market if

$$b_{ij} = 0 \ (j=0,1,2,3, \ldots\ldots\ldots\ldots N) \quad \text{---------------(5)}$$

in which case the data would be better described by the corresponding restricted form of equation (4).

(b) Short-run market integration :- A price increase in the central market will be immediately passed on the i^{th} market price if

$$b_{i0} = 1 \quad \text{---------------(6)}$$

Of course, there will also be lagged effects on future prices unless, in addition to (6) :

$$a_{ij} = b_{ij} = 0 \quad (j = 1,2,3,\ldots\ldots\ldots\ldots N) \quad \ldots\ldots\ldots\ldots\ldots(7)$$

If both equation (6) and (7) are accepted as parameter restrictions, then one can say that market "i" is integrated with the central market within one time period. A weaker form of market integration will also be tested in which the lagged effects need only vanish on average:

$$a_{ij} + b_{ij} = 0 \quad (j = 1,2,3,\ldots\ldots\ldots\ldots N) \quad \ldots\ldots\ldots\ldots\ldots(8)$$

(c) Long-run market integration :- A long run equilibrium is one in which market prices are constant overtime, undisturbed by any local stochastic effects. So consider the form that equation (4) takes when $P_{it} = P^*_i$, $P1t = P^*_1$, and $e_{it} = 0$ for all t, then

$$P^*i = \frac{P^*_1 \Sigma_j b_{ij}}{1 - \Sigma_j a_{ij}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(9)$$

It can be seen that market integration now requires that

$$\Sigma_j a_{ij} + \Sigma_j b_{ij} = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots(10)$$

If this parameter restriction is accepted, then the short-run process of price adjustment descripted by the model is consistent with an equilibrium in which a unit increase in central price is passed on fully in local prices. Acceptance of the short-run restrictions implies long-run market integration but that the reverse is not true.

If the long-run market integration restriction is accepted, then more efficient estimates of the remaining parameters and more powerful statistical tests will be possible if the model is re-estimated with long-run integration imposed. For example, under long-run integration equation (4) can be written in the following equivalent form.

$$\Delta P_{it} = (a_{i1}-1)(P_{it-1} - P_{1t-1}) + \Sigma_j a_{ij}(P_{it-j} - P_{1t-j}) + b_{i0}\Delta P_{1t} + \Sigma_j(b_{i0} - 1 + \Sigma a_{ik} + b_{ik})\,\Delta P_{1t-j} + e_{it}$$

-----------(11)

This is a member of the class of error correlation models. By interpretation, changes in local prices are attributed to changes in central prices and past spatial price differentials: the latter variables allow for the possibility that the markets are not observed in an integrated equilibrium at a given point in time and so there is feedback from prior disequilibria.

Ordinary least square method was used to estimate equations (3) and (4). For convenience we have taken only one period lag. Statistical significance of estimates was tested using Student's t test.

7.1. Market Integration of Cereals

Market integration of cereals is estimated by taking wholesale prices of rice. For this Thiruvananthapuram market is considered as the central market and markets at Kollam, Alappuzha, Ernakulam, Thrissur, Palakkad, Kozhikode and Kannur as local markets. Table 7.1 depicts price efficiency of rice markets in Kerala. 96.49% of variation in central market price was determined by local markets. Out of the 15 coefficients, only 6 were found to be significant. Current year prices at Thrissur and Kozhikode were inversely related to central price. But their lagged effects have positive relation to central price. Except Alappuzha, Palakkad and Kannur, all other lagged prices were directly related to the selected central price. Coefficient of determination of all 7 district markets on central price was high. All slope coefficients are positive which shows the direct influence of lagged local price and current central price on local price. Also except the lagged Alappuzha price, all others were found to be significant.

From the table, we can analyse that all the estimated b_{i0}'s were greater than zero which imply that central market price influences prices in

Table 7.1

Price Efficiency of Rice

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma_k \Sigma_j b_{ij}^k P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		bio	bi1		
Thiruvananthapuram	0.482⊗			49.329	0.9649
Kollam		0.293	0.138		
Alappuzha		1.23⊗	(-)1.156⊗		
Ernakulam		0.150	0.030		
Thrissur		-0.061	0.020		
Palakkad		0.104	(-)0.164⊗⊗		
Kozhikode		(-)0.735⊗	0.397⊗		
Kannur		0.066	-0.246		

Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$					
	ai1	bio	CI	R^2	
Kollam	0.196	0.945⊗	4.888	0.931	
Alappuzha	0.495⊗	0.889⊗	(-)5.175	0.947	
Ernakulam	0.558⊗	0.973⊗	(-)27.223	0.941	
Thrissur	0.521⊗	0.887⊗	41.880	0.875	
Palakkad	0.87⊗	0.879⊗	(-)25.021	0.944	
Kozhikode	0.52⊗	0.903⊗	(-)0.196	0.925	
Kannur	0.537⊗	0.848⊗	30.019	0.938	

'⊗' - Statistically Significant at 5% level.

the local markets. Or, market segmentation performs poorly in the rice markets. Also, since all the b_{i0}'s are less than one we can say that short-run market integration within one month cannot be accepted. Constant term is not significantly different from zero and b_{i0} is not significantly different from one at Kozhikode reveals that prices at that market and central market were identical. For all other markets their relationships were proportional. Of course, there will be lagged effects on local prices because all the estimated a_{i1}'s are not equal to one. For rice markets of Kerala the short-run process of price adjustment is consistent (except for Ernakulam and Palakkad) with an equilibrium in which a unit increase in central price is passed on fully to local prices. That is, we can accept short-run restrictions or long-run market integration for rice excluding Ernakulam and Palakkad markets.

7.2. Market Integration of oilseeds

Inter district price integration of oilseeds is estimated with the example of coconut with husk. Here also Thiruvananthapuram was treated as central market and markets at Kollam, Pathanamthitta, Alappuzha and Ernakulam as local markets. 96.5% of variation in central market price was determined by these local prices (see table 7.2). Current year prices at Kollam, Pathanamthitta and Alappuzha were found to be significant. For Ernakulam, the coefficients of current year price and lagged price were not significant. Lagged prices at Kollam, Pathanamthitta and Alappuzha were inversely related to

Table 7.2

Price Efficiency of Coconut with Husk

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k\, \Sigma j\, b_{ij}^{k} P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		blo	bl1		
Thiruvananthapuram	0.543⊗			(-)66.444	0.9650
Kollam		0.276⊗	(-)0.226⊗		
Pathanamthitta		0.127⊗	(-)0.069		
Alappuzha		0.488⊗	(-)0.232⊗⊗		
Ernakulam		0.007	0.005		
Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$					
	al1	blo	Cl	R^2	
Kollam	0.215⊗	1.115⊗	337.366	0.937	
Pathanamthitta	0.096	0.9379⊗	386.889	0.844	
Alappuzha	0.159⊗⊗	1.016⊗	266.315	0.941	
Ernakulam	0.3654⊗	1.164⊗	(-)18.6165	0.911	

'⊗' - Statistically Significant at 5% level.

'⊗⊗ - Statistically Significant at 1% level.

central price. Coefficients of determination of all the local markets on central price were high. Positive slope coefficients imply the direct relationship of local price with central and lagged price. Except lagged Pathanamthitta price, all others were found to be significant.

Table reveals that all the estimated b_{i0}'s are greater than zero and therefore central market price influences prices at the local markets. That is market segmentation performs poorly in this market also. Since b_{i0}'s of Kollam, Alappuzha and Ernakulam were approximately equal to one, short-run integration within one month was accepted. Also, since all b_{i0} coefficients were not significantly different from one and constant terms significantly different from zero, a fixed differential between local and central price can be expected. Lagged effects on local prices were very small. Thus, short-run restrictions or long-run integration in Pathanamthitta market and short-run integration in all other markets could be accepted.

7.3. Market Integration of Plantation crops

Rubber

Taking Thiruvananthapuram as the central market and Kollam, Kottayam, Ernakulam, Kozhikode and Kannur as local markets (see table 7.3), the analysis shows that 99.87% of variation of central price was determined by these local prices. That is, other market forces determined only

Table 7.3

Price Efficiency of Rubber

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j\, b_{ij}^{k} P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		bio	bi1		
Thiruvananthapuram	0.5068⊗			60.25⊗⊗	0.9987
Kollam		(-)0.028⊗	0.010		
Kottayam		0.178	0.007		
Ernakulam		0.540⊗	(-)0.35⊗		
Kozhikode		0.448⊗	(-)0.209		
Kannur		(-)0.183⊗	0.084⊗		
Equation $Pi_t = a_{i1} P_{it-1} + b_{io} P_{1t-0} + Ci$					
	ai1	bio	Ci	R^2	
Kollam	0.392⊗	0.945⊗	112.658	0.963	
Kottayam	(-)0.069⊗	1.061⊗	(-)84.518⊗⊗	0.998	
Ernakulam	0.011	1.038⊗	(-)45.354	0.998	
Kozhikode	(-)0.0564⊗	1.05⊗	(-)79.905⊗⊗	0.998	
Kannur	0.039	1.06⊗	(-)105.633	0.993	

'⊗' - Statistically Significant at 5% level.

'⊗⊗' - Statistically Significant at 1% level.

very small percentage (0.13%) of variation in central price. Current year prices at Ernakulam, Kozhikode and Kannur and lagged prices at Thiruvananthapuram, Ernakulam and Kannur were significant. Also, current prices at Kollam and Kannur and lagged prices at Ernakulam and Kozhikode were negatively related to central price. Determination of central prices and lagged prices on local prices were very high (greater than 96%). b_{i0} coefficients imply that all local markets have positive relationship with central price. Lagged prices (except Kottayam and Kozhikode) also were in direct relationship with current period local price. But lagged effects at Kottayam and Kozhikode seem to be negative. Except Ernakulam and Kannur, all other central and lagged prices were significant to local price.

All estimated b_{i0}'s were greater than zero and therefore market segmentation was very poor. All b_{i0} coefficients (except Kollam market) were equal to one so that short-run integration operates in the markets at Kottayam, Ernakulam, Kozhikode and Kannur. Since all b_{i0}'s were not significantly different from one and the constant terms were significantly different from zero, a fixed differential between local and central prices can be expected. Lagged effects on local prices were very small. For Kollam the sum of a_{i0} and b_{i0} coefficients was approximately equal to one. Thus, for rubber markets of Kerala short-run integration exists at Kottayam, Ernakulam, Kozhikode and Kannur and long-run integration exists at Kollam market.

Tea

Market integration of tea is tested treating Ernakulam as central market and Kottayam and Kozhikode as local markets. 82.47% of variation in central market price was determined by local prices (table 7.4). That is 17.53% of variation was explained by other factors. All slope coefficients were positive means that both central and local prices move in the same direction. Also, current year prices at Kottayam and Kozhikode and lagged price at Ernakulam have significant relation with central price. Table also shows that 74.20% of Kottayam price and 69.43% of Kozhikode price were determined by the central and lagged prices. Sign of bio coefficients imply that these local prices have a positive relationship with central price or market segmentation has not been present in tea markets of Kerala. Central price and lagged prices have direct relation with local price at Kozhikode market while lagged price has negative relation in Kottayam market. Central prices were significant and lagged local prices for both markets were insignificant to local price.

