INSTABILITY IN TAMILNADU AGRICULTURE

An Interdistrict Analysis of Paddy & Millets

1951 - 52 to 1982 - 83

Dissertation submitted in partial fulfilment of the requirements of the award of the degree of Master of Philosophy of Jawaharlal Nehru University, New Delhi

SUDHA MAHALINGAM

CENTRE FOR DEVELOPMENT STUDIES
TRIVANDRUM

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I hereby affirm that the research for this dissertation titled " INSTABILITY IN TAMIL NADU AGRICULTURE — AN INTERDISTRICT ANALYSIS OF PADDY & MILLETS - 1951/52 - 1982/83 " being submitted to the Jawaharlal Nehru University for the award of the Degree of Master of Philosphy was carried out entirely by me at the Centre for Development Studies, Trivandrum.

Trivandrum

SUDHA MAHALINGAM

Certified that this dissertation is the bonafide work of SMT. SUDHA MAHALINGAM and has not been considered for the award of any other degree by any other university. The dissertation may be forwarded for evaluation.

CHIRANJIB SEN
FELLOW

Supervisors

SHAKTI PRASAD PADHI
RESEARCH ASSOCIATE

Director
Centre for Development Studies

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CHAPTER - I

INTRODUCTION

The Indian rural scene witnessed an impressive growth in agricultural production in the three and a half decades of the Planning era. The Primary Sector has become more dynamic, its dwindling share in the net domestic product, notwithstanding. With the advent of the new seed-fertiliser technology in the mid-sixties, Indian agriculture has become more resilient as well.

However, has this growth been accompanied by increasing instability? If so, is there a causal link between growth and instability? What has been the nature and magnitude of instability in the period before and after the adoption of the new technology? These are issues that warrant consideration, if the objective of planned development is growth with stability.

An unstable agriculture can have important implications for the economy. Sustained growth is of paramount importance in subsistence agriculture where input-output relations are still subject to uncertainty, dependent as they are, on the vagaries of the monsoon.

In India, farm families consume most of their produce, leaving only a meagre surplus for the market. This marketed surplus has, therefore, to absorb any fluctutions in output which, in turn, could potentially result in severe price fluctuations that hit particularly, the poor.

Besides, fluctuations in output can affect farm incomes, which may have far-reaching ramifications. Where output instability is chronic, crop insurance becomes a costly operation. When risk levels are high, and crop insurance, costly, it might affect the farmers' decision to sow, leading eventually, to changes in leasing patterns and even ownership of land, which does not augur well for better income distribution.

Frequent setbacks in the agricultural sector can have spill-over effects that are likely to affect the entire economy. In a developing economy, the role of agriculture in generating surpluses for investment cannot be overemphasised.

The modern welfare state has to bear the onus of stabilising consumption. In a country where droughts are not uncommon, the state is obliged to maintain emergency food stocks in order to stabilise supplies. The extent of bufferstock operations would depend upon the nature and magnitude of output instability. In view of the enormous expense involved in building up and maintaining reserve stocks of foodgrains, it becomes necessary to stabilise production.

Planned development envisages investments in agriculture aimed at achieving growth with stability. Suitable policy measures aimed at stabilising production, would call for a proper assessment of the nature and dimension of the problem of instability at the appropriate level.

Therefore, a study of instability in crop production is crucial to the understanding of the process of development in agriculture. The present study concerns itself with the measurement and analysis of instability in cereal production in Tamil Nadu in the decades following Independence. Before we come to the scope and objectives of the present study, we shall do a brief review of the relevant literature in order to bring out the specific purpose of our study.

S.R. Sen[1] has done pioneering work in the field of instability. He analysed foodgrain production for undivided India for 48 years from 1900-01 to 1947-48 and for the Indian Union for 30 years from 1936-37 to 1965-66. Each period was divided in half. For undivided India, the first 24 years showed a rising trend in foodgrain production, accompanied by higher instability. The second 24 years were marked by stagnation as well as a decline in instability. During the first 24 years, peaks and troughs tended to diverge, peaks showing a rising trend of 0.81% p.a. and troughs declining by 0.14% p.a. In the next 24 years peaks and troughs tended to converge - peaks declining by 0.04% p.a. and troughs rising by 0.10% p.a.

A similar exercise conducted for foodgrain production data of the Indian Union confirmed the earlier observation of a positive association between growth and instability of output. The first 15 years (1936-37 to 1950-51) recorded a declining rate of 0.68% p.a., while the peaks as well as the troughs registered a declining trend of 0.54% p.a. and 0.50% p.a. respectively, during the same period. On the other hand, during the next 15 years, (1951-52 to 1965-66) peaks and troughs tended to diverge, while food production increased at the rate of 2.75% p.a. Peaks rose by 2.76% while troughs dipped by 2.2% p.a.

This led Sen to conjecture that fluctuations in output increased as cultivation was extended to marginal lands where production was more susceptible to the vagaries of the weather. Also, when more intensive doses of inputs like fertilisers are used, the risk of loss from factors like drought, tended to increase considerably.

On the other hand, C.H.H. Rao[2] argued that yield variability was far greater than area variability, that yield - oriented growth strategies have contributed to greater variability in output. Analysing linear trends and coefficient of variation in agricultural production, Rao pointed out that foodgrain production showed a steady upward trend during the 7 years ending 1956-57, but the upward trend during the next 8 years was marked by significant fluctuations from year to year. During the first 7 years, area expansion dominated output expansion while thereafter, it was yield increases that mattered. And where yield increases constitute the predominant component of output increases, fluctuations are more marked. This led Rao to conclude that yield fluctuations are responsible for output instability, and therefore, productivity-oriented growth tends to render output more unstable.

A.V. Jose[3] has studied growth rates and fluctuations of principal crops for 15 states for the period 1956-57 to 1972-73. He has fitted trend equations to 3 - year moving averages of Index numbers of area and production and estimated the standard deviation from the trend. A two-way classification of the states by their growth and instability categories revealed no clear-out relationship between growth and instability.

Nadkarni & Deshpande[4] have done a district-level study of instability in crop yields. All the important crops have been covered by this study. The coefficient of variation around the linear trend (or around the mean where the trend was not significant) measures uncertainty in crop yields. The period covered extends from 1955-56 to 1975-76, and the region studied is Karnataka.

Districts have been ranked according to their growth rates and uncertainty levels for crops and crop groups. Rank coefficients have been computed between growth rates and uncertainty levels (measured by coefficient of variation) across districtts. The association between growth and uncertainty turned out to be negative and significant for Kharif pulses, and positive and significant for Rabi cereals, Rabi pulses and all Foodgrains. At the district level, in some districts, growth has occured with greater stability while in others, stagnation in crop yields has been accompanied by higher yield uncertainty. Therefore, it has not been possible to point out a unique relationship between growth and instability. The association varied from district to district and from crop to crop.

Nadkarni & Deshpande have also attempted to see if peaks and troughs show a converging or diverging trend over the years. The peaks and troughs respectively, were pooled together across districts for district level series and across individual crops for crop-level series. In each of the three cases, peaks showed a declining and statistically significant trend over the years, converging towards the trend, while troughs showed no significant tendency. Though this would suggest that fluctuations, on the whole, tended to converge, no generalisation as to the prospect of increasing stability could be made. For, this would have needed a convergent tendency in the case of troughs as well.

More recently, S. Mehra[5] has analysed instability in Indian agriculture in the context of the new technology. She has fitted exponential trends to Time-Series data on Index numbers of area, output and yield for different crops, and crop aggregates, for all major states and all-India. This exercise has been repeated for two separate time periods - one pre-dating the new technology from 1949-50 to 1964-65 and the other, coinciding with its adoption i.e. from 1967-68 to 1977-78. The standard deviation, mean and the coefficient of variation (about the trend) for the two periods are compared. Mehra has come to the following conclusions.

In the decade 1967-68 to 1977-78, the standard deviation and coefficient of variation of production for all the crop aggregates increased as compared with the period 1949-50 to 1964-65. Of the 18 individual crops examined, the standard deviation of production rose in 15 crops and the coefficient of variation of production increased in 12 crops. Fluctuations in yield turned out to be more predominant than fluctuations in area. The standard deviation of yield of foodgrains increased during the second period, as also did the standard deviation of yield of 15 other crops. She also finds a positive though not proportionate association between increases in yield variability and increases in mean yield.

Analysing intercrop, interstate data, Mehra finds only a small increase in the absolute variability of yield for rice and wheat, which she attributes to the high level of irrigation prevailing for these two crops. Also the yield variability of sugarcane and potatoes declined in the period of the new technology. Only in the case of jowar, bajra and maize, both absolute and relative variability have increased with the adoption of the new technology.

Linking up irrigation with greater stability, she finds that in Punjab, yield variability of all the 6 crops examined, either declined or remained constant in the second period compared with the first, thanks to the predominance of assured irrigation from tubewells. This finding has once again been corroborated at the district level where yield variability has registered a decline in those districts with a higher proportion of tubewells and vice versa.

However, she also finds that irrigation associated with the intensification of input use, can have a destabilising effect on crop yields. Thus, a high and positive rank correlation emerges between increase in the standard deviation of yield of a crop and the percentage of its area sown with HYVs.

Mehra concludes that Rabi cultivation with its assured irrigation is more stable, and that small farms have a better chance for stable yields, and therefore, advocates increasing the weight of the Rabi crop in total production, and better distribution of land so as to make way for more small farms.

Peter Hazell[6] has attempted to extend Mehra's work on instability. The variance of total cereal production for all-India is expressed as the sum of production variances of individual crops within states and the sum of all intercrop, interstate production covariances. The production covariances are decomposed through their statistical identities to isolate their sources of change between the two periods 1954-55 to 1964-65 and 1967-68 to 1977-78.

Hazell finds that the variance of total cereal production for all India increased by 342% between the two periods. Of this increase, he attributes only about6% to the increases in the variances of individual crop yields measured at the state level. 82%, he attributes to increases in the covariances of production between crops grown in the same and in different states. Besides, increases in intercrop, and interstate yield covariances were the dominant source of the increase in the production covariances. He also finds that nearly 90% of the increase in yield covariances was due to a simultaneous shift toward more positive correlations between the yields of crops grown in the same and in different states. Another important source of the increase in the variance of total cereal production, according to Hazell, has been due to a simultaneous increase in the year to year variability of the areas sown and the yields obtained. About 37% of the increase in the variance of total cereal production can be attributed to these sources and about 85% of this can be attributed to increases in intercrop and interstate covariances between areas sown and between areas sown and yields.

Therefore, Hazell concludes that the new technology cannot be held responsible for increased instability in foodgrain production. Greater stability may be obtained through policies aimed at distributing production among crops and states in a more risk-efficient manner.

Albeit comprehensive, the existing literature on instability tends to be at an aggregative level. Almost all the studies save one, have been at the state or all-India level. There is, however, a need to understand the problem of instability at a more disagrgregated level. A state level estimation of growth and instability patterns may subsume important and interesting variations at the district level. If interdistrict covariances are high, the state level estimation of instability may not be representative of what is happening at the district level, and at times, it could even be misleading. Particularly in view of Hazell's findings that production instability is substantially due to interstate, intercrop covariances, and not so much due to absolute increases in yield and production variances of crops, it becomes necessary to decompose production variances ans isolate the components at as disaggregated a level as possible. For, the existence of interdistrict covariances would warrant formulation of policies that would advocate distribution of crops among districts in a more risk- efficient manner. The nature of the stabilisation policies in this case would be more in the nature of cropping pattern changes, than anything else. Also, the nature of instability may differ from region to region and from crop to crop. Acreage instability may be higher in a monsoon-dependent region than in a district with assured irrigation. Yield instability may be more pronounced in some crops, than in others. Therefore, it is crucial to understand, not just the dimension of instability, but its regional and crop specific patterns as well. Besides, districts having similar agro-climatic characteristics may display differential patterns of growth and instability, in which case, a district level probe into the problem may give some valuable insights into the causes of instability.

And, the district is the basic unit of administration. It is also the lowest level at which crop production data are available. Therefore, it is appropriate that instability in crop production should be studied at the district level.

Secondly, the studies reviewed suggest that, the nature of the growth-instability nexus should be examined in greater depth and detail although some attempts have been made, to explore the nature of the association between the two. At present, the postulates on the theme seem to suggest that 'production instability is an inevitable consequence of rapid agricultural growth and there is nothing that can be effectively done about it.' (Hazell) However, such a generalisation needs to be scrutinised at the district level. In as much as the sources of growth are different from the sources of instability, growth may not be accompanied by increasing instability. In districts where growth has resulted from controlled conditions of cultivation, it may not have aggravated the level of instability. In stagnant districts where farmers use little inputs, the level of instability could be quite high, determined as it would be, by the variability of the rainfall. Therefore, a strict association between growth and instability cannot be taken for granted.

The present study purports to examine some of the issues that we have just noted. It is a district level study that measures and analyses growth and instability patterns in cereals and attempts to define the nature of the relationship between the two. This study pertains to Tamil Nadu, the traditionally paddy-growing southern state in India. No detailed study of agricultural instability of Tamil Nadu appears to have been undertaken thus far.

The Indian Government's emphasis on self-sufficiency in food lends relevance to an assessment of the growth performance of foodgrains, and particularly, cereals. Therefore, in this study, we have chosen the two major cereals, paddy amd millets. The two crops, although substitutes, are raised under very different conditions, and therefore, are expected to throw up divergent patterns in growth and instability. Besides, the new technology has not spread uniformly to these cereals, and therefore, it would be interesting to measure the level of instability in these two and hopefully, shed light on the role of traditional factors such as acreage fluctuations as well. Paddy is considered a temperamental crop that is acutely sensitive to the nature, level and timing of the inputs that go into its cultivation. On the other hand, millets are looked upon as resilient and therefore, reliable substitues, although they are generally deemed inferior to paddy, and are low-value crops. The nature of instability in these two crops could be very different. With the expansion of the irrigation base, and the advent of the varietal improvements in paddy, changing consumer preferences and relatively more attractive paddy prices may cause millet acreage to fluctuate more violently than its yield. Whereas, in the case of paddy, the intensification of input use consequent upon the new technology, may cause yield to fluctuate, more than its acreage. Therefore, our study attempts to compare and contrast instability levels in these two crops.

The objectives of the study are as follows :

1. To measure growth rates and instability levels in paddy and millets and examine the nature of the association between growth and instability at the district level.
2. To make an intertemporal comparison of growth and instability patterns in paddy and millets, so as to capture the impact of the new technology on these two aspects.

3. To compare instability patterns in paddy across seasons to see if the yield of Rabi paddy is any more stable than the yield of Kharif paddy.
4. To determine the relative contribution of acreage variability, yield variability and the interaction between the two, to output variability of paddy and millets.
5. To analyse yield instability across districts with reference to yield growth, irrigation, rainfall, technology, etc. for paddy and millets, as a tentative probe into the possible causes of yield instability.

Compound Growth Rates from Semilong trends measure growth performance, while deviations from the trend measure instability. The period studied extends over 32 years from 1951-52 to 1982-83. Intertemporal comparisons have been carried out for the sub-periods 1951-52 to 1964-65 and 1965-66 to 1982-83. Detailed description of the methodology used is given at the appropriate places in each chapter. Time - series data on output and acreage of crops from the Season and Crop Reports of Tamil Nadu have been used. Time-series data on yield has been generated by dividing the output by its respective acreage, for each year.

Agricultural performance in Tamil Nadu, like most other regions, is constrained by its geography. Situated in the Southern most tip of the peninsula, the state sports a generally dry and rugged terrain, leavened only by the Kaveri delta, and the far less substantial deltaic regions of Palar in the north and Tambaraparni in the south. The state, as constituted today, has an elevated tract in the middle with plains on both the eastern and western seaboards. The western strip is very narrow and is separated from the sea by the states of Kerala and Karnataka. The plains are cut-off from the elevated tract by the eastern and western ghats that converge in the Nilgris.

Soil fertility is dependent essentially upon the availability of water. The rather sparse Southwest Monsoon caters to the districts of Salem and N. Arcot. The slightly more abundant Northeast Monsoon serves the districts of Chingleput, S. Arcot, Thanjavur, Madurai, Tirunelveli, Coimbatore and Tiruchy. The only districts other than Nilgris to receive fairly abundant quantities of rainfall are Chingleput, Thanjavur and S. Arcot. The fact that the single largest source of irrigation in the state is tank irrigation requiring periodical replenishments from rainfall, endows the monsoons with an element of indispensability.

C.T. Kurien's[7] work on Tamil Nadu sheds some interesting light on the performance of the agricultural sector in the post-Independence era. He finds that in the quarter of a century from 1951-52, there has been no substantial change in the cropping pattern. Paddy is still the predominant crop that is gaining further acreage at the expense of millets. Kurien finds that paddy production has gone up since 1951. In the first decade, it was chiefly due to acreage expansion. The next decade was marked by stagnation in paddy production as well as productivity. Millets seem to be losing ground to paddy and other wet crops during the entire period, although productivity has increased modestly.

Unfortunately, since Independence, the districts of Tamil Nadu have witnessed many truncations and bifurcations much to the chagrin of empirical economists whose attempts at pointing out tendencies and drawing conclusions are ruthlessly thwarted by inconsistencies in the data consequent upon the modifications.

Salem spewed Dharmapuri as early as 1965-66. In 1972-73, Tiruchy and Thanjavur were maimed to create a new district called Pudukottai. In fact, this district comprises a large chunk of territory sculpted out of Tiruchy and a lone Taluk hewn out of Thanjavur, so much so that any computation for the three districts viz. Tiruchy, Thanjavur, and Pudukottai, extending beyond 1972-73 becomes inconsistent, and not exactly comparable. Hence we have calculated the trends in area, production and productivity separately for Tiruchy, and again for Tiruchy and Pudukottai clubbed together. We have however, combined the data for Salem and Dharmapuri. Periyar and Coimbatore have been treated as one entity under Coimbatore. While the reorganisation of states took place in 1956, our study dates from 1951-52, and therefore, we have included only those districts that now form part of the state of Tamil Nadu in our study, leaving out Malabar, S. Kanara, and the districts of the present Andhra Pradesh, for the first five years. We have omitted Nilgiris district from our calculations owing to the insignificance of paddy and millets in its rural economy.

While the thrust of our analysis is on instability, we have also discussed growth patterns in detail. This is with a view to providing a backdrop against which instability can be analysed. For, a study of instability without reference to growth, may not convey much especially because, the latter is considered an inevitable accompaniment of the former.

Chapter II discusses growth patterns in paddy, while Chapter III measures and analyses instability in paddy, at the district level. Intertemporal and interdistrict comparisons have been attempted. For paddy, an interseasonal comparison of instability has also been carried out. We have also decomposed instability in output into its components viz. acreage instability, yield instability, and the interaction between the two. Chapters IV & V deal with the growth and instability analyses respectively, of Millets.

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NOTES

1. Sen. S.R. - (1967)
2. Rao C.H.H. (1975) (1968)
3. Jose A.V. (1977)
4. Nadkarni M.V. & Deshpande R.S. (1980)
5. Mehra Shakuntala (1981)
6. Hazell, Peter B.R. (1982)
7. Kurien C. Thomas (1981)

CHAPTER II

TRENDS IN GROWTH - PADDY

The salience of sustained growth in crop production needs no emphasis. With the advent of technological revolution in agriculture, the process of agricultural development has assumed a janiform aspect, with growth as well as stability in crop production engaging the attention of economists and planners. The study of one without the other will put the exercise out of persepctive. The question that suggests itself is, whether instability is inherent in the process of growth.

The focus of our study is on instability patterns in paddy production, productivity and acreage in the districts of Tamil Nadu. However, since instability is best discussed in the context of growth, in this chapter, we discuss the growth performance of paddy in order that it may serve as a backdrop for our detailed analysis of instability that is to follow, in the next chapter. Besides, instability is measured around a trend line that estimates compound growth rates per annum.

In Section I of this chapter, we highlight the importance of paddy in the rural economy of the state, delineate trends in paddy acreage, yield and output through semilog trend equations and report compound growth rates per annum for the years 1951-52 to 1982-83. We also examine the intra-zonal similarities and differences in growth patterns. This becomes necessary, if we are to determine which inputs are critical to each zone, and within the same zone, whether the districts respond uniformly to these inputs. Supportive details on the likely determinants of growth are given, wherever necessary.

Section II is an intertemporal study. It traces the behaviour of the districts over two time periods, one predating the new technology and the other coinciding with it. Intrazonal and inter-zonal differences and similarities in growth performance are highlighted to show how different districts within the same zone have responded differently to the advent of the green revolution.

SECTION - I

INTERDISTRICT PATTERNS IN GROWTH

Paddy fields dominate the Tamil countryside. Paddy has been the single most dominant crop in Tamil Nadu in the post-Independence era. It occupies nearly a third of the gross cropped area in the State. In wet lands commanding flow irrigation, two or even three crops are raised annually, depending on the duration of water flow. In single crop lands, paddy is rotated with crops like banana, sugarcane betal or pulses. Table 2.1 highlights the importance of paddy in the Gross Cropped Area of the state, as well as in each of its districts in the decades following Independence. The districts are arranged in the descending order of the proportion of their Gross Cropped Area allocated to paddy in 1951-52.

From Table 2.1., we find that paddy acreage has peaked in the sixties only to slide back slightly in the eighties. The trend persisted in the state as a whole, as well as in most of the districts. It is interesting to note

TABLE 2.1.

% SHARE OF PADDY IN THE GROSS CROPPED AREA

	3year Average 1951-52 to 1953-54	3 year Average 1965-66 to 1967-68	3 year Average 1980-81 to 1982-83
Tamil Nadu	30.37	36.27	34.83
1. Thanjavur	80.97	75.93	72.27
2. Chingleput	65.83	72.86	72.17
3. S.Arcot	37.43	44.5	34.23
4. N. Arcot	28.03	41.8	28.23
5. Ramnad	28.97	41.33	48.0
6. Tirunelveli	23.3	26.27	29.13
7. Tiruchy	23.27	28.0	38.53
8. Madurai	21.53	24.4	24.03
9. Kanyakumari	-	50.27	44.0
10. Salem	11.6	13.67	11.07
11. Coimbatore	5.4	10.17	13.03

Source : Season and crop Reports of Tamil Nadu.

that the share of paddy acreage has been slightly eroded in the traditionally paddy intensive coastal districts although these continue to be leading paddy districts in the eighties as well. On the other hand, in the relatively drier districts like Ramnad Coimbatore, Tiruchy and Tirunelveli, there seems to be a shift towards paddy. This shift implies changes in these districts that might have rendered paddy cultivation more attractive.

Nevertheless, the inter district differences notwithstanding, paddy continues to be the single most important crop in Tamil Nadu in terms of acreage. Hence our focus on paddy.

TABLE 2.2

COMPOUND GROWTH RATES PER ANNUM - PADDY (1951/52 - 1982/83)

DISTRICTS	Average share of Paddy in the GCA of the District 1951/52-1982/83 %	Average share of District in the total PADDY area of the State 1951/52-1982/83 %	Average share of District in the total PADDY output of the State 1951/52-1982/83 %	COMPOUND GROWTH RATES P.A. OUTPUT	ACREAGE	YIELD	Mean yield per hectare in Kgs. 1951-52-1982-83
1. Chingleput	72.01	12.72	10.87	2.3*	0.6*	1.8*	1456
2. S. Arcot	40.08	11.65	12.59	2.0*	0.5*	1.4*	1833
3. N. Arcot	36.00	9.95	10.07	1.5*	0.3*	1.2*	1716
4. Salem	11.90	4.12	4.84	1.1*	0.7@	0.4*	1859
5. Coimbatore	10.77	3.89	4.92	3.4*	1.9*	1.5*	2137
6. Tiruchy	30.54	9.64	9.35	1.8*	1.1*	0.7*	1636
(Tiruchy - Truncated)	-	(8.14)	(7.93)	(0.1)	(1.0)*	(1.1)*	(1693)
7. Thanjavur	75.23	24.67	24.79	1.5*	0.3*	1.1*	1717
8. Madurai	23.19	6.08	6.95	1.4*	0.2	1.2*	1940
9. Ramnad	35.58	9.78	6.13	1.6*	2.0*	-0.3	1071
10. Tirunelveli	26.35	5.95	7.07	1.4*	0.1	1.3*	2022
11. Kanyakumari	49.61	2.29	2.57	0.1	-1.1*	1.2*	1927
TAMILNADU	32.50	100.74£	100.15£	1.8*	0.9*	1.0*	1705

* - Indicates significance of Trend at 95% Level.
@ - Indicates significance of Trend at 90% Level.
£ - Exceeds 100% perhaps due to double counting of Arantangi Taluk in Tiruchy as well as Thanjavur.

We have used time series data on paddy output, acreage and yield for 32 years from 1951-52 to 1982-83.[1] We have fitted time trends through semilog regressions for each of the three variables, viz. output, acreage and yield. The study focuses on interdistrict as well as intertemporal patterns. Constant growth rates estimated from semilog regression results have been reported.

We begin with an assessment of the district level patterns of growth. An interdistrict pattern of growth will assume a proper perspective only when analysed in the context of the district's share in the state's total paddy acreage and output. Therefore, Table 2.2. presents, in addition to the estimated growth rates, districtwise, for paddy output, area and yield, the relative share of each district in the state's paddy acreage and output.

First, a look at the state level performance of paddy. According to our estimates, during the 32 years under review, Tamil Nadu produced an average of 4128 thousand tonnes of paddy from 2412 thousand hectares of land. The growth rate of output has been estimated at 1.8% p.a. Considering that Tamil Nadu lies in the low-to-moderate rainfall region (500-1000 m.m.) within India and that its soil is deficient in organic matter, nitrogen and phosphoric acid, the state's growth rate of paddy production is not unimpressive[2].

In our estimates, output growth seems to stem as much from acreage expansion as from growth in yield. Yield seems to have grown slightly faster at 1% p.a. while area growth is 0.9% p.a. during the 32 years under review.

With a mean yield of 1705 kgs/hectare Tamil Nadu can be ranked in the High Productivity Group of states for rice. Alagh and Bhalla's study[3] also ranks Tamil Nadu in High Productivity Group with 2007 kgs/hectare for the three year period from 1970-71 to 1972-73.

High productivity is perhaps not to be unexpected in a state where more than two thirds of paddy area is irrigated. While the paddy intensive districts are irrigated by all sources of irrigation including those that depend upon rainfall for their replenishment, wells are becoming a more important source in the state, in recent times. Wells (sole irrigation and supplementary) provide an assured and regulated source of water supply and hence are considered conducive to high yields per hectare. Table 2.3. shows the sourcewise share of Net Irrigated Area in selected years across the four decades, at the district level.

The state level scenario of growth subsumes widely variant but interesting patterns at a more disaggregated level. Therefore we now look at the districtwise patterns of growth In our interdistrict analysis we propose to see if districts with similar agro-climatic characteristics behave in a similar fashion when it comes to growth patterns. We shall further attempt to see what distinguishes districts within the same agro-climatic zone. For this purpose we have grouped the districts into five agro-climatic zones.

The cost of cultivation surveys of the Ministry of Agriculture divide Tamil Nadu into seven agro-climatic zones according to their soils, annual rainfall etc. In out study if we were to classify 11 districts into 7 agro-

TABLE 2.3.

SOURCEWISE PERCENTAGE SHARE OF NET IRRIGATED AREA IN SELECTED YEARS

	DISTRICTS	1951-52				1961-62				1971-72				1980-81			
		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
1.	CHINGLEPUT	4.46	69.07	0	24.4	1.93	75.02	0	20.73	2.81	70.43	1.87	22.02	2.14	50.9	11.63	34.12
2.	SOUTH ARCOT	38.56	34.37	0	25.7	23.57	45.61	1.33	25.22	23.34	33.62	2.56	37.30	22.93	10.85	26.00	38.61
3.	NORTH ARCOT	5.99	42.43	0	51.12	6.13	47.02	0	43.65	4.32	38.87	0.13	55.84	3.45	17.01	0.23	78.49
4.	SALEM $	11.07	30.52	0	56.08	17.76	17.18	0.05	62.67	13.38	17.72	0	68.62	9.6	5.52	0	83.68
5.	COIMBATORE	21.27	4.41	0	71.72	42.43	2.6	0	54.08	46.58	1.99	0	50.23	23.00*	3.19*	0*	73.79*
6.	TIRUCHY	35.85	36.99	0	23.67	45.23	28.51	0.04	23.43	33.05	33.14	1.65	30.41	44.04@	9.87@	1.41@	43.56@
7.	THANJAVUR	95.11	4.07	0	0.77	93.82	5.2	0	00.94	91.31	5.77	0.04	2.76	94.16	0.63	0.67	3.83
8.	MADURAI	35.35	27.02	0	36.59	31.16	27.02	0	41.82	29.47	24.73	0.79	44.02	24.54	21.56	0.45	52.89
9.	RAMNAD	0.15	64.66	0	33.67	0.15	88.86	0	10.95	0.14	81.81	0	17.99	0	72.10	0.13	27.42
10.	TIRUNEL-VELI	14.56	61.34	0	23.39	13.81	58.55	0	27.17	13.02	45.23	0	40.68	11.95	45.80	0.22	41.59
11.	KANYAKU-MARI	--	--	-	--	82.5	17.5	0	0	59.62	35.7	0.15	2.06	41.3	56.38	0.58	0.95

* - Figures relate to truncated Coimbatore excluding Periyar District.
@ - Figures relate to truncated Tiruchy excluding Pudukottai District.
A - Canals, B - Tanks, C - Tubewells, D - Wells.

$ - Salem includes Dharmapuri.

Source : Compiled from Season & Crop Reports of Tamil Nadu (various issues).

climatic zones, we may not be able to arrive at any meaningful patterns. Therefore, we have slightly modified the zonal classification given in the cost of cultivation surveys and divided Tamil Nadu into five agro-climatic zones, in which we have taken into account, in addition to soil and rainfall characteristics, the importance of paddy in the rural economy of the district. Zone 1 therefore comprises of Chingleput, South Arcot and North Arcot, all three districts falling in the High Rainfall category[4] and contributing approximately 10% each to the state's paddy acreage and output. Zone 2 comprises of Thanjavur only. Although Thanjavur is akin to the districts in Zone 1 as far as rainfall is concerned, its soils are richer. Besides, Thanjavur contributes one fourth to the state's paddy acreage as well as output thus forming the leading paddy district. Zone 3 comprises of Coimbatore and Salem, whose share in the paddy acreage and output of the State are relatively unimportant. However, Salem has better rainfall than dry Coimbatore and the former's soils are richer too. In zone 4 we have grouped Tiruchy, Madurai, Ramnad and Tirunelveli, all receiving moderate rainfall (between 700 and 900 m.m. per annum) and that, chiefly from North East Monsoon. However Tiruchy has fertile soils in deltaic regions, unlike the other districts. Yet, owing to the fact that all the four districts from the state's secondline paddy districts with a share of approximately 6% to 10% each in the State's paddy acreage and output, we have included Tiruchy in zone 4. Finally, in Zone 5, we have Kanyakumari, a very heavy rainfall district, which is also paddy intensive, although its contribution to the State's paddy output is negligible, owing to its' small size.

Zone 1 Chingleput, South Arcot, North Arcot.

Zone 2 Thanjavur.

Zone 3 Salem (including Dharmapuri), Coimbatore (including Periyar)

Zone 4 Tiruchy (including Pudukottai), Madurai, Ramnad, Tirunelveli.

Zone 5 Kanyakumari.

Growth patterns in a paddy intensive district would be of greater relevance from the standpoint of total paddy output of the state, than, growth patterns in non-paddy districts. Besides, it woud be interesting to assess, the growth performance of the already paddy intensive districts against those districts, whose potential for paddy cultivation, may not have been fully tapped, as yet. Therefore, it becomes necessary to rank the districts in the descending order of their mean paddy output, mean paddy acreage and mean paddy yield (vide Table 2.4) and again, in the descending order of their growth rates in paddy output, acreage and yield (vide Table 2.5) and juxtappose the two (vide Table 2.6).

A scrutiny of Table 2.4 revelas that ranking of districts by mean paddy output is almost similar to ranking of the districts according to mean paddy accreage, but not to, ranking of districts by mean paddy yields per hectare. This would imply that the acreage component in mean output is weightier than the yield component. However, in recent times, yield is becoming more important for paddy output and this is evident from the growth rates of paddy yield which are higher than growth rates of paddy acreage in 7 out of 11 districts. In other

TABLE 2.4

DISTRICTS RANKED IN THE DESCENDING ORDER OF THEIR MEAN OUTPUT, MEAN ACREAGE AND MEAN YIELD OF PADDY 1951-52 - 1982-83

	MEAN OUTPUT		MEAN ACREAGE		MEAN YIELD
1.	Thanjavur	1.	Thanjavur	1.	Coimbatore
2.	South Arcot	2.	Chingleput	2.	Tirunelveli
3.	Chingleput	3.	South Arcot	3.	Madurai
4.	North Arcot	4.	North Arcot	4.	Kanyakumari
5.	Tiruchy	5.	Ramnad	5.	Salem
6.	Tirunelveli	6.	Tiruchy	6.	South Arcot
7.	Madurai	7.	Madurai	7.	Thanjavur
8.	Ramnad	8.	Tirunelveli	8.	North Arcot
9.	Coimbatore	9.	Salem	9.	Tiruchy
10.	Salem	10.	Coimbatore	10.	Chingleput
11.	Kanyakumari	11.	Kanyakumari	11.	Ramnad

words, perhaps, acreage expansion is reaching a plateau and output growth in the future will have to come chiefly, from yield increases.

Yet another observation that strikes us is that, growth patterns in paddy output, acreage and yield, as well as mean yields cut across zonal classifications. Districts within the same zone display differential yield levels as well as differential rates of growth.

From Table 2.6, we find that in Zone 1, Chingleput is a Low Productivity district that has a low yield level of 1456 kgs/hectare while the two Arcots figure in the Medium Productivity group. Considerating that these three districts have similar rainfall patterns and that Chingleput is in fact, a coastal district with deltaic soils,

TABLE - 2.5

DISTRICTS RANKED IN THE DESCENDING ORDER OF GROWTH RATES IN PADDY OUTPUT, ACREAGE AND YIELD FOR THE PERIOD 1951-52-1982-83

OUTPUT		ACREAGE		YIELD	
1.	Coimbatore	1.	Ramnad	1.	Chingleput
2.	Chingleput	2.	Coimbatore	2.	Coimbatore
3.	South Arcot	3.	Tiruchy	3.	South Arcot
4.	Tiruchy	4.	Salem	4.	Tirunelveli
5.	Ramnad	5.	Chingleput	5.	North Arcot Madurai and Kanyakumari
6.	North Arcot and Thanjavur	6.	South Arcot	6.	Thanjavur
7.	Madurai and Tirunelveli	7.	North Arcot and Thanjavur	7.	Tiruchy
8.	Salem	8.	Madurai	8.	Salem
9.	Kanyakumari	9.	Tirunelveli	9.	Ramnad
		10.	Kanyakumari		

TABLE 2.6

TWO-WAY CLASSIFICATION OF DISTRICTS BY THEIR MEAN OUTPUT, MEAN ACREAGE AND MEAN YIELD LEVLS AND GROWTH RATE CATEGORIES.

	O U T P U T		A C R E A G E		Y I E L D	
	HIGH GROWTH	LOW GROWTH	HIGH GROWTH	LOW GROWTH	HIGH GROWTH	LOW GROWTH
HIGH MEAN	South Arcot Ching-leput	Thanjavur North Arcot	---	Thanjavur Chingleput South Arcot North Arcot	Coimbatore Tirunelveli Madurai Kanyakumari	---
MEDIUM MEAN	T i r u c h y	Tirunelveli Madurai Ramnad	Ramnad Tiruchy	Madurai Tirunelveli	South Arcot Thanjavur North Arcot	Salem
LOW MEAN	Coimb-atore	Salem Kanya-kumari	Coimba-tore	Salem Kanya-Kumari@	Chingleput	Tiruchy Ramnad@

* - Tiruchy has the same growth rate as the state.

@ - Indicates Negative growth rates.

it is surprising that none of these districts figures in the High Productivity category. Moreover, what distinguishes yield levels within the same Zone?

During 1951-52 to 1982-83, Chingleput has only 81.4% of its' paddy area irrigated, the second lowest in the state (vide Appendix 4), Besides, tanks form the main source of irrigation in the district (Table 2.3.) with ground water sources making a dent in the irrigation scenario only in recent times. The vulnerability of tank irrigation to the vagaries of the monsoon may be a reason for Chingleput's low productivity status. However the two Arcots have a much higher proportion of their paddy area irrigated (93.33% in South Arcot and 97.32% in North Arcot) North Arcot has a very significant proportion of its paddy watered by wells which are considered dependable. This nothwithstanding, if productivity levels in the districts are low, it is indeed baffling.

However, growth rates in paddy yields in all the three districts in Zone 1 are impressive. They figure in the High Growth rate category for yield. However, within the Zone, North Arcot has the lowest growth rate despite its dependable and considerable source of irrigation. This compels one to look beyond the quality and extent of irrigation, perhaps, towards technological factors, for the determinants of yield levels and yield growth rates in the districts within Zone 1.

What determines productivity levels and growth rates in the paddy-bowl zone ? Thanjavur with three quarters of its cultivated area under paddy, and contributing a sizeable 25% to the states' paddy output is too saturated to register high growth rates in paddy acreage or output.

However, when it comes to productivity, this delta district with heavy rainfall has a mean yield level lower than than of six other districts in the state. Its growth rate is 1.1 % p.a. for yield, which is just above the state's average growth rate.

An explanation for this none-too-spectacular performance of Thanjavur is to be sought in its sources of irrigation, levels of multiple cropping and the extent of technological upgradation.

Thanjavur is a high rainfall district. However most of the rain in the district comes from the North-east monsoon at a time when it is not directly usable due to concurrent availability of riverflows. Besides, although 95.74% of paddy in Thanjavur is irrigated, it is lower than the proportion of paddy area irrigated obtaining in the High Productivity group of districts. (vide Appendix 4). Canals are Thanjavur's mainstay.

Fertile Thanajavur has induced farmers to grow two paddy crops a year from days of yore. While area under third crop is virtually negligible, the level of multiple cropping in quite high because of the large area under the second crop. Whether this would depress productivity of land is a moot question. The answer will have to take into account, inter-alia, the level of inputs and technology.

Thanjavur has an average of 93.31% of its paddy in HYV, in the last 7 years under our review (vide Appendix 5). It is the second highest proportion of HYV. area in the state for that period. This notwithstanding, if its productivity level is not impressive enough, perhaps, technology and irrigation are not the only factors to reckon with, in

Thanjavur's yield performance. Structural and institutional factors may have a role to play in Thanjavur's productivity performance.

Now we come to the most striking of intra-zonal differences. Zone 3 has two districts - Coimbatore and Salem which are dissimilar in their behaviour. In our analysis Coimbatore stands out as the only district with high rates of growth in paddy output, acreage as well as yield. Paddy is not an important crop in this relatively dry district. It occupies' just 10.77% share in the district's Gross Cropped Area. The district contibutes a mere 3.89% to the state's paddy acreage and 4.92% to its output.

Coimbatore is the fastest growing district in the state with 3.4% p.a. growth rate in paddy output. Acreage growth is not inconsiderable either, at 1.9% p.a. as against the state's average growth rate of 0.9% p.a.

While rapid growth rates in output and acreage in a district with low mean output and low mean acreage need not be surprising, one is struck by the high yiled levels in Coimbatore - 2137 kgs/hectare (State averge is 1705 kgs/hectare) in this rain shadow district. Coimbatore has not only high mean yields, but also high yield growth rate at 1.5% p.a., second only to Chingleput's growth rate of 1.8% p.a.

Salem, the other non-paddy-intensive district in the same zone turns out to be a mixed bag. While it figures in Low Growth category for acreage, its performance in output and yield fronts has not been satisfactory either. Even mean yield is only 1859 kgs/hectare, enough to warrant the district's inclusion in the Medium Productivity group only. And to crown it all, Salem's yield is growing at a slow pace of 0.4% p.a. only-the second lowest in the state.

In fact, Salem receives more rainfall than Coimbatore. Both the districts have a very high proportion of their paddy area irrigated, viz. Salem 98.84% and Coimbatore, 99.46% (vide Appendix 4). Even when it comes to quality of irrigation, Salem has a much higher proportion of its paddy irrigated by ground-water sources (vide Table 2.3).

However, Coimbatore has almost all its paddy under HYVS (in the last 7 years) whereas in Salem, it is just 60.56% for the same period. Perhaps, that is what accounts for Coimbatore's spectacular performance vis-a-vis Salem. If it is so, in Zone 3, technology may be said to be the more important determinant of productivity levels.

Zone 4 comprises of the State's secondline paddy districts. They display similar characteristics with respect to mean output and acreage, but display different productivity and growth patterns.

Interestingly, Tirunelveli and Madurai are the High Productivity districts while Tiruchy and Ramnad are Low Mean Yield districts within the same zone. Ramnad has the lowest proportion of paddy area irrigated, in the State, 75.1% and most of it from tanks. Tiruchy on the other hand, has over 90% paddy area irrigated and relies almost equally on ground water and on canals. While Ramnad's HYV area is less than half of its paddy area, Tiruchy has 77.38% of its paddy area in HYVS. Yet Tiruchy figures in the Low Productivity category.

Madurai and Tirunelveli which fall in the High Productivity group have over 99% of their paddy area irrigated and most of it from wells. Also, in recent years considerable paddy area is under HYVS, in these two districts, which perhaps, explains their high yield levels.

When it comes to yield growth rates, the two high productivity districts (Madurai and Tirunelveli) are fast growing, while the other two low productivity districts (Tirunelveli and Ramnad) are slow growing. In fact, in Ramnad, yield levels are decelerating at the rate of -0.3% which makes this district unique. Perhaps in Zone 4, both irrigation and technology may be critical factors for productivity levels as well as productivity growth. Acreage expansion is high in Ramnad and Tiruchy, despite their low yield levels, while it is low in Madurai and Tirunelveli.

Output growth in Madurai, Tirunelveli and Ramnad is low, while in Tiruchy, paddy output is growing at the same rate as the state's average growth. If output growth in Ramnad is slow despite fast acreage expansion, it must be due to rapid deceleration in yield levels.

Kanyakumari in Zone 5 deserves mention for its high productivity levels, which we may ascribe, atleast partially, to almost all its paddy area being irrigated. However, paddy area is declining at a fast pace of -1.1% p.a. indicating, diversification of cultivation in that district.

To sum up, we examined output, acreage and yield levels of paddy and their compound growth rates per annum, across districts and across agro-climatic zones. We also speculated on the likely determinants of yield levels and growth rates in each district/zone. We found that factors critical to high productivity levels and fast growth rates appeared to differ from zone to zone and even within the same zone, between districts. While technology seems to be critical to high yield levels in one zone, in another its importance is not that paramount. In yet another zone, it is the quality (source) of irrigation that distinguishes a High Productivity - High Growth rate district from a Low Productivity-Low Growth rate district. Yield levels seem to be depressed, despite technological upgradation and extensive and dependable irrigation in another zone, perhpas, owing to multiple-cropping or institutional factors.

The foregoing discussion on interdistrict growth patterns is expected to serve as a background for the discussion on instability. It would be interesting to see if those factors that distinguish growth pace amongst districts are reflected in differential instability patterns as well. In other words, we shall see, whether high growth rates achieved under controlled conditions of cultivation make for greater stability or whether fast growth is inevitably attendant with greater instability, etc.

But before we go into the instability analysis, we will look at the inter-temporal patterns in growth, in the next section.

SECTION - II

INTER TEMPORAL PATTERNS IN GROWTH

Instability is often associated with the new technology. It has been said that the varietal improvements and improved use of fertilisers has not just accelerated the pace of growth, but has also rendered production, relatively more unstable[5]. Rao argues that this is so because, the new technology is essentially yield-oriented, and that, fluctuations in yield are far greater than fluctuations in area. Therefore, output increases through higher yileds are unstable[6].

To assess the nature and magnitude of production instability in the period of the new technology, one requires a thorough understanding of the nature and magnitude of growth patterns in that period. Therefore, in this section we look at growth rates in paddy output, acreage and yield during two time periods, the first preceding the new technology and the second, coinciding with it. This would help us find out, whether it is indeed yield growth that has contributed to fast output growth, in recent years.

There is further justification for an inter-temporal study of growth rates. 32 years is a long period which has witnessed many developments. A single average growth rate for this entire period may be too compressed to bring out the effect of these developments on growth processes. Therefore, we decided to split the 32 years into two sub-periods, one extending over 14 years from 1951-52 to 1964-65 and the second, over 18 years from 1965-66 to 1982-83 [1965-66 was a drought year elsewhere in the country but the districts of Tamil Nadu, were not so severly affected, although the trend was unmistakeably downward (vide Appendix 1)].

Our periodisation does not correspond exactly to the introduction of the seed-fertiliser technology in Tamil Nadu. This took place gradully, over a period of time, and, at a differential pace in the different districts. However, our Second Sub-period (1965-66 to 1982-83) is likely to capture the impact of the new technology in substantial measure[7].

A cursory glance at Table 2.7 reveals that output grew much faster in the state as well as in a majority of the districts, during the First period. This owes to, rapid area expansion which is evident from the high growth rates of paddy acreage during Period I. In the Second Sub-period, if output growth is positive, it owes substantially to yield growth, because paddy area has actually been declining in the Second Period in most of the districts, as well as, at the state level.

Two conclusions emerge from the foregoing observations. The first is, that the era of green revolution is associated with faster yield growth. Secondly, judging from the dimension of the output growth rates in both the sub- periods, it is acreage growth that is the weighier component in output growth. This second observation suggests that if indeed it is yield instability that makes for production instability in the Second Sub-period, it (yield instability) has to be fairly high to make output fluctations felt.

Another tentative conclusion we might come to is that, perhaps, acreage expansion is generally reaching a plateau. This may be so, because, the share of paddy in the Gross Cropped Area has been more or less stable although, paddy seems to losing ground in most of the districts in the Second Sub-period.

TABLE 2.7

INTER TERPORAL COMPARISON OF GROWTH RATES

(Period I - 1951/52 - 1964/65) (Period II 1965/66 - 1982/83)

DISTRICTS	OUTPUT		G.C.A.		YIELD		MEAN GCA IN HECTARES		MEAN YIELD IN KG./HA.	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
1. Chingleput	4.4*	1.7	3.9*	-0.7	0.6	2.4*	295213	315486	1215	1644
2. S. Arcot	2.0	0.2	3.0*	-1.6*	-1.0	1.8*	261190	296258	1561	2045
3. N. Arcot	4.1*	1.5	4.9*	-2.6	-0.8	3.0*	227816	249640	1549	1846
4. Salem	3.9*	0.4	3.8*	-1.4	0.1	1.3	99362	113443	1814	2390
5. Coimbatore	8.4*	2.6*	8.2*	1.4	2.0	1.2*	84382	101048	1813	1895
6. Tiruchy	0.4	2.2	2.2*	0.9	-1.8	1.3	209974	249923	1519	1728
7. Thanjavur	0.8	1.8*	1.1*	-0.4	-0.3	2.2*	572902	612218	1554	1844
8. Madurai	2.0	2.5	2.1*	-0.3	0.1	2.8*	144806	148128	1751	2088
9. Ramnad	1.9	0.7	5.2*	0.2	-3.4	0.3	196914	266284	1069	1074
10. Kanyakumari	2.9	-0.4	-0.2	-1.6*	3.1	1.2	59611	53048	1737	2022
11. Tirunelveli	1.8	2.9*	2.4*	-0.1	-0.5	3.1*	144975	142202	1798	2197
Tamilnadu	2.5*	1.6	3.6*	-0.5	-1.1	2.1*	2233045	2551315	1558	1819

* - Indicates that the trend is significant at 95% level.