Table revealed that b_{i0} coefficient at Kottayam is equal to one so that short-run integration within one month can be accepted for that market. Since b_{i0} coefficient was equal to one and constant term was non zero for Kottayam it reflects a fixed differential between the local and central price. But for Kozhikode b_{i0} was significantly different from one and the constant term was significantly different from zero. Thus local prices and central price of tea at

Table 7.4

Price Efficiency of Tea

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j\, b_{ij}^{k} P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		bio	bi1		
Ernakulam	0.6599⊗			5.3689	0.8247
Kottayam		0.4979⊗	0.1297		
Kozhikode		0.1845⊗	0.0155		
Equation $Pi_t = a_{i1} P_{it-1} + b_{io} P_{1t-0} + Ci$					
	ai1	bio	Ci	R^2	
Kottayam	(-)0.2166⊗	1.018⊗	6.790	0.7420	
Kozhikode	0.1487	1.587⊗	(-)6.951	0.6943	

'⊗' - Statistically Significant at 5% level.
'⊗⊗' - Statistically Significant at 1% level.

Kozhikode were proportional, neglecting their low lagged values. Sum of a_{i1} and b_{i0} were greater than one and therefore short-run process of price adjustment described by the model is not consistent with an equilibrium in which a unit increase in central price is passed on fully to local prices. Thus, we can accept neither short-run integration nor long-run integration within one month for tea market at Kozhikode.

7.4. Market integration of spices and condiments

Turmeric

Ernakulam as central market and Alappuzha and Kozhikode as local markets showed that 90.8% of the variation of central market price were determined by these local prices. Current year local prices have direct and their lagged prices have indirect relation to central prices. Also current and lagged prices at Kozhikode market have significant while those at Alappuzha have insignificant relation to central market. 59.3% of Alappuzha price and 87.4% of Kozhikode price were determined by central and lagged local prices. All price coefficients were directly related to current local price. Table also reveals that central prices were significant while lagged local prices were insignificant in the determination of local prices.

b_{i0} coefficients of both markets are greater than zero and therefore market segmentation was absent in turmeric markets. We can not

Table 7.5

Price Efficiency of Turmeric

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \, \Sigma j \, b_{ij}^{k} P_{kt-j}$

Districts	a_{11}	b_{ij}		a	R^2
		blo	bl1		
Ernakulam	0.516⊗			309.3410	0.9080
Alappuzha		0.075	(-)0.119		
Kozhikode		1.003⊗	(-)0.388		

Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$

	al1	blo	Cl	R^2	
Alappuzha	0.270	0.592⊗	549.025	0.5930	
Kozhikode	0.1150	0.829⊗	(-)105.23	0.8740	

'⊗' - Statistically Significant at 5% level.

'⊗⊗' - Statistically Significant at 1% level.

accept short-run integration in either the Alappuzha or the Kozhikode markets because their b_{i0} coefficients were not equal to one. Weaker form of integration has also not been reflected in both these markets due to the reason that sum of a_{i1} and b_{i0} were greater than zero. Similarly, short-run restrictions (i.e., long-run integration) can not be accepted because sum of a_{i1} and b_{i0} coefficients were not equal to one. In other words, short-run and long-run integration for turmeric markets within one month can not be accepted. Constant term along with slope coefficients imply proportional influence of lagged local price and central price on current local price. Thus, only proportional relationship exists in the turmeric markets of Kerala.

Arecanut

Price efficiency of arecanut markets is explained by treating Thiruvananthapuram as central market and Ernakulam, Thrissur, Kozhikode and Kannur as local markets. Table 7.6 shows that 92.29% of central price were determined by various local prices . Current year prices at Kannur and lagged prices at Ernakulam, Thrissur and Kozhikode were inversely related to central price. Also current year prices of Thrissur, Kozhikode and Kannur and lagged price at Kozhikode have significant relation to central price. Table also shows that 82 to 89% of variation in local prices were determined by their central and lagged prices. Coefficient of determination was high in Kozhikode and was low in Ernakulam market. Value of constant terms was greater and significant. All

Table 7.6

Price Efficiency of Arecanut

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j b_{ij}^{k} P_{kt-j}$

Districts	a_{11}	b_{ij}		a	R^2
		bio	bi1		
Thiruvananthapuram	0.488⊗			(-)412.326	0.9229
Ernakulam		0.011	(-)0.08		
Thrissur		0.3850⊗⊗	(-)0.1330		
Kozhikode		1.03⊗	(-)0.652⊗		
Kannur		(-)0.5470⊗	(-)0.250		

Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$

	al1	bio	Cl	R^2	
Ernakulam	0.3310⊗⊗	0.8467⊗	1013.202⊗⊗	0.8250	
Thrissur	0.040	1.009⊗	1136.828⊗⊗	0.8398	
Kozhikode	0.3530⊗	1.022⊗	761.8495⊗⊗	0.8914	
Kannur	0.154	1.0195⊗	904.143⊗⊗	0.8574	

'⊗' - Statistically Significant at 5% level.
'⊗⊗ - Statistically Significant at 1% level.

coefficients corresponding to central and lagged local price at Ernakulam and Kozhikode markets have significant influence upon local price. Also, all lagged and central price coefficients have positive relation to local price.

Table also reveals that all b_{i0} coefficients were greater than zero and therefore market segmentation was poor in arecanut markets of Kerala. That is central price influences all local prices. We can accept short-run integration in Thrissur, Kozhikode and Kannur markets, but that in Ernakulam market was rejected. Eventhough lagged effects on Ernakulam market was very low, weaker form of market integration can not be accepted. Summation of a_{i1} and b_{i0} coefficients of Ernakulam market was approximately equal to one, which signifies short-run restrictions. Thus, arecanut markets at Thrissur, Kozhikode and Kannur had short-run and Ernakulam had long-run integration.

Ginger

Integration of ginger (dry ginger) is analysed by treating Ernakulam as central market and Pathanamthitta, Alappuzha, Palakkad, Kozhikode and Kannur as local markets. 99.69% of variation in central market (table 7.7) was determined by these local markets. Current year local prices of Alappuzha, Palakkad, Kozhikode and Kannur and lagged prices of Ernakulam and Alappuzha were significant to central market. Slope coefficient of lagged Ernakulam price was greater and all others were very small. Also most of the

Table 7.7

Price Efficiency of Dry Ginger

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j b_{ij}^k P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		blo	bl1		
Ernakulam	0.455⊗			37.941	0.9969
Pathanamthitta		0.002	(-)0.002		
Alappuzha		0.259⊗	(-)0.184⊗		
Palakkad		0.336⊗	(-)0.066		
Kozhikode		0.259⊗	0.001		
Kannur		0.166⊗⊗	(-)0.087		

Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$					
	al1	blo	Cl	R^2	
Pathanamthitta	0.4910⊗	0.6190⊗	1012.472	0.5850	
Alappuzha	(-)0.0240⊗	0.9897⊗	(-)0.7799	0.9495	
Palakkad	0.0770⊗⊗	0.9690⊗	(-)44.905	0.9854	
Kozhikode	0.040	0.9765⊗	(-)35.164	0.9869	
Kannur	0.1187⊗	0.9632⊗	(-)40.1817	0.9873	

'⊗ - Statistically Significant at 5% level.
'⊗⊗ - Statistically Significant at 1% level.

lagged local coefficients were negatively related to central ginger market price. About 58.5% to 98.73% of variation in local prices is determined by central and local lagged prices. This determination was high at Kannur and low at Pathanamthitta district. It was decreasing when we move from northern to southern districts. It reflects the fact that other factors influencing ginger prices were greater in southern districts. Except Alappuzha lagged price, all other lagged and central prices were directly related to local prices. Also, all central and lagged prices at Pathanamthitta, Palakkad and Kannur were significant.

Here b_{i0} coefficients were greater than zero and therefore market segmentation performs poorly in ginger markets also. We can not accept short-run integration in any of these markets, due to the fact that all b_{i0} coefficients were less than one. Weaker form of short-run integration was also rejected because lagged coefficients were not equal to zero. But we can accept short-run restrictions for Pathanamthitta, Palakkad, Kozhikode and Kannur markets because summation of lagged local and central prices were approximately equal to one. For Alappuzha identical prices exist between local and central prices (here constant term and lagged price was very low but central price is high). Thus long-run integration exists in most of the ginger markets.

Pepper

Integration of black pepper, treating Thiruvananthapuram as central and Kollam, Pathanamthitta, Alappuzha, Thrissur, Kozhikode and Kannur as local markets, showed that 99.87% of variation of central price was determined by these local prices (see table 7.8). Thus only 0.13% of variation of central price was determined by other factors. All local prices were directly related to central price. But lagged prices at Kollam, Thrissur and Kozhikode were indirectly related to it. Prices at Kollam, Pathanamthitta and Thrissur and lagged prices at Kollam and Thrissur were significant to central pepper price.

Table also showed that 57.82 to 99.72% of variation in local prices were determined by central and lagged prices. Coefficient of determination was highest at Thrissur and lowest at Kannur market. All slope coefficients of central market and lagged coefficients of Kozhikode and Kannur were significant to local prices. It was interesting to note that all lagged local prices and central prices were directly related to local pepper prices.

In the table all b_{i0} coefficients were greater than zero and therefore pepper markets were not segregated. Since b_{i0} coefficients at Kollam, Pathanamthitta, Alappuzha, Thrissur and Kozhikode were approximately equal to one, we can accept short-run integration of black pepper within one month in all these 5 markets. But in the case of Kannur, since b_{i0} coefficient corresponding to

Table 7.8

Price Efficiency of Black Pepper

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j\, b_{ij}^{k} P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		bio	bi1		
Thiruvananthapuram	0.4887⊗			(-)85.394⊗⊗	0.9987
Kollam		0.1484⊗	(-)0.1127⊗		
Pathanamthitta		0.1574⊗	0.005		
Alappuzha		0.011	0.005		
Thrissur		0.6065⊗	(-)0.3132		
Kozhikode		0.0522	(-)0.0494		
Kannur		0.0005	0.0001		
Equation $PI_t = a_{i1} P_{it-1} + b_{io} P_{1t-0} + CI$					
	ai1	bio	CI	R^2	
Kollam	0.013	1.021⊗	111.814	0.990	
Pathanamthitta	0.013	1.022⊗	97.880	0.994	
Alappuzha	0.035	1.055⊗	47.559	0.996	
Thrissur	0.002	1.023⊗	86.173	0.997	
Kozhikode	0.093⊗	1.011⊗	407.105	0.991	
Kannur	0.4956⊗	0.9572⊗	711.104	0.578	

'⊗' - Statistically Significant at 5% level.

it was less than one, short-run integration is rejected. Considering lagged effects of Kannur along with b_{i0} coefficient leads us to the rejection of long-run integration. Therefore only proportional relationship exists between pepper local prices at Kannur and the central market.

7.5. Market Integration of Fruits and Vegetables

Banana

Thiruvananthapuram as central and Kollam, Pathanamthitta, Alappuzha, Ernakulam, Thrissur, Kozhikode and Kannur as local markets showed that 93.18% of variation in central banana prices was determined by these local prices (table 7.9). The constant term seems to be negative but not significant. All current prices, except that at Thrissur, were directly and all lagged local prices except at Thrissur and Kannur were indirectly related to central price. Prices at Kollam, Pathanamthitta, Ernakulam, Thrissur and Kannur and lagged prices at Kollam, Ernakulam and Thrissur were significant. 82 to 89% of variation in local prices were determined by central and lagged local prices. Slope coefficients of local lagged prices and central prices were positive and significant which strongly supports the direct influence of lagged prices and central price on local prices.

All b_{i0} coefficients were positive reveals poor segmentation in banana markets. We can accept neither short-run nor weaker integration in any

Table 7.9

Price Efficiency of Banana

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j\, b_{ij}^{k} P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		blo	bl1		
Thiruvananthapuram	0.4358⊗			(-)17.6701	0.9318
Kollam		0.551⊗	(-)0.283⊗		
Pathanamthitta		0.197⊗⊗	(-)0.114		
Alappuzha		0.064	(-)0.050		
Ernakulam		0.243⊗	(-)0.124⊗⊗		
Thrissur		(-)0.305⊗	0.168⊗⊗		
Kozhikode		0.124	(-)0.023		
Kannur		0.303⊗⊗	0.022		
Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$					
	al1	blo	Cl	R^2	
Kollam	0.3310⊗	0.7889⊗	145.825⊗⊗	0.8991	
Pathanamthitta	0.3491⊗	0.8442⊗	57.585	0.8601	
Alappuzha	0.4440⊗	0.6830⊗	174.283⊗⊗	0.8588	
Ernakulam	0.4440⊗	0.7099⊗	83.033	0.8268	
Thrissur	0.4056⊗	0.9097⊗	(-)134.136	0.8247	
Kozhikode	0.4653⊗	0.9354⊗	(-)173.579⊗⊗	0.8698	
Kannur	0.4630⊗	0.8705⊗	(-)102.148	0.8904	

'⊗' - Statistically Significant at 5% level.

'⊗⊗ - Statistically Significant at 1% level.

of these selected markets. But the sum of the coefficients of lagged and central prices were approximately equal to one and therefore we can impose short-run restrictions. Thus, long -run integration exists in all banana markets of Kerala.

Tapioca

As in the case of banana, here also we treat Thiruvananthapuram as central and Kollam, Pathanamthitta, Alappuzha, Ernakulam, Thrissur, Kozhikode and Kannur as local markets. About 95% of variation in central price were determined by these local prices (table 7.10). Local prices (except that of Pathanamthitta and Alappuzha market) and lagged prices at Kollam and Thrissur were significant to central price. Except local prices at Pathanamthitta, Ernakulam and Thrissur and lagged prices at Kollam, all other local prices were directly related to central price. Price efficiency of tapioca markets showed a wide range of variation in the coefficient of determination. Absolutely it varied from 54.81% to 92.41%. We can see a high R^2 at Kollam and a very low R^2 at Thrissur. All slope coefficients were positively significant which reflect the strong influence of central and lagged prices on local prices.

In the table b_{i0} coefficients were greater than zero and it implies that tapioca markets were not segmented. Since these coefficients were less than one we can not accept short-run integration. All lagged coefficients were positive and significant which leads to the rejection of weaker short-run

Table 7.10

Price Efficiency of Tapioca

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j\, b_{ij}^{k} P_{kt-j}$					
Districts	a_{11}	b_{ij}		a	R^2
		blo	bl1		
Thiruvananthapuram	0.4446⊗			(-)59.028⊗	0.9498
Kollam		0.7333⊗	(-)0.5060⊗		
Pathanamthitta		(-)0.043	0.049		
Alappuzha		0.223	0.099		
Ernakulam		(-)0.2110⊗⊗	0.168		
Thrissur		(-)0.0470⊗	0.0260⊗⊗		
Kozhikode		0.2530⊗	0.001		
Kannur		0.2920⊗	0.002		
Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$					
	al1	blo	Cl	R^2	
Kollam	0.8088⊗	0.7406⊗	42.699⊗	0.9241	
Pathanamthitta	0.4520⊗	0.8410⊗	18.233	0.8840	
Alappuzha	0.5222⊗	0.7550⊗	51.526⊗	0.9097	
Ernakulam	0.6240⊗	0.7850⊗	42.804⊗⊗	0.8755	
Thrissur	0.4990⊗	0.5115⊗	98.770⊗⊗	0.5481	
Kozhikode	0.4140⊗	0.6840⊗	57.732⊗	0.8688	
Kannur	0.2910⊗⊗	0.9610⊗	87.675	0.8880	

'⊗' - Statistically Significant at 5% level.

'⊗⊗ - Statistically Significant at 1% level.

integration. But as in the case of banana, the sum of the coefficients of lagged price and central price was approximately equal to one in all markets. Therefore existence of long-run integration is accepted in tapioca markets.

7.6. Market integration of Sugarcane

Ernakulam as central and Kollam, Alappuzha, Kottayam, Kozhikode and Kannur as local markets reveals that 99.92% of variation in central price were determined by these local prices (see table 7.11). Except slopes of current prices at Kollam, Alappuzha and Kottayam, all other lagged and current coefficients were negative which imply their negative relationship with central price. Also except Kollam (current and lagged price) and Alappuzha (current price), all others were insignificant. Their lagged and central price determined almost all local prices (99.5%). Certainly, coefficient of determination was very high in all markets. Slope coefficients of central prices were positive and significant which reflect the close relationship of local and central markets. Lagged prices were positive or negative and significant or insignificant according to local market conditions.

Here, market segmentation was poor since all b_{i0} coefficients were greater than zero. These coefficients were approximately equal to one in all markets so that we can accept short-run integration for sugar markets of Kerala.

Table 7.11

Price Efficiency of Sugar

Equation $P_{1t} = a + a_{11} P_{1t-1} + \Sigma k \Sigma j\, b_{ij}^{k} P_{kt-j}$

Districts	a_{11}	b_{ij}		a	R^2
		blo	bl1		
Ernakulam	0.516⊗			(-)2.245	0.9992
Kollam		0.374⊗	(-)0.205⊗⊗		
Alappuzha		0.44⊗	(-)0.131		
Kottayam		0.153	(-)0.004		
Thrissur		(-)0.011	(-)0.0002		
Kozhikode		0.055	(-)0.103		
Kannur		(-)0.013	(-)0.045		

Equation $Pl_t = a_{l1} P_{lt-1} + b_{lo} P_{1t-0} + Cl$

	al1	blo	Cl	R^2	
Kollam	(-)0.014	1.005⊗	1.449	0.9980	
Alappuzha	0.002	1.0002⊗	5.813	0.9979	
Kottayam	0.033⊗⊗	0.998⊗	3.366	0.9977	
Thrissur	0.111⊗	1.004⊗	(-)3.238	0.9946	
Kozhikode	0.0002	0.9905⊗	5.544	0.9963	
Kannur	(-)0.055⊗⊗	0.9954⊗	2.334	0.9961	

'⊗' - Statistically Significant at 5% level.
'⊗⊗ - Statistically Significant at 1% level.

Conclusion

The foregoing analyses revealed that the prices of agricultural commodities in Kerala were determined interdependently. That is, very good price integration exists in agricultural markets of Kerala. In cereals markets, long-run integration was greater than short-run integration. Some commodities in the spices and condiments group (e.g. Ginger) also perform in this way. In the case of fruits and vegetables the percentage of long-run integration was much greater (about 100%). Coconut, tea, rubber, turmeric, arecanut, pepper and sugar are good examples of agricultural commodities having short-run market integration.

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PRODUCTION, PRODUCTIVITY AND PRICES - A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

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August 1999

Chapter 8

Summary and Conclusion

SUMMARY AND CONCLUSION

In the foregoing chapters we have discussed the various facets of the problem of production, productivity and prices of Kerala agriculture. It is now attempted here to draw the threads together in the form of a brief summary of findings.

We know that primary sector contributes more than 29% of the Net State Domestic Product of Kerala and out of this contribution agricultural crop production is more than 85%. Therefore, production sector deserves special and separate treatment. The need to implement policies which will induce the expansion of agricultural production is becoming continually more urgent. The selection of proper policies is a matter of considerable dispute, however, partly because of widespread disagreement over the responsiveness of the agricultural sector to various incentives. It is in this context that we have set our objectives as follows.

(1) To assess the extent of growth and instability in agricultural production, productivity and prices of Kerala after 1960.

(2) To analyse the cyclical phenomenon in agricultural production, productivity and prices and to measure their length.

(3) To analyse the impact of price movements on agricultural production and productivity and to establish their inter-relationships.

(4) To identity aggregate sources of relative price variability of agricultural commodities of Kerala.

(5) To examine the variability of agricultural prices before and after1991.

(6) To test inter-district price integration of agricultural commodities.

Specifying these objectives, this study also attempted to test the following hypotheses.

(a) Growth rate of prices (both farm and wholesale prices) was greater than that of production and productivity in agriculture.

(b) Moving average type of cyclical series exists in production, productivity and prices of Kerala agriculture.

(c) Macro economic conditions affect the relative price variability of commodity prices within agriculture.

(d) Agricultural price variability increased after 1991.

For this we collected time series data on production, productivity and prices (both wholesale and farm prices) of 12 important agricultural commodities of Kerala. The commodities selected are under 2 categories:

foodgrains and non-foodgrains. Under foodgrains category cereals – rice has been selected. Non-foodgrains have been divided into the following 5 categories.

(1) Oil seeds –Coconut

(2) Plantation crops – Tea and rubber

(3) Spices and condiments – Pepper, ginger, turmeric and arecanut

(4) Fruits and vegetables – Banana, cashewnut and tapioca

(5) Miscellaneous crops – Sugarcane.

We also used consumer price indices (with 1960-61 base), unemployment rate, real GNP growth rate, money supply, exchange rate etc. The study covers a period of 36 years extending from 1960-61 to 1995-96. However, to examine the impact of economic reforms and price efficiency we have included monthly data of only 10 calendar years i.e., from 1987 to 1996.

For collecting necessary data we used a number of publications of Bureau of Economics and Statistics, Directorate of Economics and Statistics (DES), Central Statistical Organisation etc. Apart from this, substantial volume of materials (especially wholesale and farm prices of agricultural commodities) has been drawn from the unpublished records kept by DES.

The methodology adopted for the study is both descriptive and analytical. Assessment of growth was done using log-lin model taking all observations in the series. Decomposition of growth rates was done by methodology of Ashok Parikh (1966). CaddeVille Index explains instability of agriculture. Seasonal variation of prices was analysed by calculating monthly seasonal indices.

Cyclical trend of production, productivity and farm and wholesale prices were separated using second-degree polynomial function. Then cropwise cyclical behaviour of agricultural commodities is analysed using harmonic analysis. Calculating Fourier coefficients, we estimated cyclical length and significance of these lengths was tested using F-test. Actual series is separated as series generated by moving average method, autoregressive method and harmonic series using sample autocorrelation function. Significance of these autocorrelation coefficients is tested using Barlett test and Ljung-Box statistic.

Applying linear regressions tested interrelationships between production, productivity and farm and wholesale prices. Relative price variability was calculated by constructing divisia price index and this variability was treated as dependent variable and aggregate factors as explanatory variables in the regression model. Changes in mean price levels and variability of each agricultural commodity after liberalisation was analysed by Autoregressive Conditionally Heteroskedastic (ARCH) approach. Using monthly wholesale prices, first, we tested whether ARCH effects were present or not by White's criteria and error model. These ARCH models were estimated by Ordinary Least Squares method.

Monthly wholesale prices of different markets at district level were used to test price efficiency of agricultural commodities. Depending upon the availability of data Thiruvananthapuram or Ernakulam market was treated as central market and others as local markets. Single lagged and actual local price was taken as independent variable to see the dependency of central market on local markets. Regression of local price on central market price and lagged price is estimated to classify markets having market segmentation, short-run or long-run market integration.

Findings

Analysis revealed that agricultural production was increasing at a compound growth rate of 1.5% during the selected period (1960-61 to 1995-96). It increased during 60s, 80s and early 90s, but decreased during 70s. But growth of production of individual crops was different from this. Growth of cereals was highest in 60s but negative during later periods. Seventies was a bad period for coconut and its growth rate was highest during early 90s, followed by 80s and 60s. Production of plantation crops was positive in all sub-periods. Greatest growth rate of tea was visible in 70s, then in 80s, 90s and was the lowest during

60s. But growth rate of rubber was highest in 60s, followed by early 90s, 80s and 70s.

Performance of spices and condiments was not in a uniform manner. 60s were worst for pepper production, early 90s were worst for ginger and 70s were worst for arecanut. Pepper production was highest during 80s followed by early 90s, and 70s. Ginger production was highest in 70s, then in 80s and 60s. Highest growth rate of arecanut production was during early 90s followed by 60s and 80s.