We shall follow the zonal classification adopted in the previous section. However, before we go into a detailed analysis of the district-wise picture, it would be relevant to mention here that yield trends in the First Sub-period and area trends in the Second, proved to be non-significant for the state as a whole, as well as for most of the individual districts (vide footnote to Table 2.7).

Table 2.8 classifies the districts into High, Low and Negative growth categories in output, area and yield of paddy in each time period. The state's average growth rate was taken as the cut-off point to distinguish between High and Low groups. Where the state's average itself turned out to be negative, as in the case of paddy acreage in the Second Sub-period, all the districts with negative growth rates were lumped together in the third category (Negative) and those with positive growth rates were considered relatively fast growing.

Tabel 2.9 complements Table 2.8 indicating the direction of movement of each district with respect to growth performance in the Second Sub-period, relative to the First.

The overall impression is one of inter-temporal change in the patterns of growth-whether it be of output, acreage or yield. However, these changes are more evident in certain zones than in others.

Zone 1 echoes the state level inter-temporal trends. All the three districts in the zone viz. Chingleput, South Arcot and North Arcot witness a deceleration in output and acreage growth and an acceleration in yield growth in the Second period vis-a-vis the First, if we take the absolute magnitude of the growth rates. However, when we classify the districts according to High/Low/Negative categories of growth as in Table 2.8, we find that, Chingleput continues to be in the High Growth category for paddy

TABLE 2.8

INTER-TEMPORAL CLASSIFICATION OF DISTRICTS INTO HIGH, LOW & NEGATIVE GROWTH CATERGORIES - PADDY (PERIOD I-1951/52-1964/65) (PERIOD II - 1965/66-1982/83)

	OUTPUT		ACREAGE		YIELD	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH-GROWTH DISTRICTS	Chingleput North Arcot Coimbatore Kanyakumari Salem	Chingleput Coimbatore Tiruchy Thanjavur Madurai Tirunelveli	Chingleput North Arcot Coimbatore Ramnad Salem	Coimbatore Ramnad Tiruchy	Kanyakumari Coimbatore Chingleput Madurai Salem	Tirunelveli North Arcot Madurai Chingleput Thanjavur
LOW-GROWTH DISTRICTS	South Arcot Thanjavur Madurai Ramnad Tirunelveli Tiruchy	South Arcot North Arcot Ramnad Salem	South Arcot Thanjavur Madurai Tirunelveli Tiruchy	---	---	Tiruchy South Arcot Salem Coimbatore Ramnad Kanyakumari
NEGATIVE-GROWTH DISTRICTS	---	Kanyakumari	Kanyakumari	Chingleput South Arcot North Arcot Thanjavur Madurai Tirunelveli Kanyakumari Salem	South Arcot North Arcot Tiruchy Thanjavur Ramnad Tirunelveli	----

TABLE 2.9

Table showing the Direction of Movement from Period - I (1951/52-1964/65) to Period - II (1965/66-1982/83) of each District in the Growth Rates of Paddy Acreage, Output and Yield.

DISTRICTS	OUTPUT	G.C.A.	YIELD
1. Chingleput	↓	↓	↑
2. South Arcot	↓	↓	↑
3. North Arcot	↓	↓	↑
4. Salem	↓	↓	↑
5. Coimbatore	↓	↓	↓
6. Tiruchy	↑	↓	↑
7. Thanjavur	↑	↓	↑
8. Madurai	↑	↓	↑
9. Ramnad	↓	↓	↑
10. Tirunelveli	↑	↓	↑
11. Kanyakumari	↓	↓	↓
Tamilnadu	↓	↓	↑

output, while North Arcot has moved down to the Low Growth category during the Second period. Thus we have two districts in Zone 1 (Chingleput and South Arcot) maintaining their earlier ranking with respect to paddy output, while one districts (North Arcot) seems to have fared worse in the Second Sub-period. This, as we have already pointed out while examining the trends for the whole period, is due to, a sharp decline in paddy acreage after the mid-sixties. We found a shift away from paddy towards sugarcane which happened in the Second Sub-period, in North Arcot .

Chingleput which figured in the High Yield Growth rate category in Period, I, continues to remain there in the Second Sub-period as well. The two Arcots have improved their yield growth rates in the latter period but the performance of North Arcot is much more impressive whence the district leaps from Negative Growth in the First Sub-period to High positive growth in the Second.

In fact, positive output growth rates in all the three districts, in the Second Sub-period, are due entirely to their impressive yield performance.

Thanjavur in Zone 2 also conforms to the state level picture - area expansion and yield decline in the former period and area shrinkage and High Yield Growth in the latter period. Mention must be made of the rather low acreage growth, 1.1% p.a., even in the First Sub-period which only goes to show that this fertile and well-irrigated district was already being extensively cultivated. Gross Cropped Area under all crops in Thanjavur district exceeded 100% of the total physical area of the district from 1972-73 onwards dipping below 100% only in two years thereafter, viz. 1976-77 and 1982-83[8]. This highlights the extent of multiple cropping in the district that would render acreage expansion difficult, unless paddy steals the ground from other crops in the district.

When we consider growth rates in yield per hectare, Thanjavur, like Tirunelveli and North Arcot, leaps from Negative to High Growth category, thanks to the advent or the new technology. (over 90% of its' paddy area was sown with HYVS).

Zone 3 provides some interesting contrasts. When we consider the absolute magnitudes of change in the growth rates, we find that Salem conforms to the state level scene, with higher output and acreage growth, and lower yield growth in the First Sub-period, relative to the Second Sub-period. However, Coimbatore has fared worse in all the three respects- output, acreage & yield in the Second Sub-period.

A massive 8.4% p.a. growth rate in output in the pre-1965 years is matched by a considerable 2.6% p.a. growth in the Second Sub period which puts Coimbatore almost on top of the list for output growth. Understandably, a substantial proportion of output growth in the First period comes from acreage expansion. But the more interesting observation is that, even in the Second period when paddy was losing ground elsewhere in the state, Coimbatore was registering high (in fact the fastest in the State) growth rate in acreage.

However, the most striking observation is that, in Coimbatore yield grew faster in the pre-green revolution era at 2% p.a. while it slackened to 1.2.% p.a. in the years after the introduction of the new technology. Thus, Coimbatore makes retrograde movement from High Yield Growth district, to a Low Yield Growth district, the technological revolution, notwithstanding. (The level of multiple cropping has come down after the mid sixties and therefore, it can not be held responsible for lower yield growth rates in the Second Sub-period).

While this can be attributed partially to the High Mean Yield levels (which precluded the possibility of spectacular increases) in the district even in the former period (1813 kgs. per hectare), it is surprising that despite an almost 100% HYV adoption, yield growth in the district has slackened in the Second Sub-period.

Salem has declined from a High output, acreage and yield Growth category to Low Growth in output and yield and Negative growth in paddy acreage.

Zone 4 is a mixed bag too. Three of the four districts viz. Tiruchy, Madurai and Tirunelveli have graduated from Low Growth to High Growth Category for output, but not for the same reason. While in Madurai and Tirunelveli this upgradation owes to high yield growth, in Tiruchy, area expansion seems to have mattered. Ramnad has remained where it was, in the Medium Growth category even in the Second Sub-period, despite a very low (0.3%) yield growth and a negligible (0.2%) growth rate in acreage in the Second period. Ramnad also has the dubious distinction of having the lowest productivity levels in the state-a mean yield of 1069 kgs/hectare, in the former period and 1074 kgs/hectare in the latter.

Zone 5 provides interesting variations. When yield was decelerating in most districts in the First Sub-period, Kanyakumari recorded a huge growth rate of 3.1% p.a., However, the green revolution seems to have slackened its pace to just 1.2.% p.a. Interestingly, in the pre-1965 years when acreage expansion was actually the order of the day, Kanyakumari was giving up paddy area and the trend continued into the recent period too. As we had pointed out earlier, in Section I there is , perhaps, a shift away from paddy in this border district.

We conclude this section by summing up our findings. Our analysis does indeed point to higher yield growth in the period of the new technology, in nine out of eleven districts and in the state as a whole. Mean yield levels have gone up considerably in the Second Sub-period. How ever, since it is acreage that is the weightier component in output, output growth rates have slackened in recent times in the state, as well as most of the districts, what with paddy losing ground almost everywhere.

There are inter-temporal, inter-zonal similarities as well as differences in growth behaviour.

Having found out that the new technology has, indeed boosted yield levels and accelerated yield growth, we may now go on to see whether this has been accompanied by higher yield instability and therefore, higher production instability. This will be dealt with in the following Chapter in Section II.

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NOTES

1. Season & Crop Reports of Tamil Nadu.

2. However, our estimates are at variance with the results obtained in other studies using different methods of computation of growth rates. C.T. Kurien (1981) reports a 4.55% Compound Growth Rate per annum for a slighty shorter period of 26 years from 1950-51 to 1975-76 while V. Rajagopalan (1982) estimates a growth rate of 2.19% p.a. for the period 1956-57 to 1978-79. This owes, perhaps, to the differences in the methodology or to the choice of time-periods, or to a combination of both.

3. Bhalla G.S. and Alagh Y (1979)

4. See Appendix 3 for data on average annual rainfall.

5. Mehra, Shakuntala (1981)

6. Rao C.H.H. (1975)

7. Changes in the cut-off year from 1965 to 1966 and again to 1967, did not make any substantial difference to Growth rates. See Appendix 6.

8. The entire physical area of the district is not cultivable. In the seventies, approximately 90% of the physical area of the district was cultivated. Therefore, when Gross Copped Area exceeds 100% of the physical area of the district, it means a high level of multiple cropping in the district.

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CHAPTER -III

PATTERNS IN INSTABILITY - PADDY

In the previous chapter, we found that the districts of Tamil Nadu witnessed giant strides in paddy production in the decades following Independence. The first decade and a half of the Planning era witnessed considerable expansion in paddy acreage, while the following decades were marked by spectacular increases in paddy productivity. This chapter aims to measure and analyse instability in paddy production at the district level. An attempt has been made to view the problem across districts intertemporally, as well as interseasonally.

In Section I of this Chapter, we present our interdistrict analysis of instability in paddy production, acreage and yield. Appendix 1 gives a graphic representation of the actual output, acreage and yield of paddy as also the paddy area irrigated during the 32 years, for each district and for the state.

SECTION - I

INTERDISTRICT PATTERNS IN INSTABILITY

Initially, we look at interdistrict patterns in instability. As we have pointed out earlier, it is output instability that is generally of concern to Governments intent on stabilising consumption. However, year to year fluctuations in acreage and yield inasmuch as they contibute to output fluctuations, are also of interest to us. Therefore, in Table 3.1, we report coefficient of variation of paddy output, acreage and yield, measured independently from their respective trend estimates. This is given districtwise, for the period of 32 years from 1951-52 to 1982-83.

TABLE 3.1.

PADDY C.V. 1951-52 to 1982-83

	DISTRICS	OUTPUT	ACREAGE	YIELD
1.	Chingleput	25.50	14.99	17.27
2.	South Arcot	15.37	14.55	23.70
3.	North Arcot	30.26	23.15	15.36
4.	Salem (including Dharmapuri)	22.57	19.75	10.58
5.	Coimbatore	22.32	22.42	10.99
6.	Tiruchi (including Pudukottai)	23.40	11.92	16.27
.	Tiruchi (truncated)¢	(18.70)	(15.81)	(14.69)
7.	Thanjavur	14.28	05.28	13.34
8.	Madurai	23.14	11.21	16.96
9.	Ramnad	35.84	14.19	31.16
10.	Tirunelveli	21.43	13.53	15.68
11.	Kanyakumari	17.95	07.32	14.41
	Tamil Nadu	15.48	11.25	13.17

¢ Tiruchy truncated gives the coefficient of variation for Tiruchy district excluding Pudukottai from the computation from 1972-73 onwards.

The foremost thing that strikes us from the Table 3.1 is that the state level variability is lower than that of most other districts. This applies uniformly to output, acreage and yield. This would suggest that there are considerable interdistrict covariances that cancel each other out to render the state level output, acreage and yield, relatively more stable.

Table 3.2. groups the districts into High, Medium and Low instability categories for output, acreage and yield. From

this Table, one finds that no district figures uniformly in the High-Instability category for all the three variables viz. output, acreage, and yield. This implies that high output variability owes either to high acreage variability or to high yield variability, but not due to both occuring simultaneously. We shall delve further into the nature and dimesions of the components of output instability when we decompose output variability into its components, later in this chapter.

TABLE 3.2.

CLASSIFICATION OF DISTRICTS+ INTO HIGH/MEDIUM/ LOW VARIABILITY CATEGORIES FOR PADDY OUTPUT, ACREAGE AND YIELD FOR THE PERIOD 1951-52 to 1982-83.

	OUTPUT	ACREAGE	YIELD
High Variability	Ramnad North Arcot Chingleput	Coimbatore North Arcot Salem	Ramnad, Tiruchy South Arcot Chingleput
Medium Variability	Tiruchy. Madurai. Salem. Coimbatore Tirunelveli	Chingleput Ramnad. Tirunelveli South Arcot	Tirunelveli Madurai. North Arcot Kanyakumari
Low Variability	Kanyakumari Thanjavur South Arcot	Tiruchy Madurai Kanya-kumari Thanjavur	Thanjavur Coimbatore Salem.

\+ Salem includes Dharmapuri, Tiruchy includes Pudukottai.

It is also evident from Table 3.2 that instability patterns cut across zonal classifications[1] i.e. districts within a zone display differential patterns of stability. Thus, we have Chingleput and North Arcot in the High-Variability group for output, in Zone 1, while the other district in the same zone, viz. South Arcot figures in the Low-Variability category. For acreage, Tiruchy and Madurai fall in the Low-Variability group while the other two districts in the same zone, viz. Tirunelveli and Ramnad are in the Medium-Variability category. When we consider paddy yields per hectare, we find that Ramnad and Tiruchy are highly variable while Madurai and Tirunelveli from the same zone, are relatively more stable. Chingleput and South Arcot are more unstable than North Arcot from the same zone. Perhaps, one has to look beyond agro-climatic characteristics for the causes of instability. In other words, no zone is doomed to instability just because of its agro-climatic characteristics, nor is there any inherent stabilizing factor within any zone[2].

High instability in a paddy-intensive district is likely to affect the state level output more severly, than high instability in a non-paddy district. Stability in paddy output in Thanjavur is much more critical to the state level output than stability in paddy output in Salem or Nilgris. Therefore, we take a look at the Mean-Variability correspondence, to see if High-Mean districts are also High-Variability districts. We have ranked the districts in the descending order, according to their mean output, mean acreage and mean yield levels, and again according to their instability levels in each category of output, acreage and yield. Table No. 3.3 presents the correspondence between mean output and output variability, mean acreage [illegible] and acreage variability and mean yield and yield variability.

TABLE No. 3.3

TWO-WAY CLASSIFICATION OF DISTRICTS ACCORDING TO THEIR MEAN AND INSTABILITY LEVELS - PADDY

(1951/52 - 1982/83)

	HIGH VARIABILITY			MEDIUM VARIABILITY			LOW VARIABLITY		
	OUTPUT	AREA	YIELD	OUTPUT	AREA	YIELD	OUTPUT	AREA	YIELD
HIGH MEAN	Chingleput North Arcot	North Arcot			Chingleput South Arcot	Madurai Tirunelveli	South Arcot Thanjavur	Thanjavur	Coimbatore
MEDIUM MEAN	Ramnad		South Arcot	Madurai Tiruchy Tirunelveli	Tirunelveli Ramnad	North Arcot Kanya-Kumari		Madurai Tiruchy	Thanjavur Salem
LOW MEAN		Coimbatore Salem	Chingleput Tiruchy Ramnad	Coimbatore Salem			Kanya-Kumari	Kanya Kumari	

If we take paddy output, we have both stable as well as unstable paddy-intensive districts. While Thanjavur and South Arcot are stable paddy districts, Chingleput and North Arcot, are unstable paddy-intensive districts. All secondline paddy districts, except Ramnad (viz. Tiruchy, Madurai and Tirunelveli) and non-paddy intensive districts like Salem and Coimbatore fall in the Medium Output Variability category. Amongst the paddy-intensive districts, only North Arcot displays a high degree of acreage variability. Thanjavur, Madurai and Tiruchy are relatively more stable in terms of paddy acreage.

Yield behaviour is interesting. Coimbatore is the only High Productivity district that is also stable. Madurai and Tirunelveli, the other two High Productivity districts in the state are less stable. However, the low-productivity districts of Chingleput, Ramnad and Tiruchy are the least stable districts in the state.

From the diversity of the combinations that occur, one may conclude that there is no pattern in the correspondence between mean output, mean acreage and mean yield on the one hand and their respective coefficients of variation on the other.

It is said that instability is inherent in the process of growth. This, however, does not preclude the possibility of fluctuations in a stagnant agriculture. It has been observed that, particularly in the post-Independence period, acceleration of the rate of growth of output has proceeded pari passu with increased instability. This inspired S.R. Sen to hypothesize a causal link between growth and instability. He argued that instability increased, as farming was extended to marginal lands.

The notion that in recent times, output variability is predominantly due to yield variability, is gaining currency. Therefore, we shall deal with those factors that might explain yield variability, in greater detail, in Section V of this chapter. Here, we merely look at the association, if any, between output variability and output growth, acreage variability and acreage growth and yield variability and yield growth. We ranked the districts in the descending order of their growth rates and variability levels in paddy output, yield and acreage, and grouped.

them into High, Medium, Low and Negative growth categories and again into High, Medium and Low variability categories. Table 3.4 indicates the growth-variability category for each district, for paddy output, yield and acreage.

Table 3.4

GROWTH -VARIABILITY CORRESPONDENCE

(1951-52 to 1982-83)

Districts	Output	Yield	Acreage
1. Chingleput	High/High	High/High	High/Medium
2. N.Arcot	Medium/High	Medium/High	Medium/High
3. S.Arcot	High/Low	High/High	Medium/Medium
4. Salem*	Medium/Medium	Medium/Low	High/High
5. Coimbatore	High/Medium	High/Low	High/High
6. Tiruchy**	High/Medium	Medium/High	High/Low
7. Thanjavur	Medium/Low	Medium/Low	Medium/Low
8. Madurai	Medium/Medium	Medium/Medium	Medium/Low
9. Ramnad	Medium/High	Low/High	High/Medium
10. Tirunelveli	Medium/Medium	High/Medium	Medium/Medium
11. Kanyakumari	Low/Low	Medium/Medium	Negative/Low

* Salem includes Dharampuri.

**Tiruchy includes Pudukottai.

From the Table 3.4, it seems to appear that there is no unique pattern of relationship between growth and instability. There are fast growing, highly unstable districts, (Chingleput for output and yield and Salem and Coimbatore for acreage) as well as fast growing but relatively stable districts (S.Arcot for output and Coimbatore for yield) High instability accompanies stagnancy in growth (Ramnad for yield) while there are districts which are stagnant, but relatively stable (Kanyakumari for output and acreage).

Before we go to the intertemporal scenario, we would do well to sum up our findings on instability across districts.

We found that considerable interdistrict covariances in paddy output, acreage and yield helped render the state level picture more stable than it otherwise would be. We also found that instability patterns, be it in output, acreage or yield, cut across zonal classifications. It is interesting to note that instability afflicts paddy-intensive districts, as much as it does non-paddy-intensive districts. High Productivity districts are as prone to instability as Medium or Low Productivity districts. And finally, no unique pattern of association was found between growth and instability for paddy, at the district level.

SECTION II

INTERTEMPORAL TRENDS IN INSTABILITY - PADDY

The advent of the new technology in Indian agriculture in the mid-sixties, has rendered an intertemporal comparison of instability, relevant. For, it has been pointed out that the new technology has not only accelerated growth rates of output, and yield of crops, but has in fact, accentuated instability, in its wake.[3] C.H.H.Rao[4] argues that the increasing use of modern inputs under unstable irrigation conditions could be an important reason for the increased instability of the post green revolution years. Mehra[5] echoes this view.

We have attempted to test the hypothesis that instability, particularly in yields is increasing in recent times, through an intertemporal analysis of instability patterns. The 32 years 1951/52 - 1982/83 have been split into two Sub-periods. The first extends over 14 years from 1951/52 to 1964/65 and the Second over 18 years from 1965/66 to 1982/83. While Tamil Nadu witnessed a delayed adoption of the new technology (i.e. the early 70s), we believe that the second period in our study is bound to capture the impact of the new technology in ample measure.

A word or two about the choice of the cut-off year in our analysis will be in order. As we have mentioned, in our earlier chapter on growth, 1965-66 and 1966-67 did not seem to be particularly bad years for paddy in Tamil Nadu, although some districts did witness a downward trend. Therefore, we had decided to use 1965 as the cut-off year. However, in order to verify whether the exclusion of either 1965-66 or both 1965-66 as well as 1966-67 from our second period variability calculations would make any material difference to the results obtained, we decided to run two further separate regressions for paddy output, acreage and yield. The first regression had split 32 years into 15 and 17 years respectively in each period, viz. 1951-52 to 1965-66 in Period I and 1966-67 to 1982-83 in Period II. The second regression had 16 years in each period viz. 1951-52 to 1966-67 in Period I and 1967-68 to 1982-83 in Period II. We have computed the coefficient of variation of the residuals from each of these trend lines. These results are given in Appendix 7. As can be seen, the choice of the cut-off year did not make any material difference to the results obtained. The instability levels as well as the growth rates remained approximately the same, in all the three cases.[6] Therefore, we report here, the results obtained from our computations for the two sub-periods 1951-52 to 1964-65 and 1965-66 to 1982-83, in Table 3.5.

The foremost observation that strikes us is that, at the state level, while instability seems to have increased for paddy acreage and output, it has actually declined for paddy yields per hectare, during the Second Sub-period.

However, when we examine the district level scene, we find that yield instability alongwith that of acreage and output, has increased in all the districts, save Thanjavur, and Tiruchy in the Second Sub-period. This could mean two things. Firstly, the stabilising impact of a stable Thanjavur that contributes a quarter to the state's paddy output, on the state level scenario. Secondly, that there are inter-district covariances in the yield of paddy, that offset the district level instability in yield. More likely, it is a combination of both.

From Table 3.6 one finds that paddy output has become relatively more unstable in the period of the new technology. This is true for the state as a whole, as well as for most of the districts. In Chingleput and Madurai, variability has almost doubled while in Coimbatore. on the other hand, the increase is negligible.

However, the most striking observation is that, a priori, percentage increases in acreage variability seem to be far greater than percentage increases in yield variability. This is contrary to expectations, because, the new technology is believed to have accentuated yield instability. In

TABLE 3.5

INTERTEMPORAL ESTIMATES OF CO-EFFICIENT OF VARIATION - PADDY
Period I - 1951/52 to 1964/65
Period II- 1965/66 to 1982/83

DISTRICTS	OUTPUT		ACREAGE		YIELD	
	Period I	Period II	Period I	Period II	Period I	Period II
1. Chingleput	13.62	27.13	5.95	13.17	13.27	18.30
2. South Arcot	13.53	24.14	6.38	13.35	11.30	15.11
3. North Arcot	19.69	33.07	11.84	22.01	12.75	13.62
4. Salem	18.64	23.21	13.88	18.60	8.00	10.98
5. Coimbatore	18.92	19.17	13.60	18.09	9.28	10.57
6. Tiruchy	19.69	23.92	8.74	12.98	14.99	14.48 ↓
-do-(truncated)	(19.69)	(16.99) ↓	(8.74)	(11.75)	(14.99)	(10.00) ↓
7. Thanjavur	13.17	14.40	1.53	4.74	13.35	11.01 ↓
8. Madurai	13.25	25.97	6.14	12.20	11.46	17.53
9. Ramnad	31.11	36.93	8.70	10.80	27.86	30.31
10. Tirunelveli	19.33	21.68	11.35	12.51	11.42	15.97
11. Kanyakumari	12.81	19.42	6.85	6.70	10.95	15.29
TAMILNADU	11.09	16.80	4.88	8.96	13.40	9.30 ↓

Note: 1. Tiruchy truncated refers to Tiruchy excluding Pudukottai from 1972-73 onwards.
2. Downward pointer (↓) indicates a decline in the C.V. from period I to Period II.