In the case of fruits and vegetables, growth rate of banana was positive only during 80s, cashewnut production was positive in 60s and 80s and that of tapioca was positive only during 60s. Banana and cashewnut production was worst during 70s and tapioca production was worst during 80s. Thus performance was not uniform in sub-periods. Sugarcane production was continuously decreasing. Its growth rate declined from 8.7% (in 60s) to 1.4% (in 70s), to –5.0 (in 80s) and to –9.15% (in 90s).

During the selected period cultivated area of coconut, rubber, pepper, ginger, banana and cashewnut increased and that of rice, tea, arecanut, tapioca and sugarcane decreased. Productivity of rice, tea, rubber, pepper, ginger, arecanut, tapioca and sugarcane improved. Cropping pattern changes were favourable to coconut, tea, rubber, pepper, arecanut and banana and unfavourable to rice, ginger, cashewnut, tapioca and sugarcane.

Results reveal that eventhough production and productivity of some agricultural commodities had declining trend during the selected period, prices (both wholesale and farm prices) of all commodities had a tremendous increase. Farm prices had higher growth rate than wholesale prices of agricultural commodities in Kerala. This leads to the acceptance of our null hypothesis that growth of prices was greater than that of production and productivity in Kerala agriculture.

Agricultural commodities in Kerala especially wholesale and farm prices were highly unstable during the selected period. Analysis of instability brought out the fact that eventhough instability (CVI) was highest in banana production, ranks of its variation (CV) were lower than other crops. Comparing variation and instability, instability was greater than variation for banana, coconut, cashewnut and sugarcane. Instability of productivity was lower than variation for rice, tea, rubber, ginger, turmeric and arecanut. Instability of wholesale prices was greater than variability only for coconut and rubber. Instability was greater than variability for the farm prices of rice, coconut, pepper and ginger. Like the growth rates, instability and variability of prices were greater than those of production and productivity of agricultural commodities. But unlike growth rates wholesale prices were more variable and unstable than farm prices. Seasonal variation in both farm and wholesale prices were also visible. Another point to be noted is the similarity of monthly seasonal indices of both of these prices.

Cyclical fluctuation was proved to be a common phenomenon in Kerala agriculture but characteristics of these fluctuations were different for different commodities. During the selected 36 years, 5 to 11 cycles occurred in the series of production, productivity and prices. Maximum cycle length was 23 (for rubber production) and minimum was 5 years (for coconut farm price). Most of the commodities had existence of 6-year cycle length in the series. Cycle length of 6 years was violated by the wholesale prices of coconut, pepper and ginger. Eventhough regular cycles of 6-year length were found to be significant for most crops, there were cycles of uneven length. Also most of the cycles occurred in production, productivity and prices were of the same period. That means cycles persist in uniform manner in Kerala agriculture. Cyclical series existed in agriculture were mainly harmonic, semi-harmonic and autoregressive types, which led us to the rejection of null hypothesis that moving average type of cyclical series, exists in Kerala agriculture.

Study proved close inter-relationships between production, productivity and prices which was reflected through their similar movements in growth, cyclical and correlogram curves. Also results showed that statistical relationship between production and productivity was significant for plantation crops, spices and condiments, banana and sugarcane. Farm prices had significant impact on the production of pepper and arecanut whereas wholesale prices affect production of tea, rubber, pepper, ginger and arecanut. Similarly, relation between farm prices and productivity was high for rice, ginger and arecanut but changes in wholesale prices significantly affect productivity of ginger, arecanut and plantation crops. These significant relations are all positive which reflect direct relationships between them. Analysis also revealed that inter-relations among production, productivity and prices are highly significant than between any two of them.

Study supports the hypothesis that variability of relative prices in agriculture is related to (a) the average rate of nominal price change among agricultural commodities, (b) actual and unexpected inflation and (c) other economic phenomenon like changes in real GNP growth rate. Or, changes in average agricultural commodity prices and unexpected inflation rate decrease the relative price variability of agricultural sector. Similarly, changes in inflation rate and real GNP growth rate increase relative price variability of agriculture. At best, the selected data suggest that relative price variability of agricultural commodity changes when economic activity is more variable.

Analysis confirms that during 1991 variability in all the selected agricultural commodities decreased. But after this year price variability was greater for tea, rubber, arecanut, turmeric, and banana. And price volatility decreased for cereals, oilseeds, pepper, ginger and sugar. Mean price levels of rice, coconut, tea, arecanut and turmeric showed increasing trend during the year 1991. The average prices of rice, rubber, ginger, arecanut, turmeric and tapioca continued to increase after 1991. Also, we can accept the fact that if trend and seasonality factors were significant, then mean price levels decreased after 1991.

Regional markets for agricultural commodities in Kerala are closely interrelated, that is, price formation in one market reflects the prices of other markets. In other words, Kerala's regional agricultural prices do not diverge and the markets are fully integrated. That is very good price integration exists between central and local agricultural markets of Kerala. For rice markets the short-run process of price adjustment is consistent (except for Ernakulam and Palakkad markets) with an equilibrium in which a unit increase in central price is passed on fully to local prices. Some commodities in the spices and condiments group also perform in this way. Short-run restrictions are accepted for ginger markets at Pathanamthitta, Palakkad, Kozhikode and Kannur because summation of lagged local and central prices were approximately equal to one, but, for Alappuzha, identical prices exist between local and central prices. Short-run restrictions are imposed in all the selected fruits and vegetables markets such as Kollam, Pathanamthitta, Alappuzha, Ernakulam, Thrissur, Kozhikode and Kannur. Long-run integration for Coconut exists at Pathanamthitta, for rubber at Kollam, and for arecanut at Ernakulam and in all other coconut, rubber and arecanut markets short-run integration was accepted. Sugar is a very good example of agricultural commodity having short-run market integration. We can neither accept short-run nor long run integration within one month for tea market at Kozhikode, pepper market at Kannur and in all the turmeric markets. But proportional relationship between these local and central markets is high.

Policy Implications

The study focused on the responses within the agricultural sector and revealed that close and significant interrelations exist among production, productivity and prices of agriculture so that any change in one affects the other two. Relations among them are important and useful because it is the degree of responsiveness of output and productivity to changing prices on which effectiveness of a price policy depends. In a planned economy like ours, price policies have a role to play especially to direct the changes in cropping pattern in a socially desired direction to subserve the national goals of growth with equity. The study revealed that price policy is the easiest tool to induce necessary changes to improve farmers response to economic incentives (reflected through changes in production and productivity), provided market mechanism is perfect to allow free play of forces determining prices.

We know that the move toward market reform has renewed an interest in the working of markets as a source of income, employment and food security. And knowledge about the extent to which markets are integrated is crucial for the success of any commercial liberalisation policies. The existence of high market integration, as per the analysis, conveys accurate price formation and helps to make proper product movements. Or, it enables free flows of information and trade among spatially separated markets. This is essential for the success of reform process in promoting equity and efficiency of the economy. High market integration also implies that transportation cost which reduce integration is very low in agricultural markets of Kerala. Certainty about the transportation cost and its relation to market integration help to fix prices of different agricultural commodities.

The study showed that during earlier years (later lag length), the magnitude of swings was high in production, productivity and price of most of the commodities. However, in the later years (earlier lag length), the magnitude of swings was less due to technological development in production and improvement in marketing environment. This clearly indicates that these variations could be minimised further with dissemination of agricultural technology at right time and right cost. Price levels and variability of some agricultural commodities like tea, rubber, arecanut, turmeric, banana etc. increased after 1991, which may be the result of the introduction of economic liberalisation.

Study reflects the fact that fluctuations in prices are greater than that of production and productivity. Therefore, price policy should ensure that farmers get for their produce a price covering all costs (both variable and fixed costs) as well as provide against risk and uncertainty arising out of seasonal and cyclical price fluctuations. Such a policy by reducing risk and uncertainty improves farmer's expectations regarding market prices, which in turn determine their production decisions.

To conclude, the study brings out the fact that although changes in non-price factors are an important factor to raise agricultural output, price incentives are more important than relative prices in inducing higher agricultural output. The relative production effect reveals that with the increase in production, there is reduction in price variations. Reducing instability in production and productivity, production efficiency can be improved through lesser price fluctuations. Excessive variability in relative prices caused by macroeconomic instability decreases the efficiency of resource allocation and increases producer risk. As relative prices become more volatile, past relative prices provide less reliable guides for current resource allocation and the information on current relative prices becomes obsolete more quickly. Furthermore, the fact that producers have less information increases the risk associated with choosing which commodities to produce. Of course, the removal of all relative price variability is not an objective of any rational policy. Relative price adjustments associated with changes in demand shift variables; resources, weather and technology are essential for the efficient allocation of resources. However, when relative prices within agriculture vary because of unavoidable macroeconomic shocks, such movements decrease economic welfare of the society as a whole and the agricultural sector in particular. Hence suitable policy measures are required to reduce risk and uncertainty of producers and to sustain and promote agricultural production.

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APPENDICES

Appendix 1

Index Number of Agricultural Production (1960-61=100)

Year	Rice	Coconut	Tea	Rubber	Peppe	Ginger	Arecan	Banan	Cashe	Tapioc	Sugarc	Total
1960-61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1961-62	94.01	100.84	105.26	108.69	100.00	100.00	104.57	192.68	101.20	97.68	98.95	100.05
1962-63	102.34	102.64	107.89	126.09	88.89	100.00	107.42	99.69	109.63	91.50	109.45	101.81
1963-64	105.62	101.30	110.53	147.83	81.48	100.00	110.13	99.69	109.63	149.97	115.75	105.71
1964-65	104.96	101.80	102.63	174.22	81.48	100.00	95.63	103.96	116.22	164.17	115.49	106.91
1965-66	93.45	102.27	115.79	204.34	81.48	100.00	103.39	110.06	118.08	183.95	107.61	106.19
1966-67	101.49	106.36	118.42	217.39	92.59	100.00	113.72	105.18	122.89	202.61	144.09	112.17
1967-68	105.24	111.58	113.16	260.87	92.59	100.00	121.48	114.02	128.92	249.43	131.23	119.98
1968-69	131.09	119.08	118.42	286.96	92.59	100.00	131.82	118.90	130.12	242.48	132.02	130.43
1969-70	113.76	122.86	105.79	334.35	88.89	109.09	134.40	123.48	133.77	277.24	131.49	131.74
1970-71	121.54	123.63	109.08	342.30	81.48	181.82	136.99	112.50	138.85	274.33	98.68	133.62
1971-72	126.59	125.90	113.16	386.96	81.48	209.09	136.99	110.37	136.14	322.58	102.62	139.67
1972-73	128.84	121.77	115.79	400.00	81.48	218.19	142.16	109.15	137.34	338.20	104.98	138.41
1973-74	117.69	115.00	126.32	513.04	92.59	245.46	144.74	107.93	139.76	336.30	134.91	131.27
1974-75	124.90	115.49	128.95	530.44	88.89	236.36	147.33	108.84	142.17	334.22	141.47	133.09
1975-76	127.81	106.83	113.16	560.56	92.59	254.55	124.06	51.83	146.98	320.26	132.81	126.11
1976-77	117.42	103.98	109.58	605.86	88.89	236.36	124.06	40.85	105.13	304.58	106.29	120.54
1977-78	121.25	94.81	136.84	591.30	74.07	290.91	131.82	42.99	102.08	248.90	99.21	11.19
1978-79	118.45	100.52	134.21	539.13	74.07	300.00	134.40	46.04	101.43	251.09	98.69	114.70
1979-80	121.07	94.16	152.63	595.65	100.00	290.91	136.99	44.21	100.00	240.16	128.08	110.22
1980-81	119.10	94.29	142.11	608.69	107.41	290.91	136.99	96.65	98.67	243.49	121.26	110.61
1981-82	125.47	93.35	126.32	608.69	103.70	290.91	134.40	100.00	96.17	222.52	125.98	109.90
1982-83	122.28	98.88	128.95	665.22	96.29	300.00	136.99	88.11	90.96	228.69	215.48	113.56
1983-84	113.11	80.81	118.42	704.35	81.48	336.36	108.56	96.65	93.22	233.15	228.61	99.37
1984-85	117.60	107.24	152.63	747.83	62.96	372.73	118.89	100.91	87.10	219.49	112.33	117.58
1985-86	109.83	104.88	136.84	804.35	122.22	409.09	129.23	110.06	96.63	194.71	111.81	112.69
1986-87	106.18	98.54	128.95	878.26	114.81	400.00	136.99	110.36	106.86	195.60	108.13	107.62
1987-88	97.28	113.98	147.89	943.48	177.78	390.91	142.16	110.37	98.17	189.00	110.76	116.00
1988-89	94.29	130.90	168.42	1036.52	155.56	409.09	152.49	133.54	130.43	188.05	141.21	127.42
1989-90	100.52	135.34	141.84	1197.39	140.74	409.09	170.59	137.19	128.01	181.46	139.97	131.51
1990-91	101.74	140.59	159.73	1336.95	173.33	425.45	171.88	149.97	123.82	166.31	142.49	134.59
1991-92	99.28	130.62	175.79	1491.73	187.40	441.82	168.26	153.05	126.02	162.65	143.59	127.01
1992-93	101.57	159.17	145.00	1602.61	184.07	458.18	182.73	151.62	115.20	156.21	112.41	146.79
1993-94	94.01	161.39	175.53	1775.22	184.81	412.73	205.48	159.39	105.43	154.62	117.56	146.79
1994-95	90.14	164.69	171.32	1925.21	192.59	433.64	209.09	174.63	115.12	153.20	117.79	148.38
1995-96	89.24	183.42	170.50	2063.30	221.98	362.09	226.42	107.17	116.60	142.96	121.78	159.89

Source : Estimated by the researcher.

Appendix 2

Index Number of Area under crops

(1960-61=100)

Year	Rice	Coconut	Tea	Rubbe	Pepper	Ginger	Areca	Banan	Cashe	Tapioc	Sugar	Total
1960-61	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1961-62	96.66	101.00	106.29	108.13	100.00	100.00	105.56	97.73	101.85	97.93	100.00	98.26
1962-63	103.0	107.80	106.29	112.19	99.00	100.00	101.85	97.73	151.85	91.73	100.00	105.15
1963-64	103.3	109.00	106.29	116.26	99.00	100.00	105.56	97.73	151.85	86.78	111.11	105.39
1964-65	102.8	111.80	106.29	119.47	100.00	100.00	111.11	109.09	159.21	86.36	111.11	106.09
1965-66	102.9	117.20	104.89	121.95	100.00	100.00	118.52	109.09	161.98	95.04	100.00	108.21
1966-67	102.5	122.00	106.29	124.39	119.00	100.00	131.48	104.55	167.70	101.24	100.00	110.01
1967-68	103.9	127.80	104.38	132.52	120.00	100.00	140.74	111.36	175.91	123.14	88.88	114.11
1968-69	118.8	137.20	109.38	137.39	119.00	91.67	150.00	118.18	177.81	123.14	88.88	125.94
1969-70	112.0	141.60	101.78	142.43	118.00	100.00	155.56	122.73	183.26	122.31	88.88	123.04
1970-71	112.3	143.80	99.89	145.73	105.00	100.00	159.26	111.36	190.20	121.48	88.88	123.82
1971-72	112.3	146.00	98.32	153.66	104.00	100.00	161.11	109.09	187.04	125.21	88.88	124.62
1972-73	112.1	149.00	100.98	159.35	104.00	100.00	164.82	106.82	188.89	126.03	88.88	125.52
1973-74	112.3	149.00	100.98	162.60	105.00	100.00	168.52	106.82	190.74	126.45	111.11	125.75
1974-75	113.0	149.60	100.98	164.23	106.00	100.00	172.22	106.82	194.44	131.40	111.11	126.84
1975-76	113.6	138.60	100.98	168.29	108.00	100.00	142.59	93.18	201.85	135.12	100.00	124.75
1976-77	109.6	139.00	96.09	170.51	109.00	83.33	125.93	90.91	209.86	133.47	77.77	122.49
1977-78	107.8	134.80	95.66	180.49	101.00	108.33	114.81	90.91	235.12	119.83	77.77	120.28
1978-79	102.5	132.20	95.66	182.93	80.00	108.33	114.81	90.91	152.87	119.83	77.77	116.69
1979-80	101.7	132.80	95.67	183.18	107.00	108.33	112.96	81.82	159.26	113.22	88.88	116.47
1980-81	102.9	133.20	95.67	200.81	106.00	108.33	112.96	111.36	261.62	100.41	88.88	116.87
1981-82	103.5	133.40	95.67	213.82	108.00	108.33	112.96	113.64	259.19	102.48	88.88	117.59
1982-83	99.87	134.80	93.01	226.02	107.00	108.33	112.96	109.09	261.68	94.21	88.88	115.38
1983-84	94.99	136.40	93.01	239.02	104.00	125.00	111.11	113.63	263.59	96.28	88.88	113.12
1984-85	93.71	137.60	93.01	252.03	106.00	116.67	105.56	115.91	253.70	89.67	88.88	112.15
1985-86	87.03	141.00	93.01	260.16	122.00	133.33	105.55	120.45	255.56	88.84	88.88	109.18
1986-87	95.24	141.20	93.01	274.79	129.00	125.00	107.41	120.45	248.15	79.75	88.88	107.65
1987-88	77.54	173.00	91.95	282.93	155.00	125.00	111.11	120.45	225.09	73.97	88.88	110.37
1988-89	74.07	163.40	92.21	298.13	157.00	116.67	116.67	134.09	231.00	70.25	88.88	106.01
1989-90	74.22	166.40	92.21	306.34	167.00	116.67	116.67	138.64	229.00	66.11	91.11	106.80
1990-91	71.81	172.82	92.21	331.54	168.50	119.17	120.00	149.09	214.11	60.74	88.88	106.62
1991-92	69.49	169.26	92.21	340.81	178.10	123.33	117.59	148.86	207.52	58.76	90.00	104.18
1992-93	69.02	175.40	92.21	348.69	183.50	127.50	118.33	147.95	201.93	55.66	68.89	105.29
1993-94	65.19	176.46	92.75	360.16	184.40	115.83	127.96	153.41	197.65	54.13	61.11	103.19
1994-95	64.61	182.19	92.75	360.41	200.97	115.58	133.11	164.93	191.56	47.23	58.89	103.90
1995-96	60.48	196.42	93.10	365.04	190.84	93.38	141.73	169.84	212.64	49.07	63.89	105.73

Source : Estimated by the researcher.

Appendix 3

Index Number of Agricultural Production Under 1960-61 Cropping Pattern

Year	Rice	Coconu	Tea	Rubbe	Pepper	Ginger	Arecan	Banan	Cashe	Taploc	Sugarc	Total
1960-61	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1961-62	95.56	98.10	97.30	98.77	98.26	98.26	97.35	193.73	97.64	98.01	97.23	101.57
1962-63	102.7	102.91	115.47	130.05	96.09	107.02	119.13	106.69	78.69	104.54	117.13	105.23
1963-64	105.6	100.42	110.78	142.99	81.67	100.23	106.51	99.93	109.89	158.91	104.42	107.41
1964-65	106.18	99.90	103.30	170.65	81.19	100.66	91.45	93.74	111.57	166.04	116.24	106.61
1965-66	95.19	99.51	119.69	204.19	83.11	102.00	98.86	112.26	118.38	170.51	121.96	106.96
1966-67	103.57	103.88	118.79	216.67	79.10	101.66	104.21	111.58	120.66	193.37	146.49	113.28
1967-68	107.68	110.48	119.52	253.98	95.24	103.72	117.71	111.03	127.48	212.71	153.13	121.18
1968-69	126.56	122.41	124.73	305.47	103.05	120.40	136.51	123.66	142.07	267.63	145.71	139.17
1969-70	117.89	116.29	111.07	315.09	87.57	97.69	126.61	116.16	126.80	272.68	128.46	131.72
1970-71	122.03	122.52	111.85	336.67	92.15	182.98	134.65	124.77	134.63	277.96	99.32	138.03
1971-72	127.41	124.81	115.71	369.39	82.79	210.45	136.29	113.39	139.35	315.03	103.29	143.46
1972-73	129.91	120.17	113.55	388.48	82.06	219.74	139.96	112.27	136.98	338.39	105.74	144.91
1973-74	117.78	115.21	126.55	503.72	91.88	245.91	141.82	108.13	138.66	335.83	108.13	143.80
1974-75	125.13	116.03	130.06	529.72	88.81	238.71	145.40	109.78	140.67	324.39	142.69	147.07
1975-76	125.14	113.41	111.29	538.32	89.38	250.36	147.38	58.44	139.26	306.32	145.14	142.39
1976-77	119.48	101.80	113.07	587.21	86.48	278.52	137.95	41.12	99.29	302.78	134.20	135.22
1977-78	121.05	96.00	134.97	548.51	78.49	219.73	141.96	42.21	89.47	272.21	97.42	130.96
1978-79	120.81	99.45	130.21	516.09	90.73	291.06	130.39	44.66	91.50	243.62	95.75	129.23
1979-80	121.75	93.55	152.33	584.11	74.62	290.34	138.96	49.02	97.35	253.69	111.86	131.79
1980-81	118.17	94.32	142.59	566.27	108.79	291.90	137.45	71.25	98.12	275.49	121.67	133.74
1981-82	125.47	93.79	127.10	575.53	102.42	292.72	135.24	98.61	97.68	219.39	126.78	132.64
1982-83	124.46	96.01	130.14	617.49	95.37	294.36	134.41	90.05	88.39	244.08	211.43	135.55
1983-84	116.58	78.29	116.09	652.94	82.19	285.79	108.19	90.96	90.73	223.67	224.12	123.39
1984-85	118.19	105.39	151.32	703.12	61.24	395.91	124.07	98.08	89.72	233.64	111.37	137.29
1985-86	115.12	99.63	133.22	758.56	103.38	348.47	125.81	103.10	93.38	191.31	108.85	134.30
1986-87	106.89	97.02	127.14	819.84	107.06	420.69	132.74	108.82	108.52	214.85	106.62	135.87
1987-88	111.97	95.24	153.39	889.50	143.47	427.51	138.46	113.16	114.27	232.76	113.56	143.63
1988-89	94.80	133.11	161.30	944.79	147.51	420.99	139.49	115.22	122.08	190.19	135.62	150.52
1989-90	101.07	133.89	142.91	1174.04	133.30	412.16	171.87	133.69	130.09	194.25	137.58	161.90
1990-91	104.98	135.14	159.46	1233.17	171.49	415.80	166.81	139.21	132.19	180.70	145.80	166.51
1991-92	100.25	130.32	171.77	1418.00	173.25	417.13	167.78	149.78	127.06	164.29	138.58	168.48
1992-93	103.34	155.23	146.54	1583.04	180.56	447.93	183.52	154.17	119.66	166.67	148.73	183.08
1993-94	97.54	157.23	171.04	1684.42	180.24	445.23	186.22	150.66	105.57	155.81	129.88	184.66
1994-95	91.59	160.61	172.50	1937.25	177.94	437.59	202.40	163.56	119.60	176.82	123.09	194.49
1995-96	96.99	173.11	172.82	2072.79	237.86	456.06	216.38	105.89	106.88	140.02	114.22	202.49

Source : Estimated by the researcher.