TABLE 3.6

INTER TEMPORAL INCREASES IN INSTABILITY, MEAN LEVELS AND GROWTH RATES FOR PADDY

Period I 1951/52 to 1964/65
Period II 1965/66 to 1982/83

DISTRICTS	OUTPUT		YIELD		ACREAGE	
	% Change in C.V. from Period I Period II	Growth rate in Period II	%Change in C.V. from Period I to Period II	Growth rate in Period II	%Change in C.V. from Period I to Period II	Growth rate in Period II
Chingleput	99.19 (47.33)	1.7	37.21 (35.3)	2.4	121.34 (6.86)	-0.7
South Arcot	78.42 (48.39)	0.2	33.72 (31.00)	1.8	109.25 (13.42)	-1.6
North Arcot	67.95 (30.77)	0.5	6.82 (19.17)	3.0	85.9 (9,58)	-2.6
Salem	24.52 (18.62)	0.4	37.25 (4.46)	1.3	34.0 (14.17)	-1.4
Coimbatore	1.32 (57.07)	2,6	13.9 (31.83)	1.2	33.01 (19.75)	-1.4
Tiruchy	23.82 (37.67)	2.2	-1.1 (13.76)	1.3	52.29 (19.03)	0.9
Thanjavur	9.34 (27.14)	1.8	-17.53 (18.66)	2.2	209.8 (6.86)	-0.4
Madurai	96.0 (23.8)	2.5	52.97 (19.25)	2.8	98.7 (2.29)	-0.3
Ramnad	18.7 (39.61)	0.7	8.79 (0.47)	0.3	24.74 (35.23)	0.2
Tiruneveli	12.16 (19.2)	2.9	39.84 (22.19)	3.1	10.22 (-2.91)	-0.1
Kanyakumari	51.6 (3.58)	-0.4	39.63 (16.41)	1.2	-2.19 (-11.01)	-1.6
TAMILNADU	51.49 (35.04)	1.6	-30.6 (16.75)	2.1	83.61 (14.25)	-0.5

Note: Figures in parentheses indicate percentage increases in Mean output, Mean Acreage, Mean Yield as the case may be.

the districts of Tamil Nadu, acreage seems to fluctuate far more palpably than yield, after the introduction of the new technology. In 8 out of 11 districts and for the state, percentage increases in acreage variability exceed percentage increases in yield variability, and that, significantly. Perhaps, acreage fluctuations are linked up with the availability of HYVs, fertilisers, and irrigation. Kanyakumari is the only district where paddy acreage has become more stable in the second sub-period.

Table 3.6 gives the percentage increase in mean paddy output, mean paddy acreage and mean paddy yield (given in parentheses) as also the percentage increase in the coefficient of variation of the respective variables from the First Sub-period to the Second. We find that the percentage increase in instability is not proportionate to the growth rates in the respective categories. For example, Coimbatore which is the second fastest growing district in the state in terms of paddy output, has registered the lowest increase in the coefficient of variation of output (2.6% and 1.32% respectively) while Kanyakumari with a negative growth rate of -0.4% in paddy output has become more unstable by 51.6% in the Second Sub-period. Similarly, although most districts witnessed shrinkage in paddy acreage, acreage instability increased considerably in most of the districts. Thanjavur with a -0.4% growth rate in paddy acreage shows a 209.8% increase in acreage variability. Again, in paddy yields, North Arcot with a 3% growth rate has increased its instability by 6.82% only. Thus, there seems to be neither determinate nor proportionate relationship between percentage increase in variability and the respective growth rates.

As we have already pointed out, the thrust of our study is on yield instability. At the state level, as we have already pointed out, yield instability has actually declined in the period of the new technology. However, this is chiefly due to interdistrict covariances. At the district level, yield variability has gone up in most of the districts, although not by the same magnitude as the increases in acreage variability. Only in 2 districts, viz. Thanjavur and Tiruchy, yield variability has actually declined in the Second Sub--period. But the magnitude of the decline is quite modest, at -17.53% in Thanjavur and -1.1% in Tiruchy.

Table 3.7 gives a two-way classification of the districts, according to their growth-variability correspondence in each period, for paddy output. The movement of the districts diagonally, upwards or rightwards, indicates a movement for the better in terms of either growth or stability or both. If the district has moved to a higher growth category and/or better stability category it is indicated by an upward pointer, while the converse is indicated by a downward pointer. Where the movement has been for the better in terms of growth and worse in terms of stability or vice versa, as in the case of Madurai, in Table 3.7, we have put a question mark.

Thus we find that for paddy output, 4 districts have registered an upward movement, and five districts show retrograde movement either in terms of growth or in terms of stability or both. Only Ramnad has retained its earlier position while Madurai presents a unique case where its growth rate as well as instability has gone up. Only Madurai of all districts conforms to expectations, having moved to a higher growth as well as instability category in Period II.[7]

TABLE 3.7

GROWTH-VARIABILITY CORRESPONDENCE OF PADDY OUTPUT INTHE TWO PERIODS

Period I - 1951/52-1964/65
Period II - 1965/66-1982/83

	HIGH VARIABILITY		MEDUIUM VARIABILITY		LOW VARIABILITY	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH GROWTH	N. Arcot Coimbatore	Madurai?	Chingleput Salem	Tiruchy↑ Tirunelveli↑		Coimbatore↑
MEDIUM GROWTH	Tirunelveli Ramnad	Chingleput↓ N. Arcot↓ Ramnad↔	S. Arcot Madurai		Kanya-Kumari	Thanjavur↑
LOW GROWTH	Tiruchy		Thanjavur	South Arcot↓ Salem↓		Kanya-kumari↓

It is striking that there are some intra-zonal similarities in the direction of the pointer. All the 3 districts in Zone 1 have registered a downward movement in the Second Sub-period, all 3 having decelerated in their output growth. In addition, Chingleput has become more unstable as well. Thanjavur has improved its growth category while improving its stability position as well. In Zone 3, Tirunelveli and Tiruchy have improved both their growth as well as stability, while Madurai seems to have become more unstable. Zone 4 districts contrast each other. Coimbatore has improved its stability only, while Salem in the same zone has deteriorated in terms of growth. Kanyakumari is just as stable as before, but has decelerated its growth rate.

What is it that has rendered paddy output in Chingleput and Madurai relatively more unstable in the Second Sub-perio(What has made for growth with stability in Tiruchy, Thanjavu and Tirunelveli? Why has Coimbatore combined greater stability with stagnation? These are some of the question that pose themselves, when we do an intertemporal comparison of the performance of the districts in paddy production. However, detailed analysis of explanatory factors for each district is beyond the scope of this study, and left for future work.

The intrazonal differences and interzonal similarities confirm our earlier finding that there is more to growth and stability than mere agro-climatic characteristics, or else, districts in the same zone would be behaving in a similar fashion.

Table 3.8 presents a two-way classification of distric according to their growth and variability categories in the

TABLE 3.8

GROWTH-VARIABILITY CORRESPONDENCE OF PADDY ACREAGE IN THE TWO PERIODS

Period I - 1951/52-1964/65
Period II- 1965/66-1982/83

	HIGH VARIABILITY		MEDIUM VARIABILITY		LOW VARIABILITY	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH GROWTH	North Arcot Coimbatore	Coimbatore↔ Salem↑	Chingleput Ramnad	Tiruchy↑		Ramnad↑
MEDIUM GROWTH	Tirunelveli Salem		South Arcot Tiruchy			
LOW GROWTH					Thanjavur Madurai	
NEGATIVE GROWTH	Kanyakumari	Kanyakumari↔		Chingleput↓ South Arcot↓ North Arcot↓ Madurai↓ Tirunelveli?		Thanjavur↓

two time periods for paddy acreage. Once again, a diagonal upward or rightward movement from Period I to Period II indicates a change for the better either in terms of acreage growth or in terms of acreage stability or both. Only 3 out of 11 districts have registered a movement for the better. Salem and Tiruchy have bettered their growth category only, while Ramnad and Tirunelveli have bettered their stability status only. However, Tirunelveli has worsened its growth status, and hence the question mark. Coimbatore continues to be a High Acreage Growth-High Acreage Variability district in the Second Sub-period as well. All of the 5 districts that have downward pointers have worsened their growth position. In fact, all of them have negative acreage growth in the Second Sub-period. In addition, Madurai has become worse off in terms of stability as well. Only N. Arcot has moved into a higher stability category while moving into negative category for growth.

Thus there are intrazonal similarities as well as differences in growth and stability patterns across time. Another conclusion that emerges is that there can be fluctuations even in a stagnant situation.

Table 3.9 presents a two-way classification of the districts with reference to their growth and variability categories in paddy yield in the two periods. Again, an upward, rightward or diagonally rightward movement indicates an improvement in terms of growth or stability or both. Upward pointers indicate a movement for the better, while a downward pointer would mean a retrograde movement either in terms of growth or stability or both.

TABLE 3.9

GROWTH-VARIABILITY CORRESPONDENCE OF PADDY YIELDS IN THE TWO PERIODS

Period I - 1951/52-1964/65
Period II - 1965/66-1982/83

	HIGH VARIABILITY		MEDIUM VARIABILITY		LOW VARIABILITY	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH GROWTH	Chingleput	Chingleput↔ Madurai↓	Madurai	North Arcot↑ Thanjavur↑	Coimbatore Salem Kanyakumari	
MEDIUM GROWTH				South Arcot↑ Tiruchy↑ Tirunelveli↑		Salem↓ Kanyakumari↓
LOW GROWTH		Ramnad ↑				Coimbatore↓
NEGATIVE GROWTH	Thanjavur Tiruchy Ramnad		South Arcot North Arcot Tirunelveli			

From Table 3.9 we find that 6 out of 11 districts have improved their position, all of them in terms of their growth in paddy yield, while Tiruchy and Thanjavur have improved their stability position as well.[9]

What are the factors that have pushed Tiruchy and Thanjavur ahead of others, in their growth as well as stability status vis-a-vis the other districts? In Thanjavur, it is perhaps because of the very high proportion of HYVs used. Tiruchy presents a curious case where its proportion of paddy area irrigated has declined from an average of 99.61% for the first 14 years to an average of 89.34% in the next 18 years (Vide Appendix 4). Even its HYV area is only 77.38%, lower than that of 4 other districts. (Vide Appendix 5). Yet Tiruchy has moved to a higher category for growth as well as stability in the Second Sub-period vis-a-vis other districts.

Chingleput is more unstable than the other two districts in the same zone. Whether this can be attributed to the predominance of canal irrigation in the district, which makes it dependent of the vagaries of the monsoon to some extent, is a moot question. Ramnad's poor performance in terms of growth as well as stability in paddy yields can, perhaps, be due to its poor quality and extent of irrigation.
In Zone 4, both the districts (Salem & Coimbatore) appear in the Low-Variability category for both the sub-periods. Certainly, the quality and extent of irrigation in these two districts will have a role to play. Coimbatore has 99.24% and Salem has 99.13% of their paddy area irrigated, and that, to a large extent from groundwater sources.

To attempt a more systematic explanation of the instability in paddy yields in the state, we will carry out an interdistrict cross-section regression analysis of yield variability, in terms of some of its likely determinants, in Section V of this chapter.

SECTION III

SEASONAL INSTABILITY - PADDY

This Section deals with instability patterns in paddy output, acreage and yield across seasons, at the district level. Thus far, in our study, paddy has been treated as a composite crop, and instability patterns have been computed for the data on total annual output, acreage and average annual yield per hectare. Three paddy crops are raised in a year, and it is reasonable to surmise that instability patterns across seasons will not be uniform. Perhaps measurement of instability should be made separately, for each season.

A study of instability across seasons becomes even more relevant in the context of the current debate over the need to expand Rabi cultivation, in order to stabilise production. For, it has been said that Rabi crops raised in the dry season depend upon irrigation sources heavily, and perhaps even entirely, and therefore, are less susceptible to the whims of the monsoon. Kharif crops, on the other hand, are dependent upon the monsoon and therefore, their yield levels are linked up with the fluctuations in rainfall.

However, it is also possible, that in the period of the new technology, irrigation has not merely served to increase yield levels, but has also resulted in the intensification of inputs associated with the new technology, and therefore, is also likely to accentuate yield instability, and thereby, increase fluctuations in production as well.

In order to test this, we have attempted to measure instability across seasons. We have once again fitted semi-log trends to Time-Series data on paddy output, acreage and yield for each season, separately, and estimated the compound growth rates per annum, as well as the coefficient of variation of the residuals from the trend. Time-Series data, seasonwise, were available only for 24 years from 1959-60 to 1982-83. In order to make this analysis compatible with our earlier ones, we have estimated growth rates and variability for 18 years only, from 1965-66 to 1982-83, which is the same as our Second Sub-period in the inter-temporal analysis of composite paddy.

Table 3.10 gives the Coefficient of Variation and Compound growth rates per annum, separately for the first, second and third paddy crops for the 18 years under review.

The first paddy crop is far more important in terms of acreage and output, than the second and third crops. At the state level, it contributes 73.94% to the total annual paddy acreage and 75.29% to the annual paddy output. The Second crop which can be identified as the Rabi Season crop contributes just 24.31% to the annual paddy acreage and 22.77% to the annual paddy output. The third paddy crop is negligible, in terms of acreage as well as output. These proportions are the average of the 18 years for the state as a whole and they may differ from district to district although the trend is likely to be similar in the districts too.

From Table 3.10 one finds that the first crop is

TABLE 3.10

SEASONWISE GROWTH RATES (GIVEN IN PARENTHESES) AND COEFFICIENT OF VARIATION - PADDY FOR THE PERIOD 1965-66 TO 1982-83

ISTRICTS	OUTPUT			ACREAGE			YIELD		
	I Crop	II Crop	III Crop	ICrop	II Crop	III Crop	I Crop	II Crop	III Crop
. Chingleput	24.07 (2.1)	33.93 (1.4)	40.41 (-5.5)x	9.98 (-0.5)	23.61 (-0.9)	32.19 (-7.5)x	18.65 (2.5)x	17.04 (2.3)x	17.01 (1.9)x
. South Arcot	23.89 (0.6)	27.38 (-0.3)	39.27 (-9.5)x	11.45 (-1.1)@	21.2 (-2.3)@	31.43 (1.9)x	16.98 (1.8)x	10.4 (2.0)x	15.69 (-4.5)x
. North Arcot	26.88 (0.5)	47.43 (0.5)	59.66 (-5.5)	16.58 (-2.4)x	35.3 (-2.9)	50.85 (-8.4)x	13.07 (2.9)x	17.6 (3.4)x	13.48 (2.9)x
. Salem	20.9 (0.4)	32.8 (-1.7)	39.26 (0.4)	15.5 (-1.3)	31.85 (-1.4)	35.38 (2.1)	9.16 (1.7)x	9.47 (0.3)	10.58 (-1.7)x
. Coimbatore	18.97 (2.9)x	28.02 (2.0)	55.42* (-6.8)@	17.98 (1.9)@	22.4 (0.3)	45.12* (-9.2)x	11.9 (1.0)@	13.3 (1.7)x	15.27* (2.4)x
. Tiruchy	23.73 (2.8)x	28.13 (0.0)	76.64 (-1.5)x	11.10 (1.6)x	22.29 (-1.7)	77.93 (-17.6)x	18.16 (-2.0)x	18.68 (0.6)	19.54 (0.7)
. Thanjavur	11.77 (1.5)x	28.88 (3.3)x	--	2.76 (-0.7)x	14.87 (0.5)	--	10.38 (2.2)x	17.49 (2.9)x	--
. Madurai	21.55 (3.1)x	42.3 (-1.1)	111.63* (5.5)	27.16 (1.5)	30.76 (-5.0)	112.10* (1.7)	23.58 (1.5)	19.7 (3.0)x	16.66* (3.8)x
. Ramnad	30.81 (2.4)	55.11 (1.3)	119.74* (-7.8)	11.05 (0.5)	51.42 (-0.7)	112.41* (-7.1)	25.28 (2.2)	25.03 (2.0)	35.74* (-0.7)
0. Tirunelveli	23.58 (2.6)x	23.65 (3.2)x	80.52 (9,3)x	11.26 (0.0)x	18.27 (-0.2)	74.62 (6.4)x	18.01 (2.6)	15.99 (3.4)x	14.84 (2.7)x
1. Kanyakumari	13.72 (0.8)	18.92 (-1.2)	--	4.22 (-1.4)x	8.56 (-1.9)x	--	12.03 (2.1)x	14.82 (0.7)	--
TAMILNADU	15.28 (1.6)x	22.9 (1.7)	40.55 (-5.3)	7.19 (-0.2)	16.06 (-0.8)	32.82 (-7.7)	9.90 (2.0)x	9.16 (2.5)	10.73 (2.3)

* refers to C.V. and growth rates for 17 year period viz. 1965-66 to 1981-82.
x Indicates significance of trend at 5% level.
@ Indicates significance of trend at 10% level.
- Indicates that continuous time series data was not available for the III Crop in these districts.

more stable than the second and third crops for output and acreage, but not necessary so, for yields. For the second and third crops, acreage variability is more than yield variability, in a majority of the districts and in the state. It is understandable that the acreage under the second and the third crops fluctuates more perceptibly than the acreage under the first crop, in each of the districts.

As for the notion that yield from the Rabi crop is more stable than the yield from the Kharif crop, the districts of Tamil Nadu do not bear this out[10]. 6 out of 11 districts register a higher coefficient of variation for the Second crop yields. However, the difference in the variability between the first and second crop yields is only marginal in most of the districts and at the state level. Out of the 4 paddy-intensive districts, in Thanjavur and N.Arcot, Rabi yield is more variable than Kharif yield, while in Chingleput and S.Arcot, the reverse tendency prevails Therefore, there is not enough evidence in our results that would enable us to recommend Rabi crop in preference to Kharif crop as a measure to stabilise paddy yields.

From Table 3.10, one finds that growth rates across seasons exhibit widely variant patterns. For composite paddy, we found that for the same period, most districts registered shrinkage in paddy area. This phenomenon seems to be common to both Rabi and Kharif crops in 5 out of 11 districts and in the state. If 4 out of 11 districts, it is Rabi crop that is losing ground. Only in Thanjavur, the shrinkage in paddy area seems to be entirely in the Kharif season.

To sum up, we found that fluctuations in paddy output in the second and third Crops were chiefly due to fluctuations in area during these two seasons. There is no evidence in our results to show that the Rabi crop yield is invariably more stable than Kharif yield. The first crop was found to be more stable than the second and third crops for output and acreage.

SECTION - IV
COMPONENTS OF OUTPUT INSTABILITY-PADDY

In the earlier sections of this chapter, we have reported our estimates of the variability of paddy output, area and yield, computed separately from their respective Time-Series data. However, output variability is not merely the sum of acreage variability and yield variability. It depends also on the Covariance between acreage and yield variabilities. In other words, output variability reflects, in addition to acreage variability and yield variability, the effect of area changes on yield levels (as when yield levels drop as a result of bringing in marginal lands) as also the effect of yield changes on area sown with paddy.

Therefore, we have, in this section, broken up output variability into its component parts viz. acreage variability, yield variability and the covariance between the two. For this purpose, we have used the formula expounded by David Murray in his article on Export Earnings Instability: Price, Quantitity, Supply, Demand[11]. There, he conceptualises Export Earnings Instability as a function of Price Instability, and Quantity Instability, as also the covariance between the two, which is a mathematically analogous problem. The decomposition formula is as follows :

Given the identity, OUTPUT = ACREAGE X YIELD

$$O = A.Y. \quad \text{-----------------------------} (1)$$

$$\text{Log } O = \text{Log } A + \text{Log } Y \quad \text{---------------} (2)$$

and the variance of Log O around a fitted constant growth rate trend line is given by the identity,

$$\text{Var (Log O)} = \text{Var (Log A)} + \text{Var (Log Y)} + 2\ \text{CoVar(Log A.Log Y)} \quad (3)$$

where the Variances and Covariances are around trend lines. The variances of area and yield are divided through by their sum and expressed as percentages. The covariance term, positive or negative, reflects the extent to which area and yield movements are mutually reinforcing or offsetting.

This exercise has been carried out for the Whole period (1951-52 to 1982-83) as well as for each of the Sub-periods (1951-52 to 1964-65 and 1965-66 to 1982-83). Table 3.11 gives the contribution of each of the components to output variance.

First, we analyse the interdistrict patterns, for the Whole period. Once again, at the state level, we find that acreage variance and yield variance are mimimal at 6% and 7% respectively, and the rest of the 86% is made up of covariance between acreage variance and yield variance. The positive sign of the covariance term suggests that both area and yield are moving together in the same direction and their interactio effect is quite pronounced, and mutually reinforcing.

The district level scenario is quite different. In Section I, we found that output instability was highest in Ramnad, North Arcot and Chingleput. While in Ramnad and Chingleput, yield variability is dominant, in North Arcot, acreage variability is slightly higher than yield variability.

TABLE 3.11

DECOMPOSITION OF OUTPUT VARIANCE - PADDY.

in % Shares.

DISTRICTS	WHOLE PERIOD (1951/52-1982/83)			SUB PERIOD I-1951/52 to 1964/65			SUB PERIOD II 1965/66-1982/83		
	% Share of variance of acreage	% share of variance of Yield	% share of Covariance	% share of variance of acreage	% share of variance of Yield	% share of Co-variance	% share of Variance of Acreage	% share of Variance of Yield	% share of Covariance
1. Chingleput	63.58	72.19	-35.77	23.33	108.65	-31.99	29.13	31.00	39.86
2. South Arcot	40.68	45.32	14.00	118.27	70.14	-88.41	24.16	40.61	35.23
3. North Arcot	46.87	39.26	13.87	135.58	57.80	-93.38	31.44	30.25	38.31
4. Salem*	23.61	47.94	28.45	32.52	28.42	39.07	69.33	23.24	7.43
5. Coimbatore	84.03	9.55	6.42	58.39	15.33	26.28	75.32	9.43	15.25
6. Tiruchy**	25.85	52.50	21.65	44.44	29.42	26.14	26.41	37.06	36.53
7. Thanjavur	75.23	64.16	-39.39	22.25	59.12	18.63	56.46	33.20	10.32
8. Madurai	13.13	88.28	-1.42	1.18	97.30	1.52	11.26	57.24	31.50
9. Ramnad	26.25	49.11	24.64	115.66	56.01	-71.68	22.64	39.82	37.54
10. Tirunelveli	13.21	68.67	18.12	9.68	64.51	25.81	5.70	65.64	28.66
11. Kanyakumari	40.19	58.28	1.53	33.98	30.22	35.79	9.00	63.41	27.59
Tamilnadu	6.36	7.22	86.42	23.02	108.84	-31.86	29.03	30.97	40.00

* Salem includes Dharmapuri.
** Tiruchy includes Pudukattai.

Totally, in 8 out of 11 districts, it is yield variance that predominates output fluctuations. In addition to North Arcot, it is in Coimbatore and Thanjavur, that acreage fluctuations are higher than yield fluctuations. In North Arcot, the increasing importance of sugarcane may explain the high level of fluctuations in paddy acreage.

Amongst the districts where the proportion of yield variance is higher than the proportion of area variance, Madurai tops the list with 88% of its output fluctuations emanating from yield fluctuations. Madurai is followed by Chingleput (72%) and Tirunelveli (68%).

The covariance term is negative in 3 out of 11 districts viz. Chingleput, Madurai and Thanjavur. This would mean that in these three districts, changes in paddy area are offset by changes in yield or vice-versa (i.e.when yield levels drop from its trend level, more land is sown with paddy so that output is not so severly affected or when more area is sown with paddy, the yield level tends to fall.