Appendix 4

Index Number of Contribution of Changes in Cropping Pattern to Agricultural Production

Year	Rice	Coconut	Tea	Rubber	Pepper	Ginger	Arecan	Banana	Cashe	Tapio	Sugar	Total
1960-61	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1961-62	98.4	102.8	108.2	110.0	101.8	101.8	107.4	99.5	103.6	99.7	101.8	98.5
1962-63	99.6	99.7	93.4	97.0	92.5	93.4	90.2	93.4	139.3	87.5	93.4	96.7
1963-64	100.0	100.9	99.8	103.4	99.8	99.8	103.4	99.8	99.8	94.4	110.9	98.4
1964-65	98.9	101.9	99.4	102.1	100.4	99.3	104.6	110.9	104.2	98.9	99.4	100.3
1965-66	98.2	102.8	96.7	100.1	98.0	98.0	104.6	98.0	99.7	107.9	88.2	99.3
1966-67	98.0	102.4	99.7	100.3	117.1	98.4	109.1	94.3	101.8	104.8	98.4	99.0
1967-68	97.7	101.0	94.7	102.7	97.2	96.4	103.2	102.7	101.1	117.3	85.7	99.0
1968-69	103.6	97.3	94.9	93.9	89.8	83.1	96.6	96.2	91.6	90.6	90.6	93.7
1969-70	96.5	105.6	95.2	106.1	101.5	111.7	106.2	106.3	105.5	101.7	102.4	100.0
1970-71	99.6	100.9	97.5	101.7	88.4	99.4	101.7	90.2	103.1	98.7	99.4	96.8
1971-72	99.4	100.9	97.8	104.8	98.4	99.4	100.5	97.3	97.7	102.4	99.4	07.4
1972-73	99.2	101.3	102.0	103.0	99.3	99.3	101.6	97.2	100.3	99.9	99.3	95.5
1973-74	99.9	99.8	99.8	101.9	100.8	99.8	102.1	99.8	100.8	100.1	124.8	91.3
1974-75	99.8	99.5	99.1	100.1	100.1	99.0	101.3	99.1	101.1	103.0	99.1	90.5
1975-76	102.1	94.2	101.7	104.1	103.6	101.7	84.2	88.7	105.5	104.6	91.5	88.6
1976-77	98.3	102.1	96.9	103.2	102.8	84.9	89.9	99.3	105.9	100.6	79.2	89.1
1977-78	100.2	98.8	101.4	107.8	94.4	132.4	92.9	101.8	114.1	91.4	101.8	8.5
1978-79	98.0	101.1	103.1	104.5	81.6	103.1	103.1	103.1	110.9	103.1	103.1	88.8
1979-80	99.4	100.7	100.2	102.0	134.0	100.2	98.6	90.2	102.7	94.7	114.5	83.6
1980-81	100.8	100.0	99.7	107.5	98.7	99.7	99.7	135.6	100.6	88.4	99.7	82.7
1981-82	100.0	99.5	99.4	105.8	101.2	99.4	99.4	101.4	98.5	101.4	99.4	82.9
1982-83	98.2	103.0	99.1	107.7	101.0	101.9	101.9	97.8	102.9	93.7	101.9	83.8
1983-84	97.0	103.2	102.0	107.9	99.1	117.7	100.3	106.3	102.7	104.2	102.0	80.5
1984-85	99.5	101.8	100.9	106.4	102.8	94.1	95.8	102.9	97.1	93.9	100.9	85.6
1985-86	95.4	105.3	102.7	106.0	118.2	117.4	102.7	106.8	103.5	101.8	102.7	83.9
1986-87	99.3	101.6	101.4	107.1	107.2	95.1	103.2	101.4	98.5	91.0	101.4	79.2
1987-88	86.9	119.7	96.4	106.1	123.9	91.4	102.7	97.5	85.9	81.2	97.5	80.8
1988-89	99.5	98.3	104.4	109.7	105.5	97.2	109.3	115.9	106.8	98.9	104.1	84.7
1989-90	99.5	101.1	99.3	102.0	105.6	99.3	99.3	102.6	98.4	93.4	101.7	81.2
1990-91	96.9	104.0	100.2	108.4	101.1	102.3	103.0	107.7	93.7	92.0	97.7	80.8
1991-92	99.0	100.2	102.3	105.2	108.2	105.9	100.3	102.2	99.2	99.0	103.6	75.4
1992-93	98.3	102.5	98.9	101.2	101.9	102.3	99.6	98.3	96.3	93.7	75.6	80.2
1993-94	96.4	102.6	102.6	105.4	102.5	92.7	110.3	105.8	99.9	99.2	90.5	79.5
1994-95	98.4	102.5	99.3	99.4	108.2	99.1	103.3	106.8	96.3	86.6	95.7	76.3
1995-96	92.0	106.0	98.7	99.5	93.3	79.4	104.6	101.2	109.1	102.1	106.6	79.0

Source : Estimated by the researcher.

Appendix 5

Index Number of Contribution of Productivity to Agricultural Production

Year	Rice	Coconu	Tea	Rubber	Pepp	Ginger	Areca	Bana	Cashe	Tapio	Sugar	Total
1960-61	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1961-62	98.9	97.1	91.5	91.3	98.3	98.3	92.2	198.2	95.9	100.1	97.2	103.4
1962-63	99.6	95.5	108.6	115.9	97.1	107.0	117.0	109.2	51.8	114.0	117.1	100.1
1963-64	102.2	92.1	104.2	123.0	82.5	100.2	100.9	102.3	72.4	183.1	94.0	101.9
1964-65	103.3	89.4	97.2	142.8	81.2	100.7	82.3	85.9	70.1	192.3	104.6	100.5
1965-66	92.5	84.9	114.1	167.4	83.1	102.0	83.4	102.9	73.1	179.4	122.0	98.8
1966-67	101.0	85.1	111.8	174.2	66.5	101.7	79.3	106.7	71.9	191.0	146.5	103.0
1967-68	103.6	86.4	114.5	191.7	79.4	103.7	83.6	99.7	72.5	172.7	172.3	106.2
1968-69	106.5	89.2	114.0	222.3	86.6	131.3	91.0	104.6	79.9	217.3	163.9	110.5
1969-70	105.2	82.1	109.1	221.2	74.2	97.7	81.4	94.6	69.2	222.9	144.5	107.1
1970-71	108.6	85.2	112.0	231.0	87.8	183.0	84.5	112.0	70.8	228.8	111.7	111.5
1971-72	113.4	85.5	117.7	240.4	79.6	210.5	84.6	103.9	74.5	251.6	116.2	115.1
1972-73	115.8	80.7	112.4	243.8	78.9	219.7	84.9	105.1	72.5	268.5	119.0	115.4
1973-74	104.9	77.3	125.3	309.8	87.5	245.9	84.2	101.2	72.7	265.6	97.3	114.4
1974-75	110.6	77.6	128.8	322.5	83.8	238.7	84.4	102.8	72.3	246.9	128.4	115.9
1975-76	110.1	81.8	110.2	319.9	82.8	250.4	103.4	62.7	69.0	226.7	145.1	114.1
1976-77	109.0	73.2	117.7	344.4	79.3	334.2	109.5	45.2	47.3	226.9	172.6	110.4
1977-78	112.3	71.2	141.1	303.9	77.7	202.8	123.6	46.4	38.1	227.2	125.3	108.9
1978-79	117.8	75.2	136.1	282.1	113.4	268.7	113.6	49.1	59.9	203.3	123.1	110.7
1979-80	119.6	70.4	159.2	318.9	69.7	268.0	123.0	59.9	61.1	224.1	125.9	113.2
1980-81	114.8	70.8	149.0	282.0	102.6	269.5	121.7	64.0	37.5	274.4	136.9	114.4
1981-82	121.1	70.3	132.9	269.2	94.8	270.2	119.7	86.8	37.7	214.1	142.6	112.8
1982-83	124.6	71.2	139.9	273.2	89.1	271.7	119.0	82.5	33.8	259.1	237.9	117.5
1983-84	122.7	57.4	124.8	273.2	79.0	228.6	97.4	80.0	34.4	232.3	252.2	109.1
1984-85	126.1	76.6	162.7	279.0	57.8	339.3	117.5	84.6	35.4	260.6	125.3	122.4
1985-86	132.3	70.7	143.2	291.6	84.7	261.4	119.2	85.6	36.5	215.3	122.5	123.0
1986-87	112.2	68.7	136.7	298.4	83.0	336.6	123.6	90.3	43.7	269.4	120.0	126.2
1987-88	144.4	55.1	166.8	314.4	92.6	342.0	124.6	93.9	50.8	314.7	127.8	130.1
1988-89	128.0	81.5	174.9	316.9	94.0	360.8	119.6	85.9	52.8	270.7	152.6	142.0
1989-90	136.2	80.5	155.0	383.2	79.8	353.3	147.3	96.4	56.8	293.8	151.0	151.6
1990-91	146.2	78.2	172.9	372.0	101.8	348.9	139.0	93.4	61.7	297.5	164.0	156.2
1991-92	144.3	77.0	186.3	416.1	97.3	338.2	142.7	100.6	61.2	279.6	154.0	161.7
1992-93	149.7	88.5	158.9	454.0	98.4	351.3	155.1	104.2	59.3	299.4	215.9	173.9
1993-94	149.6	89.1	184.4	467.7	97.7	384.4	145.5	98.2	53.4	287.8	212.5	179.0
1994-95	141.8	88.2	186.0	537.5	88.5	378.6	152.1	99.2	62.4	374.4	209.0	187.2
1995-96	160.4	88.1	185.6	567.8	124.6	488.4	152.7	62.3	50.3	285.3	178.8	191.5

Source : Estimated by the researcher.

Appendix 6

Trend Values of Agricultural Production in Kerala

(1960-61 to 1995-96)