Thus, in Chingleput and Thanjavur, despite the high level of yield and acreage fluctuations, the negative covaraiance acts as a cushion to depress the output variance to a certain extent. In Madurai, yield varaince is quite high, but the covariance effect is only mildly offsetting. In all the other districts, the covariance term is positive, implying thereby that whenever area changes, yield also changes in the same direction to compound the effect.

Intertemporal patterns in the decomposition of output variance are interesting. At the state level, yield variance is higher than area variance for either Sub-period, although the contribution of yield fluctuations to output instability is very high in the pre-1965 era. In both the sub-periods, the covariance term is considerable, However, what is interesting is the fact in the First Sub-period the covariance term is negative and large, so much so, it offsets the huge yield variance to reduce output fluctuations, whereas, in the period of the new technology, the covariance term is positive and considerable and thus, compounds the acreage and yield fluctuations to add to output instability. One must remember, however, that the yield trend for the First Sub-period and the area trend for the Second sub-period were non-significant, and the variance terms that have been used in this decomposition analysis have been computed from the deviation of the error term from the trend estimates[12]

From our earlier analysis of instability, we found that 5 out of 11 districts turned out to be highly unstable for paddy output, in the First Sub-period. These were, North Arcot, Tiruchy, Tirunelveli, Ramnad and Coimbatore. In the Second Sub-period, 4 out of 11 districts viz. Chingleput, North Arcot, Madurai and Ramnad, figured in the High-Instability group for paddy output.

In the days before the advent of the green revolution, it was acreage instability that was chiefly responsible for output instability, in 4 out of the 5 districts which recorded high levels of output instability. After the adoption of the short-staple technology, in 3 of the 4 High Output Instability districts, yield variance dominates output varian

Having seen the role played by yield variance in output instability in the highly unstable districts, we now look at the contribution of yield variance to output variance in all the 11 districts. In 4 out of 11 districts, yield variance is more pronounced than acreage variance, in the First

Sub-period, whereas, the proportion goes up to 7 out of 11 in the Second Sub-period. This is a clear indication that the new technology has accentuated yield instability at the district level. However, when we look at the state level scenario, this contention is not valid, because, the difference between the shares of acreage variance and yield variance to output variance is minimal in the Second Sub-period vide Table 3.11.

The covariance term is negative in 4 out of 11 districts, in the First Sub-period, while it is positive for every district in the Second. Perhaps more marginal lands are being brought under cultivation in recent times, compounding the level of instability. Or perhaps, yield levels are fluctuating so much that they are having an adverse effect on area sown. This can be ascertained only when we measure the nature and size of interdistrict covariances.

Nevertheless, from the results of our analysis, we may conclude that at the state level, while in the First Sub-period, area and yield fluctuations were moving in opposite directions, in the period after the adoption of the HYVs, they tend to move in tandem, reinforcing each other. This is not an encouraging trend, and underscores the need to stabilise yield levels, which are becoming predominant source of output instability in a majority of the districts.

Stabilisation of yield is possible only when we identify the causes of yield instability. Therefore, in Section V we inquire into the causes of yield instability.

SECTION V

FACTORS BEHIND YIELD INSTABILITY - REGRESSION ANALYSIS

In the previous section, we decomposed output variance into its components, viz, acreage variance, yield variance and the covariance between the two. At the state level, and in a majority of the districts, we found that the contribution of fluctuations in yield were more pronounced than that of fluctuation in area during the entire period of 32 years and marginally so in the Second Sub-period which witnessed the adoption of the new technology. In this section, we inquire into the possible

causes of yield instability, with inderdistrict cross section data.

Technological upgradation of agricultural practices seems to have been no unmixed blessing in the light of the findings of C.H.H. Rao, Barker, Gabler and Winklemann and Shakuntala Mehra.[13] They have traced yield instability to yield growth and have pointed to the possibility of a causal link between the two. Specifically, Rao argues that since variability in yields per hectare tends to be far greater than that of area, productivity-oriented growth has contributed to greater variability in output. Mehra confirms this observation when she finds a significant association between increases in yield variability and the use of the new seed-fertiliser technology, aimed at growth of productivity.

Yield fluctuations could also be inversely linked to the extent and quality of irrigation. Mehra finds that irrigation could have a stabilising influence on yield and production.[13] By stretching the same logic, one could hypothesize an association between variations in rainfall and variations in year-to -year yields. And finally, the marginal land argument traces yield instability to fluctuations in acreage. S.R. Sen argued that variability increased as cultivation was extended to marginal lands where yields were more susceptible to the vagaries of the monsoon.[13]

Therefore, we have hypothesized yield instability to be a function of yield growth, proportion of paddy area irrigated, the variability of annual rainfall, and the variability of paddy acreage. For the 32 year period, as well as for each of the sub-periods, we have estimated, the compound growth rates per hectare of yields (discussed in Chapter II), the average proportion of paddy area irrigated, the coefficient of variation of total annual rainfall, and the coefficient of variation of paddy acreage. A cross-section regression analysis of yield variability was carried out, using each of the variables listed above. This exercise has been carried out for the whole period of 32 years and again for each of the sub-periods. However, since the number of degress of freedom at the cross section level is very small, we have only regressed the dependent variable on one independent variable at a time , and interpreted the t-ratio with respect to the appropriate degrees of freedom. The results are, nevertheless,to be interpreted with caution.

It must be pointed out that compound growth rates of yield, estimated from trend equations may not explain yield variability satisfactorily, if the trend fit had not been significant. Therefore, we have also estimated point-to-point growth rates of yield. For the 32 year period, we have used five-year averages on either end, while for each of the sub-periods, we have used three year averages on either end.

We have carried out a cross-section regression analysi where, the coefficient of variation of paddy yields was used as the dependent variable and the yield growth rates per annum (trend growth rates and point-to-point growth rates, separately) were used as the independent variable. The following Table gives the regression results for the Whole period and for each of the Sub-periods.

WHOLE PERIOD (1951-52 to 1982-83)	$YVAR = \alpha + \beta\ YGRO$
	$YVAR = 0.228 - 0.09\ YGRO$ (point-to-point)
	(9.13) (-2.82) $R^2 = .47$
	Negative & Significant at 5% level
	$YVAR = 0.219 - 0.048 YGRO$ (trend)
	(6.20) (-1.60) $R^2 = .22$
	Negative & Non-significant
SUB PERIOD I (1951-52 to 1964-65)	$YVAR1 = \alpha + \beta\ YGRO1$
	$YVAR1 = 0.122 - 0.035 YGRO1$ (point-to-point)
	(10.02) (-3.0) $R^2 = .50$
	Negative & Significant at 5% level
	$YVAR1 = 0.128 - 0.022 YGRO1$ (trend)
	(10.9) (-3.07) $R^2 = .51$
	Negative & Significant at 5% level
SUB PERIOD II (1965-66 to 1982-83)	$YVAR2 = \alpha + \beta\ YGRO2$
	$YVAR2 = 0.215 - 0.035\ YGRO2$ (point - to-poin
	(6.79) (-2.04) $R^2 = .32$
	Negative & Significant at 10% level
	$YVAR2 = 0.915 - 0.020\ YGRO2$ (trend).
	(4.94) (-1.05) $R^2 = .11$
	Negative & Non-significant.

From the results of the regression analysis, we find that for the 32 year period, as well as for the sub-periods the association between instability and growth turned out to be negative. This finding flies in the face of the hypothesis that yield instability is a concomitant of yield growth, in the context of paddy yields in Tamil Nadu. In fact, the association proved to be negative and significant for all the three periods, when point-to-point growth rates were used. However, when trend growth rates were used the association turned out to be significant only for the First Sub-period, although it was negative in all the three periods. It is remarkable that even in the Second Sub-perio which saw the adoption of the new technology, this negative association holds.

Therefore, we may conclude, that our interdistrict regression results with point-to-point growth rates indicate that in Tamil Nadu, growth in paddy yields has occured with greater stability, while our analysis with trend growth rates precludes the possibility of yield growth being responsible for yield instability, in the period of the new technology. Our results are not in conformity with expectations, if one is to believe that instability is inherent in the process of growth.

Next, we present the results of our second set of regressions, wherein, yield variability is the dependent variable and proportion of paddy area irrigated, is the independent variable. Once again, this exercise has been conducted for the entire period of 32 years as well as for each of the sub-periods.

WHOLE PERIOD
(1951-52 to 1982-83) $YVAR = \alpha + \beta$ PIA (Average proportion of paddy area irrigated)

$$YVAR = \underset{(4.37)}{0.671} - \underset{(-3.28)}{0.005}\ PIA \qquad R^2 = .55$$

Negative & Significant at 5% level.

SUB PERIOD I
(1951-52 to 1964-65) $YVAR1 = \alpha + \beta\ PIA1$ (Average proportion of paddy area irrigated)

$$YVAR1 = 0.298 - 0.002\ PIA1 \qquad R^2 = .11$$
$$(1.88) \quad (-1.05)$$

Negative & Non-significant

SUB PERIOD II
(1965-66 to 1982-83) $YVAR2 = \alpha + \beta\ PIA2$ (Average proportion of paddy area irrigated)

$$YVAR2 = 0.614 - 0.005\ PIA2 \qquad R^2 = .73$$
$$(6.59) \quad (-4.92)$$

Negative & Significant at 5% level.

This set of results conforms to expectations. For the Whole Period, and for the Second Sub-period, the relationship between yield fluctuations and the proportion of paddy area irrigated, is inverse and significant, while for the First Sub-period, it is inverse, albeit non-significant. It is reasonable to surmise that irrigation will have a stablising impact on yield per hectare, and therefore, the negative association is not surprising. Also, it is noteworthy that, in the era of the new technology, this association is quite pronounced (t-ratio =-4.92), indicating the importance of irrigation as a stablising influence on HYVs.

When yield variability was regressed on rainfall variability (both seasonal and total annual rainfall), the association proved to be non-significant in every case. Therefore, the results are not reported here.

When yield variability across districts was regressed on the average proportion of HYVs across districts during the Second Sub-period, we found the association to be negative and significant at 10% level.

$$YVAR2 = \alpha + \beta \ PHYV2 \ \text{(Average Proportion of HYVs)}$$

$$YVAR2 = 0.281 - 0.002 \ PHYV2$$

$$(4.33) \ (-1.94) \qquad R^2 = .30$$

Negative & Significant at 10% level.

The results show that in the case of paddy in Tamil Nadu, the use of varietal improvements has made for greater stability, which is contrary to expectations. Perhaps, the new technology may not be responsible for increased instability, and one must look elsewhere for the causes of instability.

Finally, when we regressed yield variability across districts on acreage variability across districts, we found that the association was negative and weak for all the three periods (Whole and Sub-periods).

To conclude, we summarise our findings. In the districts of Tamil Nadu, yield growth cannot be said to be responsible for yield instability. In fact, in certain cases (when yield instability was regressed on point-to-point growth rates) yield growth seems to have occured with greater stability. This finding is not in conformity with expectations. We also found that better irrigation made for greater stability, particularly after the adoption of the new technology. Surprisingly, HYVs seem to contribute to greater stability in paddy yields in Tamil Nadu. From our interdistrict regression analysis, we were unable to establish a significant link between fluctuations in paddy yields on the one hand, and fluctuations in seasonal and annual rainfall, or acreage variability, on the other.

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NOTES - CHAPTER - III

1. Refer Chapter II, Section I for zonal classification.
2. Zone 4 may be an exception, because both the districts in the zone display similar characterstics with regard to instability.
3. Barker, Gabler & Winklemann (1981).
4. Rao, C.H.H. (1975)
5. Mehra, Shakuntala (1981).
6. Vide Appendix 7.
7. However, it must be remembered that output growt rate has declined in 7 out of 11 districts and in the state as a whole, while output variability has increased in all the districts and in the state, in absolute terms in the Second Sub-period. We refer here only to the relative position of the districts vis-a-vis each other in the two periods.
8. Once again, the absolute growth rates have decelerated in all the districts and in the state, and this decrease is considerable in quite a few districts. All but 2 districts have registered higher instability as well. The pointers refer to chages in their relative ranking position vis-a-vis each other only in the Second Sub-period as compared to the First.
9. Once again, the pointers refer to the movement in the relative ranking position of the districts only, from the First to the Second Sub-period. In absolute terms all but 2 districts have registered higher instability levels, while 9 out of 11 districts have registered higher growth rates in paddy yields in the Second Sub-period.
10. Mehra (op cit) found that the yield variability of Rabi crop was higher than the yield variability of Khariff crop, at the state level for the period 1967-68 to 1977-78, and ascribed this to the fact that in Tamil Nadu, more Khariff area is irrigated, than Rabi area.
11. Murray, David (1978).
12. However, this should not make a significant difference, because in the absence of a good fit on the trend line, the estimated variance about the regression line is likely to be very close to the variance about the mean.
13. Op. cit.

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CHAPTER - IV

TRENDS IN GROWTH - MILLETS

Paddy is the predominant crop grown in Tamil Nadu. Amongst other cereals, Cholam, Cumbu and Ragi are important. Together, the three major millets account for approximately a fifth of the Gross Cropped Area in the state, in the 32 year period from 1951-52 onwards. For the sake of convenience, we have clubbed together, the three major millets under the head 'Millets' in our analysis. As in the case of paddy, we have again fitted semilog trends to Time-Series data on millet output, acreage and yield[1] and estimated the compound growth rates thereof.

In this Chapter, we discuss the growth performance of millets at the State and district levels. Section I looks at the interdistrict similarities and variations in growth performance of millets during the period 1951-52 to 1982-83. Section II concerns itself with the interemporal patterns in growth at the district level.

SECTION- I

INTERDISTRICT PATTERNS IN GROWTH - MILLETS

Generally, millets are raised on dry lands where paddy cannot be grown. Therefore, it is inevitable that the bulk of millet area should come from the relatively low rainfall districts. Table 4.1 lists the share of each district in the State' s total millet acreage and output, as also the share of millets in the total Gross Cropped Area of the districts alongside compound growth rates in millet output, acreage and yield.

Salem, Coimbatore, Tiruchy and Madurai together account for nearly 70% of the total millet area in the state. Of these four, Salem and Coimbatore contribute approximately a

TABLE 4.1

COMPOUND GROWTH RATES PER ANNUM - MILLETS

DISTRICTS	SHARE OF MILLETS IN GCA OF DISTT. [AVERAGE OF 32 YEARS 1951/52 - 1982/83] %	SHARE OF DISTT. IN MILLET AREA OF STATE - [AVERAGE OF 32 YEARS 1951/52 - 1982/83] %	SHARE OF DIST. IN MILLET OUTPUT OF STATE - [AVERAGE OF 32 YEARS 1951/52 - 1982/83] %	GROWTH RATE OF MILLET OUTPUT P.A.	GROWTH RATE OF MILLET AREA P.A.	GROWTH RATE OF MILLET YIELD/ HA P.A.	MEAN YIELD PER HECTARE OF MILLETS IN KGS, [AVERAGE OF 32 YEARS 1951/52 - 1982/83]
1. Chingleput	7.59	2.14	2.73	0.6	-2.3*	2.9*	1091
2. South Arcot	17.36	8.04	8.60	1.8*	-0.8*	2.6*	867
3. North Arcot	13.09	5.77	6.80	-0.1	-1.9*	1.8*	981
4. Salem@	36.27	21.61	21.54	-0.2	-0.9*	0.7*	806
5. Coimbatore	35.32	20.32	18.96	-1.3*	-1.3*	0.07	750
6. Tiruchy£	32.40	16.30	13.05	-0.1	-0.5*	0.4x	643
(Tiruchy-truncated)		(16.17)	(10.36)	(-0.2)	(-0.6)	(0.3)	(639)
7. Thanjavur	0.66	0.35	0.44	-4.3*	-5.6*	1.3*	1087
8. Madurai	26.79	11.20	13.44	0.8X	-0.3	1.1*	966
9. Ramnad	14.67	6.43	6.0	-0.5	-1.9*	1.4*	768
10. Tirunelveli	20.69	7.45	7.74	0.9*	-1.0*	1.9*	848
TAMILNADU	20.39	97.68	98.54	0.1	-1.1*	1.2*	814

* Indicates significance of Trend at 95% level of confidence.
x Indicates significance of Trend at 90% level of confidence.
@ Salem includes Dharmapuri.
£ Tiruchy includes Pudukottai.

fifth each to the state's millet acreage while Tiruchy and Madurai together, account for a little less than 30% of the state's millet acreage. Very little millets are grown in the paddy intensive districts of Kanyakumari Thanjavur and Chingleput.

A look at the growth performance of millets reveals that, at the state level, millet output has been almost stagnant during the 32 years under review. However, it is interesting to note that the output trend was not statistically significant, although both area and yield trends were significant. Millet area has been shrinking at the rate of -1.1% p.a. offsetting the not inconsiderable yield growth rate of 1.2% p.a. at the state level. Thus we find the upward trend in yields being balanced by a downward trend in area to produce non-significant and almost stagnant output trend. What crops are millets replaced by, in Tamil Nadu? Kurien[2] finds that millets are being replaced by high-value crops like paddy and sugarcane. It is possible that as the irrigation potential goes on expanding, farmers are switching to high value crops like paddy.

The district level growth patterns in output are as unimpressive as the stagnation at the state level. In 6 out of 10 districts, millet output has been shrinking. While this shrinkage was small in districts like Tiruchy and Salem, it is quite substantial in Thanjavur. It must be remembered that output trend fits were statistically significant in only 5 out of 10 districts. In South Arcot, a spectacular 2.6% p.a. growth rate in millet yield has offset a -0.8% p.a. area shrinkage to produce a 1.8% p.a. growth rate in output, all the three trend fits being statistically significant. Similarly, in Tirunelveli, trend fits for output acreage and yield were significant, the rapid yield growth having offset the decline in area to produce a positive output growth rate of 0.9% p.a. So also in Madurai, However, in the other two districts where output growth was significant, viz. Coimbatore and Thanjavur it has been a declining trend -1.3% p.a. in the former and -4.3% p.a. in the latter. This downward trend has been influenced by the deceleration in acreage in both these districts. On the other hand, in Chingleput, a rapid growth rate in yield has been vitiated by a pronounced deceleration in area, to produce a meagre and non-significant output growth of 0.6% p.a. only.

Millet area has been shrinking in all the districts without exception. Acreage trends were statistically significant in all the districts save Madurai. Millets are losing ground to other, probably more lucrative, crops everywhere in Tamil Nadu. It is remarkable that the loss of millet area is more pronounced in the relatively better irrigated districts.

Yield trends were positive and significant in all the districts save Coimbatore, where it stagnates. Interestingly, yield growth is slowest in the two low productivity districts, viz. Coimbatore and Tiruchy, while it is fastest in the high-productivity district of Chingleput (2.9% p.a.). It may be recalled that Chingleput registered the fastest growth rate in paddy yields as well. Perhaps, in this coastal district, as the irrigation base is widening, and as ground-water sources are becoming more important, productivity of all crops is going up. In

Ramnad, which has the dubious distinction of being the only district with negative growth rate for paddy yield, millet yields register a growth rate of 1.4% p.a., a rate that is faster than the state average of 1.2% p.a. Ramnad has a much lower proportion of its Gross Cropped Area irrigated, than most other districts, and that, by tanks. Yet if millet yields are improving while paddy yields are deteriorating, it is surprising.

Growth patterns in millets also cut across zonal classifications.[3] In Zone 1, Chingleput and South Arcot are moving in tandem, with positive growth rates in output and high growth rates in yield, while the third district in the zone, North Arcot, is a straggler with negative growth rates in output and only moderate growth rate in yield. Of the 4 districts in Zone 4,Tirunelveli and Madurai register positive growth rates in output. In Tiruchy, yield seems to stagnate unlike in the other three districts in the same zone.

The upshot of this discussion is that there are intrazonal variations in growth patterns. Interzonal similarity is to be found in the fact that millet area is shrinking in all the districts irrespective of the zone they are in.

Table 4.1 gives the mean yields per hectare of millets during the 32 year period. Millet yields compare unfavourably with those of paddy, at just 814kgs/ hectare for the state. (Paddy yields for the same period were 1705 kgs/hectare, giving Tamil Nadu a high productivity status). However, considering that millets are raised mainly on dry lands and are largely unirrigated, low yield levels are not surprising.

Table 4.1 gives the mean yields per hectare of millets at the districtlevel too. Millet yields per hectare are much lower than paddy yields in all the districts. The highest average paddy yield for the corresponding period is 2137 kgs/hectare in Coimbatore as against 1091 kgs/hectare in the case of millets in Chingleput. In fact, the lowest mean yield level obtaining for paddy (1071 kgs/hectare in Ramnad) is just a little less than the highest yield level of millets viz. 1091 kgs/hectare in Chingleput. However, this may be attributed to the very high levels of irrigation in the lands sown with paddy while millets are raised mainly as dry crops. Even here, districts registering relatively higher mean yield levels, are those that have a higher proportion of their Gross Cropped Area irrigated.

Again, as in the case of paddy, none of the millet intensive, districts registers high level of productivity. In fact, Coimbatore which turned out to be a high-productivity district for paddy, falls in the low-productivity category for millets. Perhaps, in this district, all irrigated area is sown with paddy and other crops while millets are grown in the dry lands or in the dry season. Again, Chingleput which was a low-productivity district for paddy, has registered the highest productivity for millets. Perhaps, in this highly irrigated district, the irrigated proportion of millets is high and perhaps, millet yields respond far more generously to irrigation, than do paddy yields.

Table 4.2 below ranks the districts in the descending order of their mean output, mean acreage and mean yield of millets, during the 32 year period under review. Table 4.3 ranks the districts in the descending order of their growth rates in millet output, acreage and yield. Table 4.4 juxtaposes the two, i.e. grouping of districts according to High/Medium/Low/Negative categories of their mean levels and their growth rates.

TABLE 4.2

DISTRICTS RANKED IN THE DESCENDING ORDER OF THEIR MEAN MILLET OUTPUT MEAN MILLET ACREAGE AND MEAN MILLET YIELD DURING THE PERIOD 1951/52 - 1982/83

MEAN OUTPUT	MEAN ACREAGE	MEAN YIELD
1. Salem	1. Salem	1. Chingleput
2. Coimbatore	2. Coimbatore	2. Thanjavur
3. Madurai	3. Tiruchy	3. North Arcot
4. Tiruchy	4. Madurai	4. Madurai
5. South Arcot	5. S. Arcot	5. S. Arcot
6. Tirunelveli	6. Tirunelveli	6. Tirunelveli
7. N. Arcot	7. Ramnad	7. Salem
8. Ramnad	8. N. Arcot	8. Ramnad
9. Chingleput	9. Chingleput	9. Coimbatore
10. Thanjavur	10. Thanjavur	10. Tiruchy

TABLE 4.3

DISTRICTS RANKED IN THE DESCENDING ORDER OF THEIR GROWTH RATES IN MILLET OUTPUT ACREAGE AND YIELD FOR THE PERIOD 1951/52 - 1982/83.

OUTPUT		ACREAGE		YIELD	
1.	S. Arcot	1.	Madurai*	1.	Chingleput
2.	Tirunelveli	2.	Tiruchy*	2.	S. Arcot
3.	Madurai	3.	S. Arcot*	3.	Tirunelveli
4.	Chingleput	4.	Salem*	4.	N. Arcot
5.	N. Arcot* Tiruchy*	5.	Tirunelveli*	5.	Ramnad
6.	Salem*	6.	Coimbatore*	6.	Thanjavur
7.	Ramnad*	7.	N. Arcot* Ramnad*	7.	Madurai
8.	Coimbatore*	8.	Chingleput*	8.	Salem
9.	Thanjavur*	9.	Thanjavur*	9.	Tiruchy
				10.	Coimbatore

* indicates negative rates of growth

Rank Correlation Coefficient was computed for the districts according to their ranking in Mean Paddy yields and Mean Millet yields, to see if prodctivity in a district was uniform for both paddy and millets. The coefficient was -.38 which shows that there was an inverse relationship, although not statistically significant, between paddy yields and millet yields. In other words, in districts where paddy yields were high, millet yields were low and vice versa. From this one may infer that paddy productivity is dependent on controlled conditions of cultivation while millets can thrive even under uncontrolled conditions of cultivation. This also reinforces our earlier observation that perhaps, millet yields respond far more readily to rainfall and irrigation

TABLE 4.4

TWO-WAY CLASSIFICATION OF DISTRICTS ACCORDING TO THEIR MEAN OUTPUT, MEAN ACREAGE AND MEAN YIELD OF MILLETS AND THEIR RESPECTIVE GROWTH CATEGORIES.

	OUTPUT		ACREAGE		YIELD	
	Positive Growth	Negative Growth	Positive Growth	Negative Growth	High Growth@	Low Growth @
IGH MEAN	Madurai	Salem Coimbatore	----	Salem Coimbatore Tiruchy Madurai	Chingleput Thanjavur	---
EDIUM EAN	South Arcot Tirunelveli	Tiruchy North Arcot Ramnad	----	South Arcot Tirunelveli Ramnad North Arcot	North Arcot South Arcot Tirunelveli	Madurai Salem
OW EAN	Chingleput	Thanjavur	----	Chingleput Thanjavur	Ramnad	Coimbatore Tiruchy

@ classification of High and Low categories for growth rates are based on the State's average growth rates, which was used as the cut-off point.

than do paddy yields.

From Table 4.2,one finds that as in the case of paddy, the acreage component is weightier than the yield component in output, for millets as well. The ranking of the districts according to their mean output levels is almost similar to the ranking of districts according to their mean acreage levels, but not necessarily to the ranking of districts according to their mean yield levels, although there are exceptions. In other words, high mean output districts invariably have a large proportion of their Gross Cropped Area under millets.

Table 4.4 gives a two-way classification of districts according to their mean levels and growth categories. Districts are grouped into High, Medium and Low mean output, mean acreage and mean yield categories on the one hand and High,Low or Positive, Negative growth categories for output, acreage and yield. The state's average growth rate has been used as the cut-off point to distinguish between High and Low categories. Where the state's average is very low as in the case of output growth, or negative, as in the case of acreage growth, the districts have been grouped into Positive and Negative growth rate categories only.

From the Table, one finds that output is receding in two out of three millet intensive districts and in three out of five moderately important millet districts. Millet acreage is declining in all the districts. Surprisingly yield growth rates are highest in the already high-productivity districts of Chingleput and Thanjavur, and lowest in the low-productivity districts of Tiruchy and Coimbatore.

To conclude, we found that as in the case of paddy, growth patterns in millets also cut across zonal classifications. Millets are losing ground to other crops in every district as a result of which, output growth is decelerating in six out of ten districts. Yield levels in millets are far lower than yield levels in paddy. However, the better irrigated districts display relatively higher yield levels. Yield growth is positive in all districts.

SECTION II

INTER-TEMPORAL PATTERNS IN GROWTH - MILLETS.

The seed fertiliser technology was aimed primarily at staple cereals like wheat and rice. Other cereals benefited from the varietal experiments only to a limited extent. As such, an intertemporal analysis of millets with mid-sixties as the cut off point, is not expected to capture the impact of the green revolution on yield and production of millets. However, such an analysis will reflect the impact of the technological revolution in paddy on the performance of millets, which are substitute cereals for paddy. Besides, 32 years is a long period to assess growth patterns in millets. Therefore, splitting up the 32 years into two sub-periods will enable us to get a better perspective on growth performance. For the sake of comparability with our paddy analysis, we have retained the same cut-off year for millets as well. Once again, we have fitted time-trends through semi-log regression equations to Time-Series data on millets (Cholam, Cumbu & Ragi) output, acreage and yield, separately for each of the sub-periods viz. 1951/52 to 1964/65 & 1965/66 to 1982/83.

Compound Growth Rates estimated from the regression equations are reported and discussed in this Section.

Table 4.5 gives the growth rates in millet output, acreage and yield in each of the sub-periods. Before we comment on the intertemporal output performance of millets at the state level, it is necessary to mention that the output trends for both the sub-periods were statistically non-significant. The downward trend in millet acreage was significant for both the sub-periods. Similarly the upward trends in yield were significant for both the sub-periods. However, perhaps, owing to the fact that the yield trend for the First Sub-period was significant only at 90% confidence level, and the acreage trend was declining, the output trend turned out to be non-significant, and the output growth rate was 0.3% p.a. Similarly area and yield trends moving significantly in opposite directions in the Second Sub-period, produced a non-significant output trend. The scenario, therefore, is one of stagnation in millet output, contraction in millet acreage and growth in millet yield, in both the periods.

Intertemporal growth patterns cut across agro-climatic zonal classifications. There are intrazonal differences as well as interzonal similarities.

At the district level 5 out of 10 districts register decelerating growth in millet output, in either Sub-period The highest decline was in South Arcot in Sub-period I, where a significant downward movement in acreage is matched by a significant downward trend in yield to produce a significant decline in output growth to the tune of -5.3% p.a. In the Second Sub-period, Thanjavur registers a

TABLE 4.5

INTER-TEMPORAL COMPARISON OF GROWTH RATES OF MILLET OUTPUT, AREA AND YIELD, AS WELL AS MEAN GCA AND MEAN YIELD OF MILLETS IN THE DISTRICTS.
Period I = 1951/52 -1964/65
Period II = 1965/66 -1982/83

	OUTPUT		G. C. A.		YIELD		MEAN GCA IN HECTARES		MEAN YIELD IN Kgs/Ha	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
1. Chingleput	-1.3x	0.1	-2.7*	-4.0*	1.4x	4.1*	37569	28304	813	1307
2. South Arcot	-5.3*	3.4*	-2.7*	0.0	-2.6*	3.4*	131310	114226	635	1048
3. North Arcot	-1.7	1.1	-3.2*	-1.1*	1.5	2.3*	103270	74931	830	1099
4. Salem@	1.7	0.7	0.9	-1.3*	0.8x	1.9*	355490	304835	770	833
5. Coimbatore	-0.6	-0.7	-2.1*	-1.0*	1.5x	0.3	344852	278330	759	743
6. Tiruchy£	1.8	-0.8	0.0	-0.9*	1.8	0.1	255922	239474	625	658
Tiruchy (Truncated)	(1.8)	(-1.1)	(0.0)	(-1.1)	(1.8)	(0.0)	(255922)	(235904)	(625)	(650)
7. Thanjavur	-0.4	-6.5*	-2.5*	-9.0*	2.1*	2.5*	7371	3611	990	1162
8. Madurai	2.0*	1.0	-0.5	-0.6	2.5*	1.6	172236	167257	882	1031
9. Ramnad	0.9	-0.3	-2.3*	-2.6*	3.3*	2.4*	112181	85726	702	820
10. Tirunelveli	0.9	-0.4	-0.5	-0.3*	1.5	2.1*	119282	107697	701	962
TAMILNADU	0.3	0.8	-1.0*	-1.5*	1.2x	2.3*	1642639	1412079	741	870

* Indicates significance of trend at 95% level of confidence.
x Indicates significance of trend at 90% level of confidence.
@ Salem includes Dharmapuri.
£ Tiruchy includes Pudokottai.

significant and large decline in millet output (-6.5% p.a.), thanks to a very large and significant shrinkage in millet area which offset the significant and positive yield growth rate. Paradoxically, South Arcot, which witnessed the steepest decline in millet output in the First Sub-period, has registered the fastest and significant growth rate of 3.4% p.a. in millet output, in the Second Sub-period. Tiruchy also witnessed a reversal of trends in millet output performance from the First to the Second Sub-period. However, none of the trend equations except that of acreage in the Second Sub-period turned out to be significant for Tiruchy.

The reversal of trends in South Arcot were statistically significant, and therefore, interesting. In fact, South Arcot is the only district that does not record deceleration of millet acreage in the Second Sub-period. When all other districts were giving up millet area, South Arcot remained stagnant with a zero growth rate. Perhaps there are factors at work that prevent cropping pattern changes against millets in that district.

With the exception of Salem in the First Sub-period, and South Arcot in the Second, all the districts record decline in millet area in both the Sub-periods. It is notable that the districts in which the decline was considerable, the downward trends in acreage were statistically significant, while in those districts where the decline in millet acreage was small, the trends-fits were statistically non-significant (Tirunelveli is an exception with a small but significant decline in acreage growth). Another notable observation is that, in the paddy intensive districts, like Thanjavur and Chingleput, the shrinkage in millet area is the largest. However, even in Ramnad which is a relatively dry district, the loss of millet area is considerable. It is evident that farmers find it a less attractive proposition to grow millets. It must be mentioned that millets are considered inferior cereals, and are generally grown on lands on which nothing else can be raised.

The yield performance of millets is not unimpressive. With the exception of South Arcot in the First Sub-period, all the districts register positive yield growth rates in both the Sub-periods. However, the trend - fits for yield were not statistically significant in 3 out of 10 districts in either Sub-period. In the First Sub-period, in 3 out of 7 districts in which the yield trends were statistically significant, the level of confidence was 90% only.

Ramnad which had deteriorating paddy yields in the First Sub-period, registers the highest growth rate for millet yields in the same period. (3.3% p.a.). This confirms our earlier observation that millets tend to thrive on dry lands and respond far more generously to rainfall and irrigation, than does paddy.

It is interesting to note that the paddy-intensive districts record very high growth rates in millet yields in the Second Sub-period. Perhaps, these districts use substantial quantities of improved millet varieties (HYVs). Table 4.6 gives the area under HYVs for paddy and millets for the years 1969-70 to 1973-74 at the state level. It is evident that at the state level, the proportion of millet area sown with HYVs is increasing, although it is far below the proportion of paddy area sown with the new varieties.

It may be recalled that paddy yields were declining in 6 out of 10 districts in the First Sub-period. However, millet yields have been improving steadily all along, and even spectacularly in some districts in the Second Sub-period. Mean yields per hectare have increased in all the districts save

Coimbatore, in the recent period, vide Table 4.5.

TABLE 4.6

PROGRESS OF HYV PROGRAMME

YEAR	PADDY		MILLETS	
	AREA UNDER HYV IN LAKH HECTARES	AREA UNDER HYV AS % OF TOTAL AREA	AREA UNDER HYV IN LAKH HECTARES	AREA UNDER HYV AS % OF TOTAL AREA
1969-70	11.42	45.35	0.91	4.39
1970-71	18.19	69.01	1.69	8.53
1971-72	22.45	83.46	3.56	18.92
1972-73	21.80	76.46	4.50	25.30
1973-74	21.43	77.96	4.76	26.39

Source : C.T. Kurien - The Dynamics of Rural Transformation P.48.

We ranked the districts according to their mean yields per hectare in paddy and millets respectively for each of the Sub-periods, and computed the Rank Correlation Coefficients between paddy and millet yields per hectare for each period, seperately. The correlation turned out to be non-significant for either period, while being negative for the Second Sub-period. Therefore, we may infer productivity varies from crop to crop within the same district, perhaps according to the level of inputs that are received by each crop.

Table 4.7 below presents an intertemporal classification of districts into High, Low and Negative growth categories for millet output, acreage and yield. From the Table, it can be seen that the two Arcots have moved up from Negative growth category in the First Sub-period to High-growth category in the Second, for millet output. On the other hand, Ramnad and Tirunelveli have slid from High-growth in Period I to

TABLE 4.7

INTER-TEMPORAL CLASSIFICATION OF DISTRICTS INTO HIGH, LOW AND NEGATIVE GROWTH CATEGORIES IN MILLET OUTPUT, ACREAGE AND YIELD.
Period I = 1951/52 - 1964/65
Period II = 1965/66 - 1982/83

	OUTPUT		ACREAGE		YIELD	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH GROWTH DISTRICTS	Madurai Tiruchy Salem Ramnad Tirunelveli	South Arcot North Arcot Madurai	Salem		Chingleput Ramnad North Arcot Tirunelveli Coimbatore Tiruchy Thanjavur Madurai	Chingleput South Arcot Thanjavur Ramnad North Arcot@
LOW GROWTH DISTRICTS	—	Salem Chingleput	Tiruchy*	South Arcot£	Salem	Salem Coimbatore Tiruchy Madurai Tirunelveli
NEGATIVE GROWTH DISTRICTS	Chingleput South Arcot North Arcot Coimbatore Thanjavur	Coimbatore Tiruchy Thanjavur Ramnad Tirunelveli	Chingleput South Arcot North Arcot Coimbatore Thanjavur Madurai Ramnad Tirunelveli	Chingleput North Arcot Salem Coimbatore Tiruchy Thanjavur Madurai Ramnad Tirunelveli	South Arcot	

@ N. Arcot recorded the same growth rate as the state average in millet yields in Period II.
* Tiruchy recorded 0 growth rate in millet acreage in period I.
£ S. Arcot recorded 0 growth rate in millet acreage in Period II.

TABLE 4.8

TABLE SHOWING THE DIRECTION OF MOVEMENT FROM PERIOD I (1951/52-1964/65) TO PERIOD II (1965/66 -1982/83) OF EACH DISTRICT IN THE GROWTH RATES OF MILLET OUTPUT ACREAGE AND YIELD.

DISTRICTS	OUTPUT	ACREAGE	YIELD
1. Chingleput	↑	↓	↑
2. South Arcot	↑	↑	↑
3. North Arcot	↑	↑	↑
4. Salem	↓	↓	↑
5. Coimbatore	↓	↑	↓
6. Tiruchy	↓	↓	↓
7. Thanjavur	↓	↓	↑
8. Madurai	↓	↓	↓
9. Ramnad	↓	↓	↓
10. Tirunelveli	↓	↑	↑
TAMILNADU	↑	↓	↑

Legend ↑ indicates improvement.
↓ indicates deterioration.

Negative-growth in Period II.

For millet yields, South Arcot has moved from Negative growth category in Period I to High-growth category in Period II. Surprisingly, yield growth rates have slowed down in 4 out of 10 districts after the mid-sixties.

Table 4.8 complements Table 4.7. The pointers indicate the direction of movement of each district from Period I to Period II, in terms of its growth rates in millet output, acreage and yield.

To conclude, we summarise our findings on the growth performance of millets. It appears that millets have been losing ground to other crops in both the Sub-periods, suggesting a diversification of cultivation away from millets, in almost all the districts. Mean yields per hectare of millets are higher in the recent period, in all but one district. However, in 4 out of 10 districts, millet yield growth has slowed down after the mid-sixties.

On the whole, the intertemporal picture seems to be one of change-unfavourable for acreage, but favourable for yields. What impact this pattern of change has on instability levels will become apparent when we discuss instability in millets in the next Chapter.

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NOTES

1. Time-Series data on Millet yield was generated by dividing the combined output of Cholam, Cumbu and Ragi for each year, by their combined acreage for that year.
2. Kurien C.T. (1981)
3. Vide Chapter II for details of zonal classification.

CHAPTER - V

PATTERNS IN INSTABILITY - MILLETS

SECTION - I

INTERDISTRICT PATTERNS :

It is generally believed that millets are sturdier than paddy, and therefore, a *priori*, one would expect millet yield and production to be more stable than paddy yield and production. As in the case of paddy, the coefficients of variation from semilog trends measure instability. The major millets, Cholam, Cumbu and Ragi have been clubbed together under one head, for purposes of analysis.

Table 5.1 gives the coefficient of variation of millet output, acreage and yield at the district level. As in the case of paddy, one finds that the level of instability for the state as a whole, is much less than the level of instability obtaining in a majority of the districts, be it for output, acreage or yield. This implies interdistrict covariances that cancel each other out, to render the state level instability much lower, than it otherwise would be. One also finds that the level of instability in millet output and yield is almost the same as in the case of paddy. However, the state level acreage instability seems to be much lower in the case of millets than in paddy, which is surprising. Whether this trend is reflected in the district level picture, will become apparent, when we discuss the interdistrict patterns of instability.

A cursory glance at Table 5.1 also reveals that yield instability at the state level is double that of acreage instability. The exact contribution of each of these components to output instability will become evident when we do the decomposition analysis in Section III of this chapter.

TABLE 5.1

COEFFICIENT OF VARIATION OF MILLETS
1951/52 - 1982/83

Districts	Output	Acreage	Yield
1. Chingleput	15.38	20.36	14.3
2. S. Arcot	31.57	8.72	26.2
3. N. Arcot	18.59	10.25	13.81
4. Salem	17.07	9.97	12.39
5. Coimbatore	18.03	8.89	13.68
6. Tiruchy	20.17	5.57	17.01
7. Madurai	22.23	11.0	17.21
8. Thanjavur	23.46	23.81	8.31
9. Ramnad	18.11	9.75	15.86
10. Tirunelveli	20.18	9.48	15.71
Tamil Nadu	14.80	6.84	12.49

Table 5.2 categories the districts into High, Medium and Low-instability groups for millet output, acreage and yield. Here too, instability patterns cut across agro-climatic-zonal classifications. Zone 1 is a typical case in point with South Arcot falling in the High Instability group; North Arcot in the Medium Instability group and Chingleput, in the Low Instability category for Millet output. Similarly, in zone 4, one district figures in the High and another in the Low instability group for millet production, while the other two districts in the same zone fall in the Medium category.

Intrazonal differences are equally pronounced in the case of millet yield instability as well. In Zone 1, South Arcot is more unstable than either Chingleput or

North Arcot Coimbatore is more unstable than Salem in Zone 3. Tiruchy and Madurai are more unstable than the other two districts in Zone 4. Even in the case of acreage instability, intrazonal differences are quite marked.

TABLE 5.2

CLASSIFICATION OF DISTRICTS INTO HIGH/MEDIUM/LOW VARIABILITY CATEGORIES FOR MILLET OUTPUT, ACREAGE & YIELD FOR THE PERIOD 1951-52 to 1982-83

	Output	Acreage	Yield
High Variability	S. Arcot Thanjavur Madurai	Thanjavur Chingleput	S. Arcot Madurai Tiruchy
Medium Variability	Tirunelveli Tiruchy N. Arcot	Madurai N. Arcot Salem Tirunelveli Ramnad	Ramnad Tirunelveli Chingleput N. Arcot Coimbatore
Low Variability	Ramnad Coimbatore Salem Chingleput	Coimbatore S. Arcot Tiruchy	Salem Thanjavur

Table 5.2 also shows that no district figures in the High Instability group for all the three categories, viz. output, acreage and yield. Therefore, one may conclude that high output instability is due either to high acreage instability or high yield instability and not due to both occuring simultaneously.

Table 5.3 gives a two-way classification of the district by their Means and instability levels for millet ouput, acreage and yield. This is to see if a district that produces a substantial quantity of millets is more unstable than a district that produces very little millets. Similarly

TABLE - 5.3

Two-way classification of Districts into High/Medium/Low categories for variability as well as Mean output, Mean acreage and Mean yield.
(1951/52 - 1982/83)

	HIGH VARIABILITY			MEDIUM VARIABILITY			LOW VARIABILITY		
	OUTPUT	AREA	YIELD	OUTPUT	AREA	YIELD	OUTPUT	AREA	YIELD
HIGH MEAN	Madurai	---	---	Tiruchy	Salem Madurai	Chingleput	Salem Coimbatore	Coimbatore Tiruchy	Thanjavur
MEDIUM MEAN	S. Arcot	---	Madurai S. Arcot	Tirunelveli N. Arcot	Tirunelveli Ramnad N. Arcot	N. Arcot Tirunelveli	Ramnad	S. Arcot	Salem
LOW MEAN	Thanjavur	Chingleput Thanjavur	Tiruchy	---	---	Ramnad Coimbatore	Chingleput	---	---

it would be interesting to see if the high productivity districts are more unstable than the low productivity districts.

Once again, as in the case of paddy, we find that there are stable as well as unstable millet intensive districts. Madurai is a relatively important district for millet output and it is highly unstable, while the other two millet-intensive districts like Salem and Coimbatore are relatively more stable. Perhaps the relatively greater stability in millet output at the state level is largely due to stability in Salem and Coimbatore which contribute a substantial proportion each, to the state's millet output.

For millet acreage, amongst the millet-intensive districts, Coimbatore and Tiruchy are more stable than Salem and Madurai.

When we consider productivity, Thanjavur, with its high productivity levels is more stable than Chingleput which is also a high productivity district for millets. Paradoxically, Tiruchy with its low productivity is highly unstable. The other two low productivity districts figure in the Medium Instability category for millet yields. There thus emerges, no definable correspondence between mean output and output instability, mean acreage and acreage instability and mean yield and yield instability.

Now we examine the growth-instability nexus for millets Table 5.4 gives the growth-instability correspondence for each district. Districts have been ranked in the descending order of their growth rates and instability levels and grouped into High, Medium, Low and Negative categories.

TABLE 5.4

GROWTH - VARIABILITY CORRESPONDENCE OF MILLETS
(1951/52 - 1982/83)

	Output	Acreage	Yield
1. Chingleput	High/Low	Negative/ High	High/Medium
2. S.Arcot	High/High	Negative/ Low	High/High
3. N. Arcot	Negative/ Medium	Negative/ Medium	High/Medium
4. Salem	Negative/ Low	Negative/ Medium	Low/Low
5. Coimbatore	Negative/ Low	Negative/ Low	Low/Medium
6. Tiruchy	Negative/ Medium	Negative/ Low	Low/High
7. Thanjavur	Negative/ High	Negative/ High	Medium/Low
8. Madurai	High/High	Negative/ Medium	Medium/High
9. Ramnad	Negative/ Low	Negative/ Medium	Medium/Medium
10. Tirunelveli	High/ Medium	Negative/ Medium	High/Medium

From the Table, it is evident that there is no unique pattern of association between growth and instability. There are fast growing stable districts (Chingleput for output), fast growing unstable districts, (South Arcot and Madurai for output and South Arcot for yield), and stagnant but stable districts (Salem for yield). For millet acreage, negative growth rates are attendant with different degrees of instability. This diversity of combinations precludes the possibility of defining a predictable pattern of association between growth and instability. Therefore, we have done an interdistrict cross-section regression analysis of yield instability with reference to yield growth and other variables, to see, to what extent yield instability can be explained by yield growth. This will be discussed in Section IV of this chapter.

Before we conclude this section, it would be interesting to compare instability levels in paddy with those in millets at the districts. If we take output, we find that paddy output in Chingleput is highly unstable, while millet output is quite stable. Similar is the case with Ramnad. On the other hand, in South Arcot and Thanjavur, while paddy production is quite stable, millet production is very unstable. In 7 out of 10 districts the absolute level of instability in paddy output is higher than the level of instability in millet output.

If we consider millet acreage, once again, in 8 out of 10 districts, the absolute level of instability is higher in the case of paddy than in millets. From Tables 3.2 and 5.2, we find that in Coimbatore, millet acreage is highly stable while paddy acreage is highly unstable. In Tiruchy, both paddy and millet acreage are quite stable. In Thanjavur while millet acreage is unstable, paddy acreage is very stable

However, only in 4 out of 10 districts, paddy yields are more unstable than millet yields, when we consider the absolute level of instability. Millet as well as paddy yields are stable in Thanjavur while the yield of both the crops is unstable in Tiruchy and South Arcot. Millets may not be as study a crop, as our a priori expectations seem to suggest. However, considering the fact that millets are grown on marginal and perhaps unirrigated lands, it is not surprising that their productivity is subject to greater fluctuations than the productivity of paddy. There seems to be some uniformity in the yield behaviour of the two crops in the districts.

To conclude, we summarise our findings on the inter-district pattern of instability in millets. As in the case of paddy, we find considerable interdistrict co-variances that render the state level scenario relatively more stable. Instability patterns in millets also cut across zonal classifications. The malaise of instability afflicts millet-intensive as well as non-millet intensive districts. High productivity districts are as prone to yield instability as low productivity districts. A cursory scrutiny of growth-instability nexus reveals no definite relationship between the two, at the district level. And finally, while paddy output and acreage seem to be more fluctuating than millet output and acreage, millet yields, however, are more unstable than paddy yields in a majority of the districts. Perhaps, millets are not as sturdy a crop as they are considered to be.