Year	Rice	Coconu	Tea	Rubb	Peppe	Ginger	Arecan	Turme	Banan	Cashe	Tapio	Sugarc
col. 1	col.2	col. 3	col. 4	col. 5	col. 6	col. 7	col. 8	col. 9	col. 10	col. 11	col. 12	col. 13
1960-61	1009.8	3822.9	40.2	51.2	28.6	5.3	44.1	2.0	400.5	98.5	1877.7	390.4
1961-62	1044.4	3728.3	40.4	48.7	27.3	6.9	44.0	2.2	384.3	98.5	2200.5	400.5
1962-63	1076.7	3641.9	40.7	47.1	26.1	8.5	44.0	2.5	369.2	98.5	2503.3	410.2
1963-64	1106.9	3563.1	41.0	46.2	25.1	10.0	44.0	2.7	355.2	98.4	2787.1	419.4
1964-65	1134.8	3492.1	41.3	46.0	24.1	11.5	44.1	2.9	342.5	98.4	3050.7	428.1
1965-66	1160.6	3428.8	41.6	46.7	23.3	13.1	44.2	3.1	330.9	98.3	3294.7	436.4
1966-67	1183.9	3373.7	42.0	48.1	22.6	14.5	44.4	3.3	320.5	98.2	3519.1	444.2
1967-68	1205.2	3326.2	42.4	50.3	22.0	16.0	44.7	3.5	311.3	98.1	3724.3	451.6
1968-69	1224.3	3286.8	42.8	53.3	21.6	17.5	45.0	3.7	303.3	98.0	3909.4	458.5
1969-70	1241.1	3255.2	43.3	57.1	21.3	18.9	45.3	3.8	296.4	97.9	4074.8	465.0
1970-71	1255.7	3231.6	43.8	61.6	21.1	20.3	45.7	4.0	290.7	97.8	4220.7	470.9
1971-72	1268.1	3215.4	44.3	66.9	21.0	21.7	46.2	4.2	286.2	97.6	4347.0	476.5
1972-73	1278.2	3207.6	44.8	73.0	21.1	23.1	46.7	4.3	282.9	97.4	4453.5	481.6
1973-74	1286.1	3207.4	45.4	79.9	21.3	24.5	47.3	4.5	280.7	97.3	4540.3	486.2
1974-75	1291.9	3215.2	46.0	87.5	21.6	25.8	47.9	4.6	279.7	97.1	4608.0	490.4
1975-76	1295.3	3230.7	46.6	96.0	22.0	27.1	48.6	4.8	279.9	96.9	4655.4	494.1
1976-77	1296.5	3254.3	47.3	105.2	22.6	28.5	49.4	4.9	281.3	96.7	4683.4	497.4
1977-78	1295.6	3285.6	48.0	115.2	23.3	29.7	50.2	5.0	283.8	96.5	4691.5	500.2
1978-79	1292.4	3324.8	48.7	125.9	24.1	31.0	51.0	5.1	287.6	96.2	4680.5	502.5
1979-80	1287.1	3371.9	49.5	137.4	25.1	32.3	52.0	5.2	292.5	96.0	4649.7	504.4
1980-81	1279.4	3427.0	50.2	149.7	26.1	33.5	52.9	5.3	298.5	95.7	4598.8	505.9
1981-82	1269.7	3489.7	51.0	162.8	27.3	34.7	53.9	5.4	305.8	95.4	4529.0	506.9
1982-83	1257.6	3560.3	51.9	176.7	28.6	35.9	55.0	5.5	314.2	95.1	4438.9	507.4
1983-84	1243.3	3639.2	52.7	191.4	30.1	37.1	56.2	5.6	323.8	94.9	4329.7	507.4
1984-85	1226.9	3725.3	53.6	206.8	31.7	42.0	57.3	5.7	334.6	94.5	4200.6	507.0
1985-86	1208.0	3819.7	54.5	223.0	33.4	38.5	58.6	5.7	346.5	94.2	4051.2	506.2
1986-87	1187.2	3921.6	55.5	239.9	35.2	39.6	59.9	5.8	359.7	93.9	3883.0	504.9
1987-88	1164.0	4031.6	56.5	257.7	37.1	43.6	61.3	5.8	374.0	93.5	3695.0	503.2
1988-89	1138.6	4153.9	57.5	276.2	39.2	42.7	62.7	5.9	389.4	93.2	3487.2	500.9
1989-90	1111.0	4275.5	58.5	295.5	41.4	45.5	64.1	5.9	406.1	92.8	3260.0	498.3
1990-91	1081.3	4409.6	59.6	315.6	43.7	44.8	65.7	5.9	423.9	92.4	3012.9	495.1
1991-92	1049.3	4550.6	60.7	336.5	46.2	45.9	67.2	6.0	443.0	92.0	2746.5	491.5
1992-93	1015.1	4700.3	61.8	358.1	48.8	46.9	68.9	6.0	463.1	91.6	2460.1	487.5
1993-94	978.6	4857.5	62.9	380.6	51.5	47.9	70.6	6.0	484.5	91.2	2154.3	483.0
1994-95	939.6	5022.7	64.1	403.8	54.3	48.8	72.3	6.0	507.0	90.7	1828.7	478.0
1995-96	898.9	5195.7	65.3	427.7	57.3	49.8	74.1	6.0	530.7	90.3	1483.5	472.6

Source : Estimated by the researcher.

Appendix 7

Trend Values of Agricultural Productivity in Kerala (1960-61 to 1995-96)

Year	Rice	Cocon	Tea	Rubb	Pepper	Ginger	Arecan	Turmer	Banana	Cashe	Tapioca	Sugarca
col. 1	col.2	col. 3	col. 4	col. 5	col. 6	col. 7	col. 8	col. 9	col. 10	col. 11	col. 12	col. 13
1960-61	1348.7	6685.4	986.7	232.5	243.5	563.3	682.8	292.3	8298.5	1488.1	9607.1	44978.0
1961-62	1354.7	6488.1	1000.0	249.3	240.0	679.2	675.2	383.9	8067.0	1425.0	10135.5	45830.3
1962-63	1361.6	6301.2	1013.9	266.2	236.8	793.0	668.9	472.8	7847.1	1364.3	10647.6	46688.2
1963-64	1369.2	6124.3	1028.7	283.2	233.9	905.1	663.9	559.0	7639.8	1306.5	11146.3	47542.0
1964-65	1377.6	5958.2	1044.1	300.5	231.3	1015.3	660.1	642.6	7445.9	1251.5	11630.2	48399.5
1965-66	1386.8	5801.6	1060.4	317.8	229.0	1123.5	657.6	723.5	7263.7	1199.0	12098.6	49265.2
1966-67	1396.6	5655.5	1077.4	335.2	227.0	1229.8	656.3	801.7	7094.2	1161.0	12552.6	50127.4
1967-68	1407.4	5519.1	1095.0	352.8	225.2	1334.3	656.4	877.3	6937.5	1102.4	12992.0	50991.3
1968-69	1418.9	5393.7	1113.6	370.6	223.8	1436.8	657.6	950.3	6793.5	1058.2	13415.6	51859.9
1969-70	1431.3	5277.8	1132.8	388.5	222.7	1537.5	660.2	1020.5	6661.3	1016.6	13825.2	52754.6
1970-71	1444.3	5172.7	1152.7	406.4	221.8	1636.4	664.0	1088.1	6542.7	977.8	14219.6	53597.9
1971-72	1458.2	5077.6	1173.5	424.6	221.3	1733.3	669.0	1153.1	6436.0	941.7	14599.1	54469.0
1972-73	1472.9	4992.5	1195.1	442.8	221.0	1828.3	675.4	1215.4	6341.7	908.2	14964.5	55346.5
1973-74	1488.2	4917.8	1217.4	461.2	221.1	1921.3	682.9	1275.0	6260.4	877.5	15314.4	56224.0
1974-75	1504.4	4853.0	1240.4	479.7	221.4	2012.5	691.8	1331.9	6191.0	849.5	15649.5	57103.5
1975-76	1521.4	4798.8	1264.2	498.4	222.0	2101.9	701.9	1386.2	6134.5	824.2	15969.0	57985.0
1976-77	1539.2	4754.5	1288.7	517.2	222.9	2189.3	713.2	1437.8	6089.8	801.6	16275.2	58869.7
1977-78	1557.7	4720.4	1314.1	536.1	224.1	2274.8	725.9	1486.8	6059.8	781.7	16565.2	59754.3
1978-79	1582.6	4696.6	1339.5	555.1	225.7	2358.5	739.7	1533.3	6041.0	764.6	16840.9	60639.3
1979-80	1597.3	4683.4	1366.9	574.3	227.4	2440.3	754.9	1576.9	6034.1	750.1	17101.6	62067.6
1980-81	1618.2	4679.8	1394.4	593.6	229.5	2520.3	771.3	1617.9	6041.1	738.3	17348.2	62418.9
1981-82	1639.8	4686.7	1422.5	613.0	231.9	2598.2	789.0	1656.2	6059.5	729.2	17577.5	63317.9
1982-83	1662.4	4703.8	1451.8	632.6	234.6	2674.3	807.9	1691.2	6090.9	722.9	17796.3	64212.9
1983-84	1685.5	4730.6	1480.9	652.4	237.6	2748.7	828.1	1724.7	6135.1	719.3	17996.6	65108.8
1984-85	1709.6	4768.2	1512.4	672.2	240.8	2820.8	849.6	1755.1	6191.2	718.3	18185.1	66008.6
1985-86	1734.4	4816.1	1543.6	692.2	244.4	2891.1	872.3	1782.8	6260.4	720.1	18357.1	66905.4
1986-87	1760.1	4874.0	1575.7	712.3	248.2	2959.7	896.2	1807.8	6342.5	724.6	18514.0	67807.8
1987-88	1786.5	4941.5	1608.6	732.6	252.4	3026.5	921.5	1830.2	6436.3	731.8	18655.2	68711.7
1988-89	1813.6	5020.1	1642.2	753.0	256.8	3091.0	948.0	1849.9	6542.5	741.8	18782.9	69624.2
1989-90	1841.5	5108.2	1676.5	773.5	261.5	3154.0	975.8	1866.9	6661.6	754.4	18894.8	70527.3
1990-91	1870.4	5207.0	1711.7	794.1	266.6	3215.2	1004.8	1881.3	6793.3	769.7	18993.3	71441.7
1991-92	1899.9	5316.1	1747.6	814.9	271.9	3274.3	1035.0	1893.0	6937.7	787.8	19076.8	72362.5
1992-93	1930.2	5434.8	1784.2	835.8	277.5	3331.1	1066.6	1902.0	6491.9	808.5	19144.9	73256.2
1993-94	1961.3	5564.2	1821.7	856.9	283.4	3386.4	1099.4	1908.3	7264.3	832.0	19198.0	74194.9
1994-95	1993.1	5703.8	1859.9	878.1	289.6	3439.8	1133.5	1912.2	7446.3	858.2	19236.1	75110.2
1995-96	2025.7	5853.2	1900.6	899.3	296.1	3491.2	1168.8	1913.2	7641.0	887.0	19259.8	76036.4

Source : Estimated by the researcher.

Appendix 8

Trend Values of Farm Prices in Kerala (1960-61 to 1995-96)

Year	Paddy	Cocon	Pepper	Ginger	Arecan	Banana	Cashe	Tapioca	Sugar
col. 1	col.2	col. 3	col. 4	col. 5	col. 6	col. 7	col. 8	col. 9	col. 10
1960-61	75.4	224.8	455.5	473.2	70.5	13.2	181.9	29.4	61.6
1961-62	73.9	222.9	405.0	408.3	59.5	12.2	147.0	24.7	56.9
1962-63	73.1	227.3	366.1	352.8	49.6	11.5	117.6	20.7	53.1
1963-64	73.0	237.8	338.8	306.7	40.8	11.0	93.7	17.2	50.3
1964-65	73.7	254.5	323.2	270.3	32.5	10.8	75.4	14.3	48.4
1965-66	75.1	277.5	319.2	243.3	26.6	10.8	62.5	12.1	47.6
1966-67	77.2	306.6	326.8	225.8	21.2	11.0	55.2	10.4	47.7
1967-68	80.1	341.9	346.1	217.8	17.0	11.4	53.4	9.3	48.8
1968-69	83.7	383.4	376.9	219.4	13.8	12.1	57.1	8.9	50.8
1969-70	88.0	431.1	419.4	232.0	11.8	13.0	66.2	9.0	53.8
1970-71	93.1	485.0	473.5	251.0	11.0	14.2	81.0	9.7	57.8
1971-72	98.9	545.1	539.3	281.1	11.2	15.5	101.2	11.0	62.8
1972-73	105.4	611.4	616.6	320.6	12.6	17.1	127.1	12.9	68.7
1973-74	112.7	683.9	705.6	369.7	15.1	19.0	158.1	15.4	75.6
1974-75	120.7	762.6	806.2	428.3	18.8	21.1	194.9	18.5	83.5
1975-76	129.5	847.4	918.4	496.4	23.5	23.4	237.2	22.2	92.4
1976-77	139.0	938.5	1063.1	573.9	29.4	25.9	284.9	26.5	102.2
1977-78	149.2	1035.8	1177.8	661.0	36.5	28.7	338.2	31.4	113.0
1978-79	160.1	1139.2	1324.9	757.6	44.6	31.7	397.0	36.9	124.7
1979-80	171.8	1248.8	1483.6	863.7	53.9	35.0	461.3	43.0	137.5
1980-81	184.3	1364.7	1653.8	979.2	64.3	38.5	531.2	49.7	151.2
1981-82	197.4	1486.6	1836.0	1104.5	75.9	42.2	606.5	56.9	165.9
1982-83	211.3	1615.0	2029.5	1239.1	88.5	46.1	687.4	64.8	181.5
1983-84	226.0	1749.4	2234.7	1383.2	102.3	50.3	773.8	73.3	198.1
1984-85	241.3	1890.0	2451.4	1536.8	117.3	54.7	865.6	82.3	215.7
1985-86	257.4	2036.8	2679.9	1699.9	133.3	59.4	962.9	92.0	234.3
1986-87	274.3	2189.7	2920.0	1872.4	150.5	64.3	1065.8	102.3	253.8
1987-88	291.9	2348.9	3171.6	2054.6	168.8	69.4	1174.2	113.1	274.3
1988-89	310.2	2514.4	3435.2	2246.5	188.3	74.7	1288.2	124.5	295.8
1989-90	329.2	2686.0	3710.2	2447.4	210.6	80.3	1407.7	136.6	318.2
1990-91	349.0	2863.6	3996.5	2658.1	230.5	86.1	1532.6	149.2	341.6
1991-92	369.6	3047.6	4294.8	2878.4	253.4	92.2	1662.8	162.5	366.0
1992-93	390.8	3237.8	4604.1	3108.2	277.3	98.5	1798.9	176.3	391.4
1993-94	412.8	3434.3	4926.0	3347.3	302.4	105.0	1940.5	190.7	417.7
1994-95	435.5	3636.9	5258.9	3596.0	328.6	111.8	2087.4	205.8	445.0
1995-96	459.0	3845.3	5603.7	3854.1	356.0	118.8	2239.8	221.4	473.3