SECTION II

INTERTEMPORAL PATTERNS IN INSTABILITY - MILLETS

As we have mentioned earlier, the technological revolution in millets was only a limited success. However, this notwithstanding, we found that the growth performance of millet yields improved in the period after the mid-sixties. Whether this accelerated growth rates in millet yields is attendant with greater yield instability as well, is what we propose to examine in this Section.

Also of interest would be the level of instability in millet acreage, when the latter has been decelerating, and the level of instability in stagnant or decelerating millet output.

Semilog trends have been fitted to Time-Series data on millet output, acreage and yield for the two time periods the first spanning 14 years from 1951-52 to 1964-65, and the second spanning 18 years from 1965-66 to 1982-83. The coefficient of variation of the residuals from the trend has been computed.

Table 5.5 gives the intertemporal levels of instability (measured in terms of coefficient of variation), in millet output, acreage and yield as also the percentage change in the coefficient of variation from Sub-Period I to Sub-Period II.

The foremost observation that strikes us is that instability has increased in all the districts in the Second Sub-Period. The state level instability is lower than that of most other districts, be it for output, acreage or yield in both the Sub-Periods. This would mean that changes in acreage and yield levels in one district are offset by changes in acreage and yield levels in another district, so much so that the total range of fluctuations for the state as a whole, is less than they could have been.

It is further evident from Table 5.5 that instability and mean levels are not moving in the same direction. In the case of millet acreage, one finds that mean acreage has been decreasing in all the districts, although instability has been increasing everywhere. A decline in mean millet output has been accompanied by higher

TABLE 5.5

INTER TEMPORAL ESTIMATES OF C.V. OF MILLET OUTPUT, ACREAGE AND YIELD.

Period I = 1951/52 - 1964/65
Period II = 1965/66 - 1982/83

DISTRICTS	OUTPUT			ACREAGE			YIELD		
	Period I	Period II	% Change	Period I	Period II	% Change	Period I	Period II	% Chan
1. Chingleput	15.02	21.55	43.48 (17.61)	13.35	15.56	16.55 (-24.66)	10.22	13.96	36.5 (60.7
2. South Arcot	21.34	27.05	26.76 (42.31)	5.58	6.64	19.0 (-13.01)	16.83	24.09	43.1 (65.0
3. North Arcot	16.19	18.27	12.85 (-3.85)	8.59	9.10	5.94 (-27.44)	11.77	14.39	22.2 (32.4
4. Salem	10.25	19.55	90.73 (-7.48)	7.39	9.93	34.37 (-14.25)	7.04	13.16	86.9 (8.1
5. Coimbatore	16.53	18.82	13.85 (-20.69)	8.03	8.89	10.71 (-19.29)	10.57	14.83	40.3 (-2.1
6. Tiruchy	16.52	21.76	31.72 (-1.01)	3.43	6.43	87.46 (-6.43)	15.75	17.34	10.1 (5.2
(Tiruchy-truncated)*	(16.52)	(20.96)	(26.88) (-3.68)	(3.43)	(7.18)	(109.33) (-7.82)	(15.75)	(16.90)	(7.3 (-3.8
7. Thanjavur	15.07	21.46	42.40 (-45.03)	14.62	17.72	21.20 (-51.01)	5.71	6.69	17.1 (17.3
8. Madurai	11.35	26.45	133.04 (-13.74)	7.24	13.22	82.6 (-2.89)	6.02	20.54	241.2 (16.8
9. Ramnad	15.49	19.55	26.4 (-11.13)	7.39	11.44	54.80 (-23.58)	12.26	15.56	26.9 (16.8
10. Tirunelveli	14.51	21.42	47.62 (22.93)	5.54	8.82	59.21 (-9.71)	12.69	16.50	30.0 (37.2
TAMILNADU	11.80	16.23	37.54 (0.20)	4.94	8.01	62.15 (-14.04)	8.37	13.09	56.3 (17.4

* Truncated Tiruchy refers to Tiruchy district excluding Pududattai from 1972/73 onwards.
igures in ( ) indicate % change in Mean output, Mean acreage and Mean Yield from Period I to Period II.

instability, in 7 out of 10 districts. In Coimbatore, a decline in productivity has gone hand in hand with higher yield instability. Perhaps, instability is a phenomenon that could accompany growth, stagnation as well as deceleration.

The percentage change in the coefficient on variation varies from district to district, ranging from 133.04% in Madurai to 13.85% in Coimbatore , in the case of output and from 241.2% in Madurai to 10.1% in Tiruchy in the case of yield, and from 87.46% in Tiruchy to 5.94% in North Arcot for millet acreage.

At the state level, percentage change in acreage variability is more pronounced that %age change in yield variability. The exact contribution of each of these to output fluctuations will be determined when we do a decomposition analysis for millet output varability, in the next Section.

Considering that the technological revolution was more widespread in paddy, than in Millets, a priori, one would expect paddy to have become more unstable than millets, after the mid-sixties. However, the intertemporal percentage increases in the variability of the two crops, belie these expectations. The intertemporal percentage increases in the output variability of millets were greater than the corresponding increases in the output variability of paddy, in 7 out of 10 districts. Again the intertemporal percentage increases in the acreage variability of millets were greater than the corresponding intertemporal percentage increases in the acreage variability of paddy, in 4 out of 10 districts. Even in the case of yield, the intertemporal percentage increases in millet yield variability were greater than the corresponding intertemporal percentage increases in the yield variability of paddy, in 8 out of 10 districts In other words, instability in millets has increased faster than the instability in paddy, although the new seed fertiliser technology was largely a paddy phenomenon. Perhaps the new technology is not to blame for increasing instability in the districts of Tamil Nadu.

Table 5.6 gives a two-way classification of districts according to their growth-instability correspondence in each period, for millet output, acreage and yield. The movement of the district diagonally upward, or rightward, would indicate a movement for the better interms of growth or stability or both. If the districts have registered higher growth and/or lower instability, it is indicated by an upward pointing arrow while the converse is indicated by a downward pointer. Where the movement has been for the better in terms of growth, but worse in terms of instability, or vice versa, we have put a question mark.[1]

5 out of 10 districts have bettered their status in the Second Sub-Period. All the three districts in Zone 1 have improved their position, but, for different reasons. South Arcot and Chingleput have bettered their growth status only, while North Arcot has bettered its growth as well as stability status. In Zone 3 Salem has remained where it was, while Coimbatore has improved its stability status. Ramnad in Zone 4 has improved its position in terms of stability while Madurai and Tirunelveli in the same zone have regis-

TABLE - 5.6

GROWTH-VARIABILITY CORRESPONDENCE OF MILLET OUTPUT IN THE TWO PERIODS.
Period I - 1951/52 - 1964/65
Period II - 1965/66 - 1982/83

	HIGH VARIABILITY		MEDIUM VARIABILITY		LOW VARIABILITY	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH * GROWTH	Tiruchy	S.Arcot ↑ Madurai ↓	Ramnad Tirunel-veli	Ching-leput ↑	Madurai Salem	N. Arcot ↑ Ramnad ↑ Salem ↔
MEDIUM GROWTH						
LOW GROWTH						
NEGATIVE GROWTH	S. Arcot Coimba-tore N. Arcot		Thanja-vur Chingle-put	Tiruchy ? Thanja-vur ↔ Tirunel-veli ↓		Coim-batore ↑

* Districts with growth rates that are above the state acreage have been classified into High Growth Districts.

tered a retrograde movement, Madurai having become more unstable and Tirunelveli dipping from High growth to Negative growth. Tiruchy has improved its stability, but has plummeted from High growth to Negative growth. And hence, the question mark.

Table 5.7 gives a similar two-way classification showing the intertemporal movement of the districts in terms of millet acreage. All the districts except Salem appear in the bottom row of the table, indicating negative growth rates in acreage. 6 out of 10 districts have retained their status quo, while the other four have deteriorated. Salem joins the Negative growth category, while Madurai, South Arcot and Tirunelveli have fared worse in terms of acreage stability.[2]

Table 5.8 gives the intertemporal growth-instability correspondence of millet yields. Only 2 out of 10 districts have an upward pointer. South Arcot has jumped from Negative to High Growth category, while still being unstable. Chingleput has also improved its growth performance only. Ramnad, Tiruchy, Coimbatore and Thanjavur have also fared worse in terms of growth while retaining their earlier stability status. North Arcot, Salem and Tirunelveli have retained their earlier status, with respect to growth as well as stability.

Madurai is an important millet district. That it should dip from High growth to Low growth while simultaneously increasing its instability status, seems surprising and needs a closer scrutiny.[3]

Our important findings on instability in millets are summarised here. Intertemporally, the level of instability in millet output, acreage and yield has increased in the

TABLE 5.7

GROWTH - VARIABILITY CORRESPONDENCE OF MILLET ACREAGE IN THE TWO PERIODS.
Period I - 1951/52 - 1964/65
Period II = 1965/66 - 1982/83

	HIGH VARIABILITY		MEDIUM VARIABILITY		LOW VARIABILITY	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH GROWTH			Salem			
MEDIUM GROWTH						
LOW GROWTH						
NEGATIVE GROWTH	Thanjavur Chingleput	Thanjavur↔ Chingleput↔ Madurai↓	North Arcot Coimbatore Ramnad Madurai	North Arcot↔ Coimbatore↔ Ramnad↔ Salem↓ South Arcot↓ Tirunelveli↓	South Arcot Tirunelveli Tiruchy	Tiruchy↔

TABLE 5.8

GROWTH VARIABILITY CORRESPONDENCE OF MILLET YIELDS IN THE TWO PERIODS.

Period I = 1951/52 - 1964/65
Period II = 1965/66 - 1982/83

	HIGH VARIABILITY		MEDIUM VARIABILITY		LOW VARIABILITY	
	Period I	Period II	Period I	Period II	Period I	Period II
HIGH CROWTH		South Arcot↑	Ramnad	Chingleput↑	Madurai Thanjavur	
MEDIUM GROWTH	Tiruchy		Tirunelveli North Arcot Coimbatore Chingleput	Tirunelveli↔ Ramnad↓ North Arcot↔		Thanjavur↓
LOW GROWTH		Tiruchy↓ Madurai↓		Coimbatore↓	Salem	Salem ↔
NEGATIVE GROWTH	South Arcot					

recent period. In fact, in a majority of the districts, yield instability in millets has increased faster than the yield instability in paddy in the Second Sub-Period, although the technological revolution did not benefit millets as much as it did paddy. Also, one finds that yields instability is increasing faster than acreage instability, in a majority of the districts, although this is not so at the state level. Considerable interdistrict covariances in acreage instability and yield instability render the scenario at the state level, more stable than it otherwise would be. Intertemporal changes in the instability patterns defy agro-climatic zonal classifications.

SECTION - III

COMPONENTS OF OUTPUT INSTABILITY - MILLETS

Using the same formula that we applied for the decomposition analysis of paddy output variability, we have now decomposed millet output variance into its components viz. acreage variance, yield variance and the covariance between the two.[4]

Table 5.9 gives the percentage contribution of each of these factors to output variance, for the Whole Period i.e. 1951/52 -1982/83 and for each of the Sub-Periods i.e. 1951/52 to 1964/65 and 1965/66 to 1982/83.

Although the decomposition of output variance at the state level has not been done, one can find that yield variability is predominant at the state level, judging from the dimensions of the coefficients of variation of acreage and yield.

In 8 out 10 districts, it is yield variance that is more predominant than acreage variance, in the Whole Period.

TABLE 5.9

DECOMPOSITION OF MILLET OUTPUT VARIANCE INTO ITS COMPONENTS - VIZ. ACREAGE VARIANCE, YIELD VARIANCE AND THE COVARIANCE (ACREAGE, YIELD) FOR THE WHOLE AND SUB-PERIODS.

DISTRICTS	WHOLE PERIOD 1951/52 - 1982/83			PERIOD - I 1951/52 - 1964/65			PERIOD - II 1965/66 - 1982/83		
	Variance of Acreage	Variance of Yield	Covariance	Variance of Acreage	Variance of Yield	Covariance	Variaance of acreage	Variance of Yield	Co-variance
1. Chingleput	63.69	45.55	-9.24	73.47	49.18	-22.65	47.88	36.32	15.80
2. South Arcot	8.06	64.85	27.10	8.80	79.22	11.97	7.40	74.65	17.95
3. North Arcot	28.91	54.25	16.84	26.58	59.32	14.10	25.27	61.79	12.94
4. Salem	37.19	48.75	14.06	51.74	42.14	6.12	29.75	47.0	23.25
5. Coimbatore	23.40	58.72	17.88	23.14	49.36	27.51	22.34	57.19	20.47
6. Tiruchy	7.80	177.06	-84.86	3.25	95.66	1.09	63.75	9.58	26.67
7. Thanjavur	96.66	12.75	-9.40	77.44	16.00	6.56	74.00	8.64	17.46
8. Madurai	22.66	61.78	15.56	33.04	29.52	37.44	21.45	64.00	14.55
9. Ramnad	29.85	74.10	-3.95	18.66	78.78	2.56	33.61	55.35	11.04
10. Tirunelveli	28.82	63.33	8.85	13.94	86.56	-0.50	19.66	58.30	22.04

Chingleput and Thanjavur are the exceptions. Being predominantly paddy districts, perhaps, these two may be growing millets as a summer crop, if the summer rains favour their cultivation. This could explain their high acreage variance. (Even in the case of paddy we found that in 8 out of 11 districts, yield fluctuations were more predominant . In the case of paddy, North Arcot, Coimbatore and Thanjavur were the exceptions.)

While yield variance of millets is quite high in most districts, it is highest in Tiruchy and lowest in Thanjavur. 4 out of 10 districts register negative covariance, and Tiruchy, considerably at that (-84.86%). In these districts acreage instability and yield instability offset each other to render output more stable than it would otherwise be. In fact, in Tiruchy, output variance is the lowest, despite the very high yield variance, only due to a negative and considerable covariance effect. (It may be recalled that the covariance for the whole period, was negative in 3 out of 11 districts, in the case of paddy).

In the First Sub-Period, 6 out 10 districts display higher yield variance than acreage variance (In the case of paddy, it was so only in 4 out of 11 districts) Acreage fluctuations are more than yield fluctuations in Chingleput, Salem, Thanjavur and Madurai. While two of these (Thanajvur and Chingleput) are paddy intensive, the other two are millet - intensive. In the First Sub-Period only 2 out of 10 districts have a negative covariance term, and of these, Tirunelveli has a negligible -0.5% share of covariance only. (For paddy, the covariance term was negative in 4 out of 11 districts)

In the Second Sub-Period, 7 out of 10 districts display greater yield variance than area varaince. (It was 7 out 11 in the case of paddy). The share of yield variance of millets is highest in South Arcot, while that of acreage variance is highest in Thanjavur. It is remarkable that, as in the case of paddy, none of the districts has a mutually offsetting negative covariance term in the period after the mid-sixties.

From the decomposition analysis, we may conclude that in the case of millets, yield instability has been more important than acreage instability in a majority of the districts in all the three periods examined. This may be due to the fact that millets are generally raised on dry lands dependent upon rainfall, and therefore, their yields fluctuate with the vagaries of the monsoon. Within the districts, in a majority of cases, acreage instability and yield instability seem to the mutually reinforcing during the 32 years, and in the First Sub-Period In the Second Sub-Period, this mutually reinforcing tendency is evident in all the districts. And this,is a sobering finding indeed.

SECTION -IV

FACTORS BEHIND YIELD INSTABILITY - MILLETS

Contrary to our a priori expectations, we found that millet yields were even more unstable than those of paddy, in a majority of the districts. At the state level, yield instability is double that of area. Intertemporally, yield instability of millets has increased faster than its acreage instability, in a majority of the districts. Therefore, it becomes necessary to probe into the likely determinants of yield instability.

We did a similar exercise for paddy in Section V of Chapter III where, we found that yield instability was only weakly and negatively associated with yield growth of paddy. Now we shall conduct a similar regression analysis for millets. Millets being a rainfall-dependent crop, one would expect their yield instability to be associated with the variability of rainfall. Although millets are largely unirrigated, we attempted to see if yield variability of millets could be explained by the proportion of gross irrigated area in the districts. The marginal lands argument could link yield variability to acreage growth or even acreage variability.

In this Section, we have hypothesized yield instability of millets to be a function of its yield growth, acreage growth, acreage variability, the proportion of gross irrigated area, and the variability of seasonal and annual rainfall. Owing to the limited degrees of freedom, we have run separate regressions for each of these independent variables across districts, with yield variability across districts as the dependent variable. This interdistrict cross-section regression analysis was carried out for the Whole Period and for each of the Sub-Periods.

The following table gives the estimates of the regression equation where yield variability across districts was hypothesised to be a function of yield growth across districts. (Since trend growth rates for yield were significant in all the districts except one for the Whole Period, and in most of the districts, for the Sub-periods, we have used only trend growth rates

for the regression analysis.)

WHOLE PERIOD: (1951/52 - 1982/83)

$$YVAR = \alpha + \beta \; YGRO$$

$$YVAR = 12.831 + 1.847 \; YGRO$$
$$(4.67) \quad (1.12) \qquad R^2 = .135$$

Positive and non-significant

SUB-PERIOD I (1951/52 - 1964/65)

$$YVAR1 = \alpha + \beta \; YGRO1$$

$$YVAR1 = 12.503 - 1.174 \; YGRO1$$
$$(8.15) \quad (-1.55) \qquad R^2 = .230$$

Negative and non-significant

SUB-PERIOD II (1965/66 - 1982/83)

$$YVAR2 = \alpha + \beta \; YGRO2$$

$$YVAR2 = 15.722 - 0.008 \; YGRO2$$
$$(4.99) \quad (-.01) \qquad R^2 = .00$$

Negative and Non-significant

From the regression results it is evident that in Tamil Nadu, yield instability of millets cannot be explained by yield growth. The association between instability and growth is weak for every period, although it is positive for the Whole Period.

The second set of regressions pertains to acreage variability of millets. The coefficient of variation of millet yield across districts was regressed on the coefficient of variation of millet acreage across districts. The results are as follows.

WHOLE PERIOD (1951/52 - 1982/83)

$$YVAR = \alpha + \beta \; AVAR$$

$$YVAR = 20.642 - 0.441 \; AVAR$$
$$(6.67) \quad (-1.85) \qquad R^2 = .299$$

Negative and significant at 5% level.

SUB - PERIOD I (1951/52 - 1964/65)

$YVAR1 = \alpha + \beta \ AVAR1$

$$YVAR1 = 16.444 - 0.685 \ AVAR1 \qquad R^2 = .383$$
$$(6.12) \quad (-2.23)$$

Negative and significant at 5% level

SUB-PERIOD II (1965/66 - 1982/83)

$YVAR2 = \alpha + \beta \ AVAR2$

$$YVAR2 = 24.068 - 0.776 \ AVAR2 \qquad R^2 = .394$$
$$(6.24) \quad (-2.28)$$

Negative and significant at 5% level.

It is notable that in all the three periods, yield variability is negatively and significantly associated with acreage variability. This would imply that across districts, the two offset each other mutually, although within the districts they may compound each other (we found that in 4 out of 10 districts, the covariance between acreage variability and yield variability was negative and therefore, mutually offsetting, during the Whole Period, while it was mutually offsetting in only 2 out of 10 district in the First Sub-Period and in none of the districts in the Second Sub-period, vide Section III of this chapter) It suggests that districts with high acreage variability tend, however, to show lower yield variability, as we look at the picture across districts. This is different from the pure intertemporal patterns observed for each of the individual districts. Hence, the relationship between yield variability and acreage variability is not uniform over time and over space.

Acreage growth could also contribute to yield instability, especially if the expansion is into marginal lands. However, since we found millet acreage to be decelerating everywhere in Tamil Nadu, one may conjecture that, with the loss of marginal lands with poor productivity, yields should stabilise.

WHOLE PERIOD (1951/52 - 1982/83)

$$YVAR = \alpha + \beta \, AGRO$$

$$YVAR = \underset{(10.29)}{18.558} + \underset{(2.30)}{1.885} \, AGRO \qquad R^2 = .398$$

Positive and significant at 5% level.

SUB-PERIOD I (1951/52 - 1964/65)

$$YVAR1 = \alpha + \beta \, AGRO1$$

$$YVAR1 = \underset{(5.23)}{10.131} - \underset{(-.51)}{0.482} \, AGRO1 \qquad R^2 = .032$$

Negative and non significant

SUB-PERIOD II (1965/66 - 1982/83)

$$YVAR2 = \alpha + \beta \, AGRO2$$

$$YVAR2 = \underset{(15.59)}{18.542} + \underset{(3.78)}{1.364} \, AGRO2 \qquad R^2 = .642$$

Positive and significat at 5% level.

The foregoing results show that yield variability can be significantly explained by acreage shrinkage in the Whole Period and in the Second Sub-period, in Tamil Nadu. The fact that acreage deceleration contributes to yield instability could mean that the more fertile lands under millets are now being diverted increasingly to other crops and as such, the productivitty of millets is fluctuating even more now, dependent as it would be, on the vagaires of weather, in the absence of complementary inputs.

When yield variability across districts was regressed on the variability of seasonal as well as annual rainfall, it failed to show up any significant association. Similarly when yield variability was regressed on the proportion of gross irrigated area, there emerged no meaningful association. Perhaps, a more appropriate measure would have been the proportion of millet area irrigated, for which compatible data was not available. These results are not reported here.

To conclude, we may infer that even in the case of millets, yield growth cannot be said to responsible for higher yield instability. Across districts, yield instability seems to be balanced by acreage instability, moving as they are, in opposite directions, although this may not be true of the trends within every district. Acreage contraction seems to explain yield instability in the Whole Period and in the period after the mid-sixties, suggesting that the more fertile lands are being diverted to crops other than millets. Rainfall, seasonal or annual, and the proportion of gross cropped area irrigated, failed to explain the yield variability of millets.

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NOTES

1. The pointers refer to the movement of districts from one category to another vis-a-vis each other and not to the absolute changes in instability levels. The absolute level of millet output instability has increased in all the districts.
2. Once again, the pointers refer to the movement of districts from one growth/instability category to another, and not to the absolute changes in growth/instability levels.
3. The absolute level of yield instability has increased in all the districts. The pointers refer to the relative position of the districts vis-a-vis each other only.
4. Vide Chapter III, Section IV.

CHAPTER - VI
SUMMARY AND CONCLUSIONS

Self-sufficiency in food could be a vital target for economies characterised by subsistence agriculture and dependent upon the whimsicality of the monsoons. In India, the post-Independence decades witnessed an impressive increase in cereal production, thanks to careful planning and new strategies. Yet, self-sufficiency in food has been a rather tenuous achievement for the country, beset as it is, with frequent year-to-year fluctuations in cereal output. Especiall in the era of the innovative technology, when irrigation base expanded appreciably, and productivity levels achieved a new breakthrough, is cereal production becoming increasingly unstable? Are productivity-oriented growth strategies more susceptible to instability than the conventional ones that seek to increase output through acreage expansion? If so, when acreage expansion is generally tapering off, is instability a price that one must pay for growth? These are issues that confront us when we attempt to evaluate the performance of Indian Agriculture in the last three decades.

We addressed ourselves to some of these issues in the limited context of cereals in Tamil Nadu, during the 32 years from 1951-52 to 1982-83. We estimated compound growth rates and measured the level of instability, separately for output, acreage and yield of paddy and millets in the districts of Tamil Nadu, during this period. We looked at interdistrict patterns in growth and instability, attempted to define the growth-instability nexus and compared the levels of instability in the periods before and after the mid-sixties (the latter is characterised by some adoption of HYVs). We also attempted to isolate the predominant contributor to output instability by decomposing it into its constituents viz. acreage instability, yield instability and the interaction between the two. Finally, we probed tentatively into the possible causes of yield instability. All these exercises were conducted separately for paddy and for millets.