Source : Estimated by the researcher.

Appendix 9

Trend Values of Wholesale Prices in Kerala (1960-61 to 1995-96)

Year	Coconut	Tea	Rubber	Pepper	Ginger	Arecanut	Turmeric	Banana	Tapioca
col. 1	col.2	col. 3	col. 4	col. 5	col. 6	col. 7	col. 8	col. 9	col. 10
1960-61	341.4	6.7	456.6	607.8	468.2	931.3	236.6	124.3	38.7
1961-62	324.1	6.1	423.6	526.4	409.3	755.7	207.5	118.6	32.9
1962-63	314.1	5.5	396.6	459.5	360.8	599.4	183.3	115.1	28.0
1963-64	311.4	5.1	376.1	405.6	321.3	460.6	163.8	113.8	23.7
1964-65	316.1	4.8	362.1	364.4	291.3	338.3	149.0	114.7	20.1
1965-66	328.0	4.6	354.8	336.8	270.6	233.5	139.1	117.9	17.1
1966-67	347.1	4.5	353.6	322.4	259.0	146.0	133.9	123.2	14.8
1967-68	373.6	4.6	359.2	321.2	256.7	75.8	133.4	130.7	13.2
1968-69	407.5	4.8	370.7	333.4	263.5	22.9	137.7	140.4	12.3
1969-70	448.4	5.1	388.9	358.7	279.9	12.7	146.9	152.4	12.0
1970-71	496.6	5.6	413.6	397.5	305.4	31.0	160.7	166.6	12.4
1971-72	552.5	6.1	444.8	449.3	340.3	32.0	179.2	182.9	13.5
1972-73	614.9	6.8	482.4	514.6	384.2	15.6	202.6	201.6	15.2
1973-74	685.2	7.6	526.4	593.0	437.9	18.0	230.9	222.2	17.7
1974-75	763.2	8.5	577.0	684.5	500.5	68.9	263.8	245.1	20.7
1975-76	847.5	9.6	634.1	789.4	572.4	137.1	301.3	270.4	24.5
1976-77	939.2	10.8	697.1	907.8	653.9	382.6	343.8	297.6	28.9
1977-78	1039.5	12.1	767.3	1039.1	744.0	325.5	390.9	327.1	34.1
1978-79	1146.3	13.5	843.5	1183.9	843.7	445.8	442.9	358.9	39.8
1979-80	1259.8	15.1	926.3	1341.7	952.8	582.9	499.7	392.9	46.3
1980-81	1380.8	16.8	1015.7	1513.0	1072.2	737.7	561.2	429.4	53.4
1981-82	1509.7	18.6	1111.4	1696.0	1198.0	910.0	627.4	467.7	61.2
1982-83	1645.5	20.5	1213.8	1895.0	1336.2	1098.9	698.9	507.9	69.7
1983-84	1788.5	22.5	1322.0	2106.7	1482.6	1305.4	774.4	550.9	78.8
1984-85	1939.7	24.7	1437.1	2329.5	1638.0	1530.2	855.1	596.1	88.6
1985-86	2096.4	27.0	1558.2	2567.4	1802.7	1771.1	940.2	643.4	99.0
1986-87	2262.4	29.5	1686.6	2818.0	1975.9	2030.1	1029.9	693.0	110.1
1987-88	2434.3	32.0	1820.4	3081.4	2161.4	2306.9	1125.5	744.2	111.1
1988-89	2614.1	34.7	1960.7	3421.0	2353.0	2598.2	1225.0	798.2	134.5
1989-90	2800.1	37.5	2108.0	3648.1	2555.4	2911.7	1329.4	854.1	147.7
1990-91	2997.5	40.4	2262.3	3952.7	2767.0	3235.5	1437.4	912.5	161.5
1991-92	3196.2	15.1	2422.3	4267.5	2984.6	3580.6	1550.8	972.8	176.0
1992-93	3405.7	46.6	2590.0	4602.8	3217.2	3944.9	1670.6	1035.0	191.1
1993-94	3620.5	49.9	2762.9	4940.6	3455.2	4325.2	1794.2	1099.5	207.1
1994-95	3842.5	53.3	2940.3	5300.5	3704.4	4718.3	1922.1	1167.5	223.6
1995-96	4074.2	56.9	3127.7	5672.4	3960.8	5137.9	2055.0	1236.5	240.6

Source : Estimated by the researcher.

Appendix 10

White's general heteroskedasticity test

White's general heteroskedasticity test is easy to implement and it does not rely on the normality assumption. As an illustration, consider the following three-variable regression model (the generalisation to the k-variable model is straight-forward).

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + u_i \quad \ldots\ldots\ldots\ldots(1)$$

Steps:-

(1) Given the data, we estimate equation (1) and obtain the residuals, u_i.

(2) We then run the following (auxiliary)regression

$$u_i^2 = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \alpha_4 X^2_{2i} + \alpha_5 X^2_{3i} + \alpha_6 X_{2i} X_{3i} + v_i \quad \ldots\ldots(2)$$

That is, the squared residuals from the original regression are regressed on the original X variables or regressors, their squared values and cross product(s) of the regressors. Higher powers of regressors can also be introduced. Note that there is a constant term in this equation even though the original regression may or may not contain it. Obtain R^2 from this (auxiliary) regression.

(3) Under the null hypothesis that there is no heteroskedasticity, it can be shown that sample size (n) times the R^2 obtained from the auxiliary regression asymptotically follows the chi-square distribution with degrees of freedom

equal to the number of regressors (excluding the constant term) in the auxiliary regression. That is,

$$N.R2 \underset{asy}{\sim} \aleph^2 \text{ d.f.} \qquad \text{..................(3)}$$

Where d.f. is as defined previously. In our example, there are 5 d.f, since there are 5 regressors in the auxiliary regression.

(4) If the chi-square value obtained in (3) exceeds the critical chi-square value at the chosen level of significance, the conclusion is that there is heteroskedasticity. If it does not exceed the critical chi-square value, there is no heteroskedasticity which is to say that in the auxiliary regression (2),

$$\alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0.$$

In the present study, to test the ARCH effects, we included 2 period lagged prices, dummy variables, trend and seasonally adjusted data to estimated equation (1). White's criteria showed ARCH effects in all the selected commodities.

Appendix 11

Seasonal Adjustment

Seasonal adjustment techniques are basically adhoc methods of computing seasonal indices and then using those indices to deseasonalize the series by removing those seasonal variations. Seasonal adjustment techniques are based on the idea that a time series Y_t can be represented as the product of four components:

$$Y_t = L \times S \times C \times I \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$ where

L = value of long-term secular trend in the series

S = value of seasonal component

C = value of long term cyclical component

I = value of irregular component.

The objective is to eliminate the seasonal component S. To do this we first try to isolate the combined long term trend and cyclical components L X C. This can not be done exactly, instead an adhoc smoothing procedure is used to remove the combined seasonal and irregular components S X I from the original series Yt. For example, suppose that Yt consists of monthly data. Then a 12 month average Yt* is computed:

$$Y_t^* = 1/12\,(Y_{t+6} + Y_{t+5} + \ldots\ldots\ldots + Y_t + Y_{t-1} + \ldots\ldots\ldots + Y_{t-5}) \quad \ldots\ldots\ldots\ldots(2)$$

Presumably Y_t^* is related free of seasonal and irregular fluctuations and is thus an estimate of L X C.

We now divide the original data by this estimate of L X C to obtain an estimate of the combined S X I :

$$\frac{L \times S \times C \times I}{L \times C} = S \times I = \frac{Y_t}{Y_t^*} = Z_t \qquad \ldots\ldots\ldots\ldots(3).$$

The next step is to eliminate the irregular component I as completely as possible in order to obtain the seasonal index. To do this, we average the values of S X I corresponding to the same month. In other words, suppose that Y_1 (and hence Z_1) corresponds to January, Y_2 to February etc. and there are 48 months of data. We thus compute

$$Z_1\# = \tfrac{1}{4}\,(Z_1 + Z_{13} + Z_{25} + Z_{37})$$

$$Z_2\# = \tfrac{1}{4}\,(Z_2 + Z_{14} + Z_{26} + Z_{38})$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$Z_{12}\# = \tfrac{1}{4}\,(Z_{12} + Z_{24} + Z_{36} + Z_{48})$$

The rationale here is that when the seasonal irregular percentages Z_t are averaged for each month (each quarter if the data are quarterly) the irregular fluctuations will be smoothed out.

The 12 averages $Z_1\#$ .... $Z_{12}\#$ will then be estimates of the seasonal indices. They should sum close to 12 but will not do so exactly if there is any long-run trend in the data. Final seasonal indices are computed by multiplying the indices in equation (4) by a factor that brings their sum to 12 (for example, if $Z_1\#$ .... $Z_{12}\#$ add to 11.7, multiply each one by 12.0/11.7 so that the revised indices will add to 12). We denote these final seasonal indices by $Z_1\wedge$ .... $Z_{12}\wedge$.

The deseasonalisation of the original series Yt is now straightforward; just divide each value in the series by its corresponding seasonal index, there by removing the seasonal component while leaving the other three components. Thus the seasonally adjusted series Y_t^a is obtained from $Y_1^a = Y_1/Z_1\wedge$, $Y_2^a = Y_2/Z_2\wedge$, $Y_3^a = Y_3/Z_3\wedge$, ..., $Y_{12}^a = Y_{12}/Z_{12}\wedge$, $Y_{13}^a = Y_{13}/Z_1\wedge$, $Y_{14}^a = Y_{14}/Z_2\wedge$ etc.

PRODUCTION, PRODUCTIVITY AND PRICES – A STUDY ON AGRICULTURAL COMMODITIES IN KERALA

By

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THESIS SUBMITTED TO THE UNIVERSITY OF CALICUT
FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy in Economics

DEPARTMENT OF ECONOMICS
UNIVERSITY OF CALICUT
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THRISSUR – 680 618

August 1999

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