When we examined the interdistrict patterns in growth and productivity levels, we found that districts within the same agro-climatic zone displayed differential patterns. Also, factors critical to fast growth and high productivity levels differed from zone to zone. Thus, while technological upgradation may be important in one zone, in another, it could be the extent and quality of irrigation that determines growth rates and productivity levels.

We also noted that although millet yields are far lower than paddy yields, the former appear to respond readily to irrigation. For, the yield level of millets is higher in the better irrigated districts, while the same cannot be said of paddy. Paddy is retaining its acreage in most of the districts, despite a general tapering off of Gross Cropped Area. Millets, however, are losing ground everywhere in the state.

The districts of Tamil Nadu present a veritable mosaic of patterns in instability levels too. Within the same agro--climatic zone, there are stable,as well as relatively unstable districts. There are intrazonal differences as well as interzonal similarities in instability patterns. High-productivity districts are as prone to instability as low-productivity districts. When districts were ranked according to their growth performance and instability levels in output, acreage and yield, separately for paddy and millet and their growth-instability status compared, no definite patterns of association between growth and instability emerged.

Intertemporally, instability has increased in the peri of the innovative strategy. However, one must caution again causally attributing the increased instability to the new technology. Especially in the case of millets where varieta improvement did not make a dent, yield instability has increased even faster than in the case of paddy, where it did, in recent years. Considerable interdistrict co-variances render the state level scenario, a lot more stable than it might have been, otherwise. In the case of paddy, we found that Rabi yields were no more stable than Kharif yields.

When we did a cross-section regression analysis of yield instability with reference to yield growth, we found that in Tamil Nadu, yield instability cannot be explained by yield growth, either for paddy or for millets. In fact, the association between instability and growth of paddy yields turned out to be negative and even statistically significant, when point-to-point growth rates were used, suggesting thereby, that growth is not necessarily accompanied by increasing instability in the districts of Tamil Nadu When yield instability across districts was regressed on acreage growth across districts, in order to see if instability was due to the cultivation of marginal lands, we found that it failed to show any significant association in the case of paddy. Surprisingly, shrinkage in millets acreage seems to have been responsible for higher yield instability of millets.

Irrigation was found to have a stabilising influence of paddy yields, although this could not be verified conclusively in the case of millets. The variability of either seasonal or annual rainfall could not explain yield instability of paddy or millets.

Contrary to a priori expectations, when yield variability of paddy was regressed on the proportion of paddy area sown with HYVs, the association was negative and significant. Perhaps, technology is not to be blamed for instability in the limited context of paddy in Tamil Nadu.

Finally, when output variance was decomposed into its constituents, we found that yield instability is increasingly becoming predominant, in a majority of the districts, in recent times.(although this is not readily apparent at the state level in the case of paddy). It is also notable that the interaction between acreage instability and yield instability is becoming mutually reinforcing in every district, after the mid-sixties—a fact with serious policy implications.

Some of our findings are in conformity with existing hypotheses, while others are not. While instability in cereal output is increasing in recent times, our findings do not enable us to causally link this increase to growth, in the context of paddy and millets in the districts of Tamil Nadu. As has been pointed out by other studies, yield instability is increasingly becoming predominant in output instability, but how far can productivity-oriented strategies be blamed for this, is still a moot question. Perhaps, the new technology may not be that critical in determining the level of yield instability. The growing tendency of acreage instability and yield instability to compound each other, may cause concern to policy makers. One can envisage an increasingly important role for irrigation as a stabilising influence on productivity.

Bearing in mind the rather limited focus and and simple framework of this study, it must be pointed out that no sweeping generalisations can be a made, on the basis of our findings. Perhaps, the results of our analysis may be sensitive to the type of functional form used to detrend and measure instability. And, a more detailed decomposition of output instability into its complex components, may throw a better light on the role each factor has had to play in contributing to output instability.

Although yield instability is emerging to be important, acreage fluctuations still remain a factor to reckon with. An in-depth analysis of the factors contributing to acreage instability may help us gain a comprehensive understanding of the problem. Perhaps, acreage instability may be easier to control than yield instability. There is also a need for a comprehensive study of instability in other crops, particularly, oilseeds and pulses whose supplies seem to fluctuate frequently.

Within the framework of the present study, we can reasonably suggest that policy measures aimed at attaining growth with stability, will have to be region-specific and problem-specific, in order to be effective.

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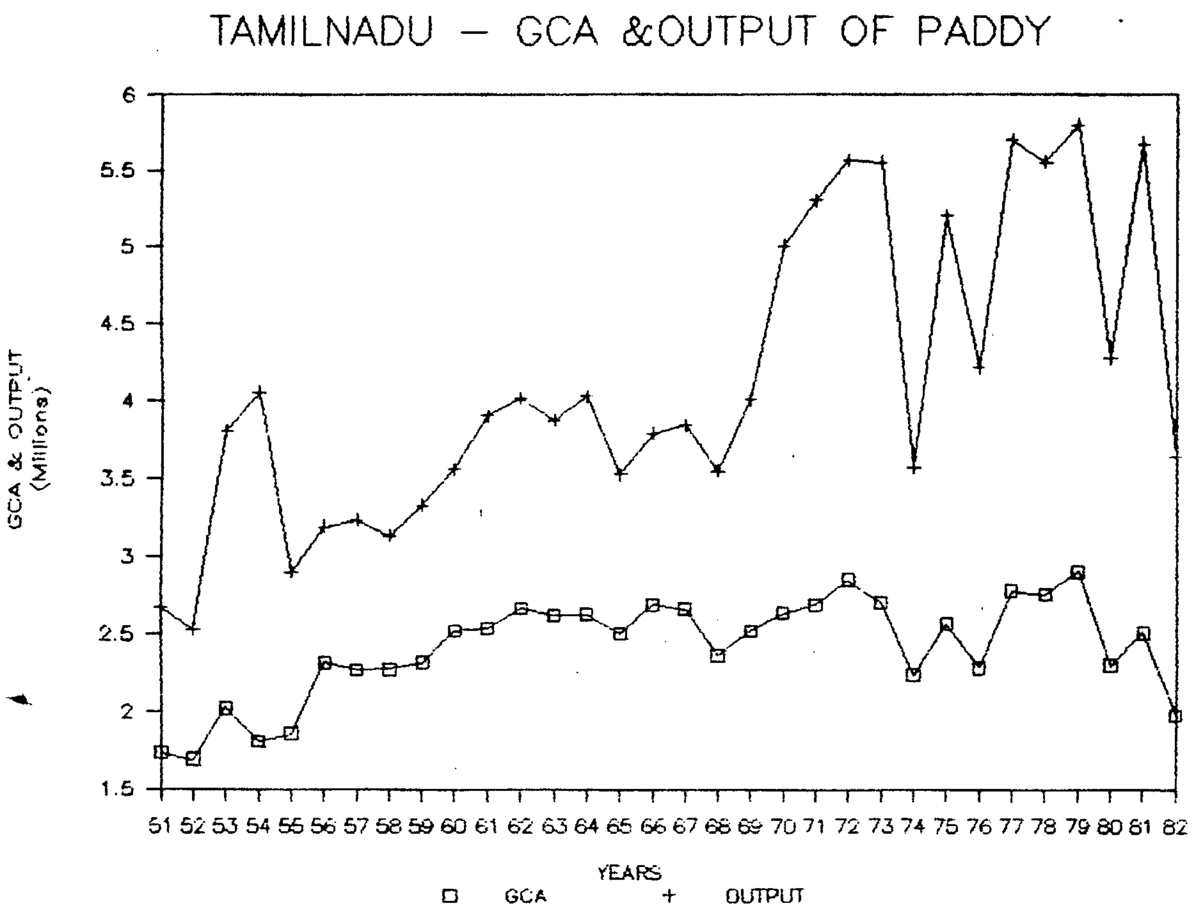
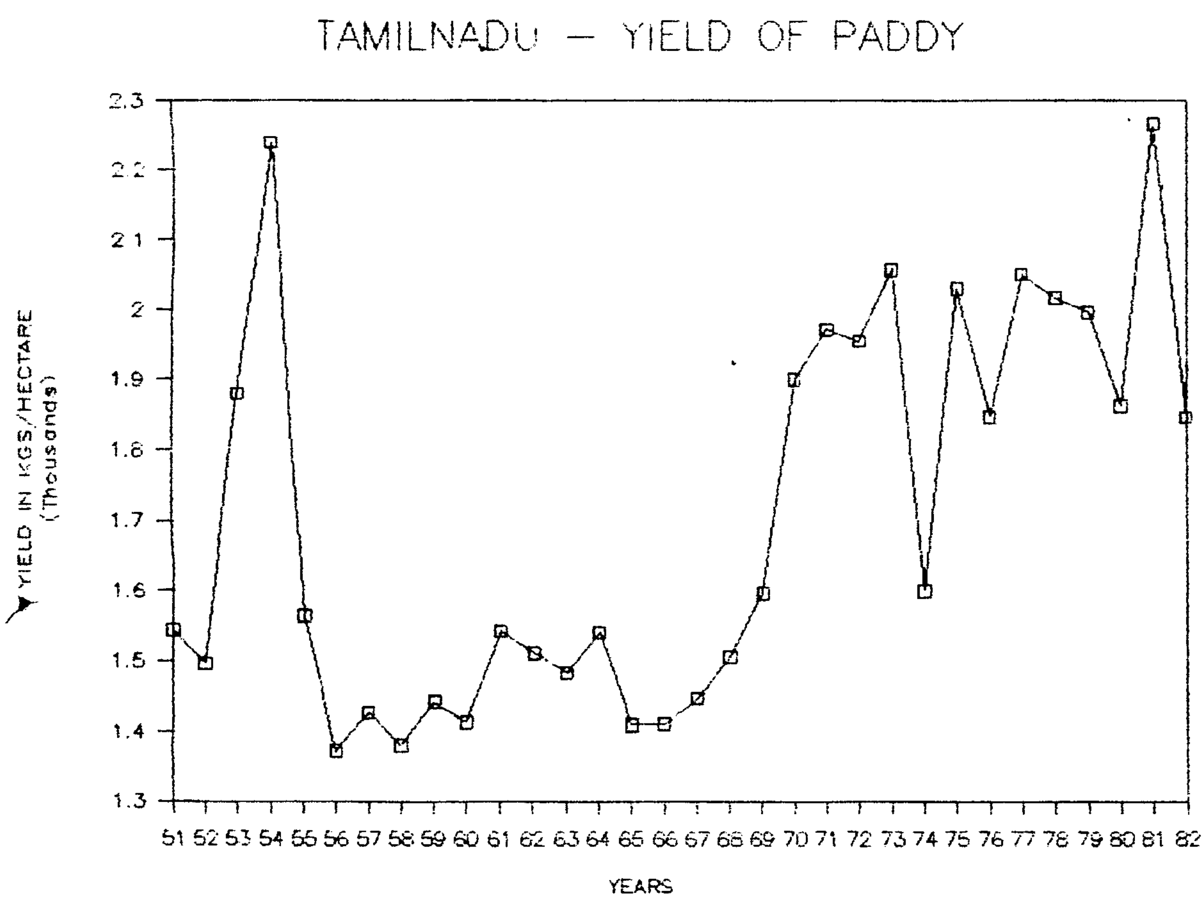
APPENDIX 1

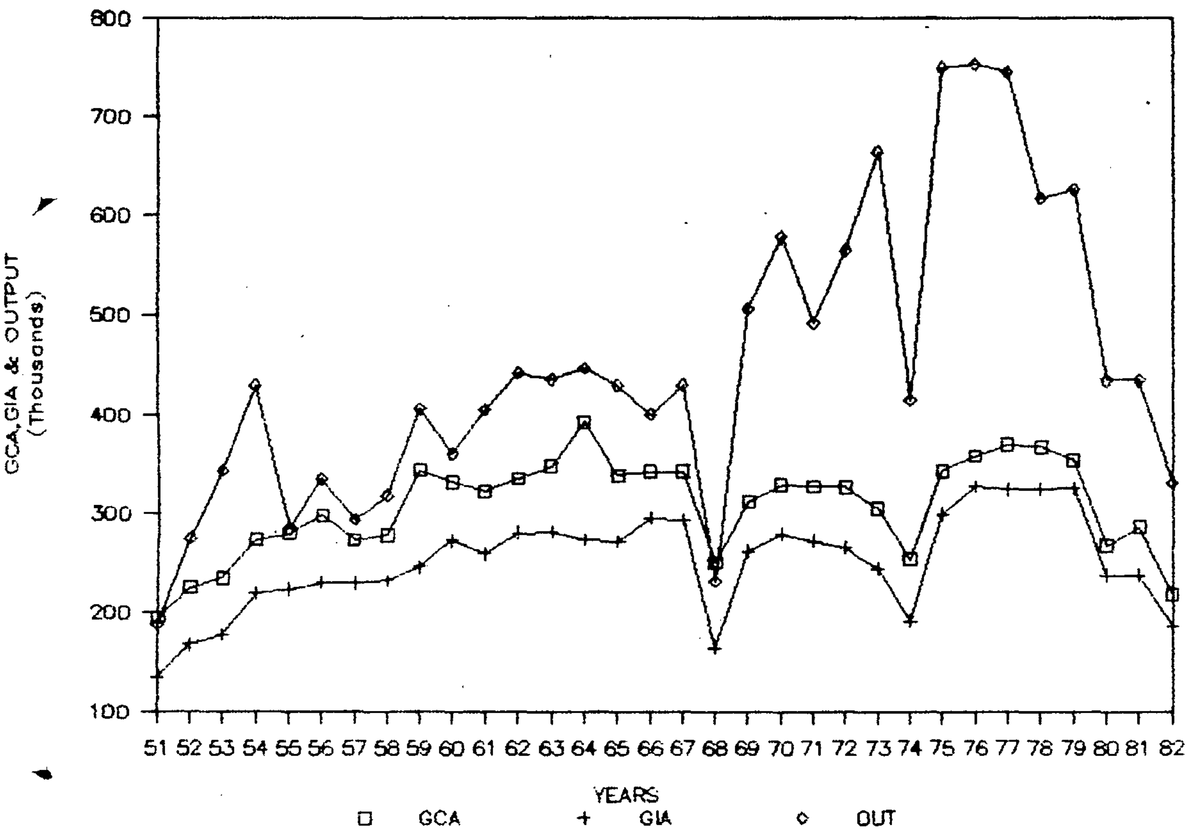


TAMILNADU — GCA &OUTPUT OF PADDY
GCA & OUTPUT (Millions)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS
GCA
OUTPUT

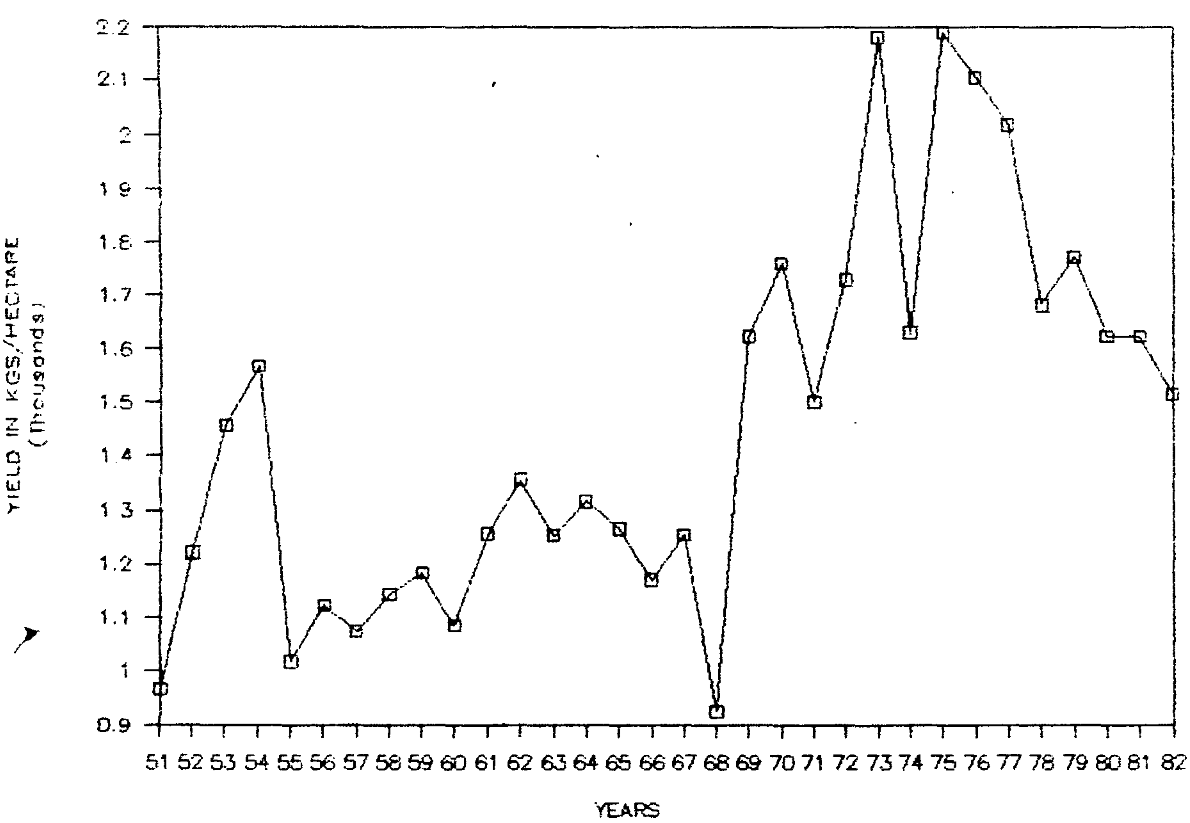


TAMILNADU — YIELD OF PADDY
YIELD IN KGS/HECTARE (Thousands)
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS

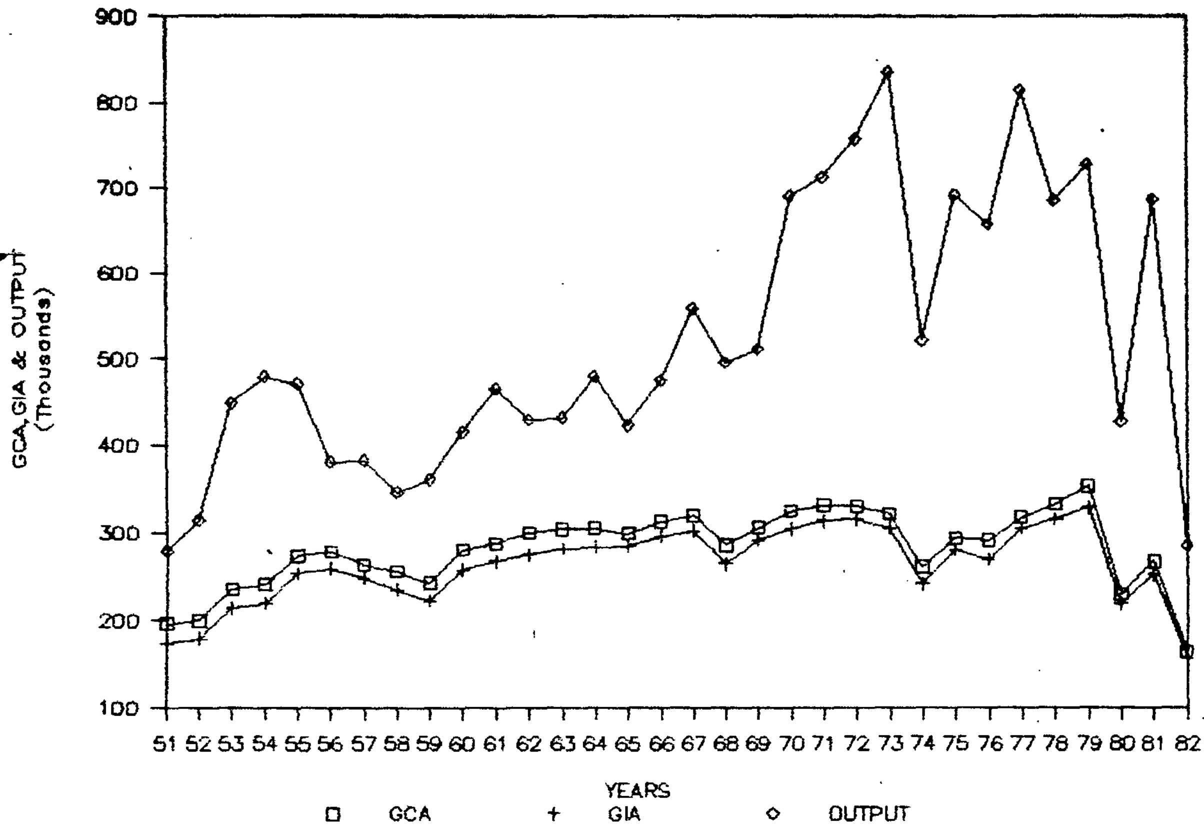
CHINGLEPUT-GCA,GIA & OUTPUT OF PADDY



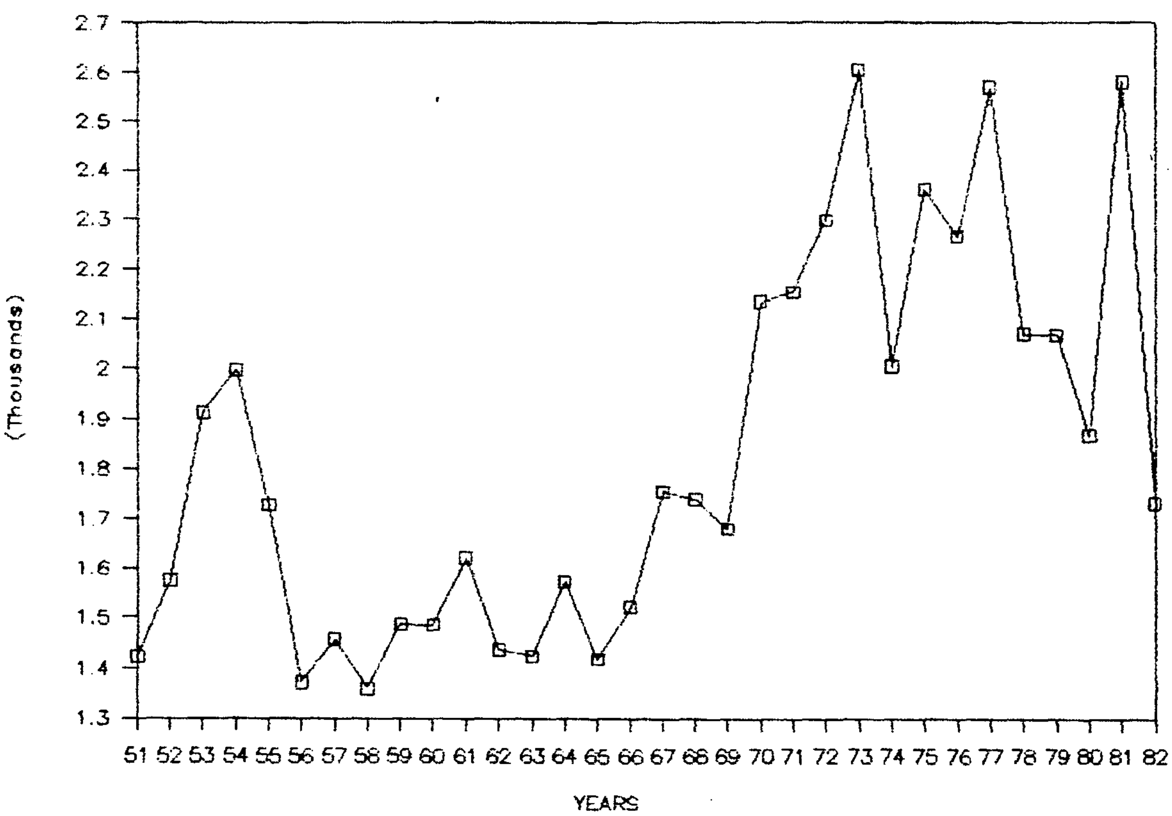
CHINGLEPUT-YIELD OF PADDY

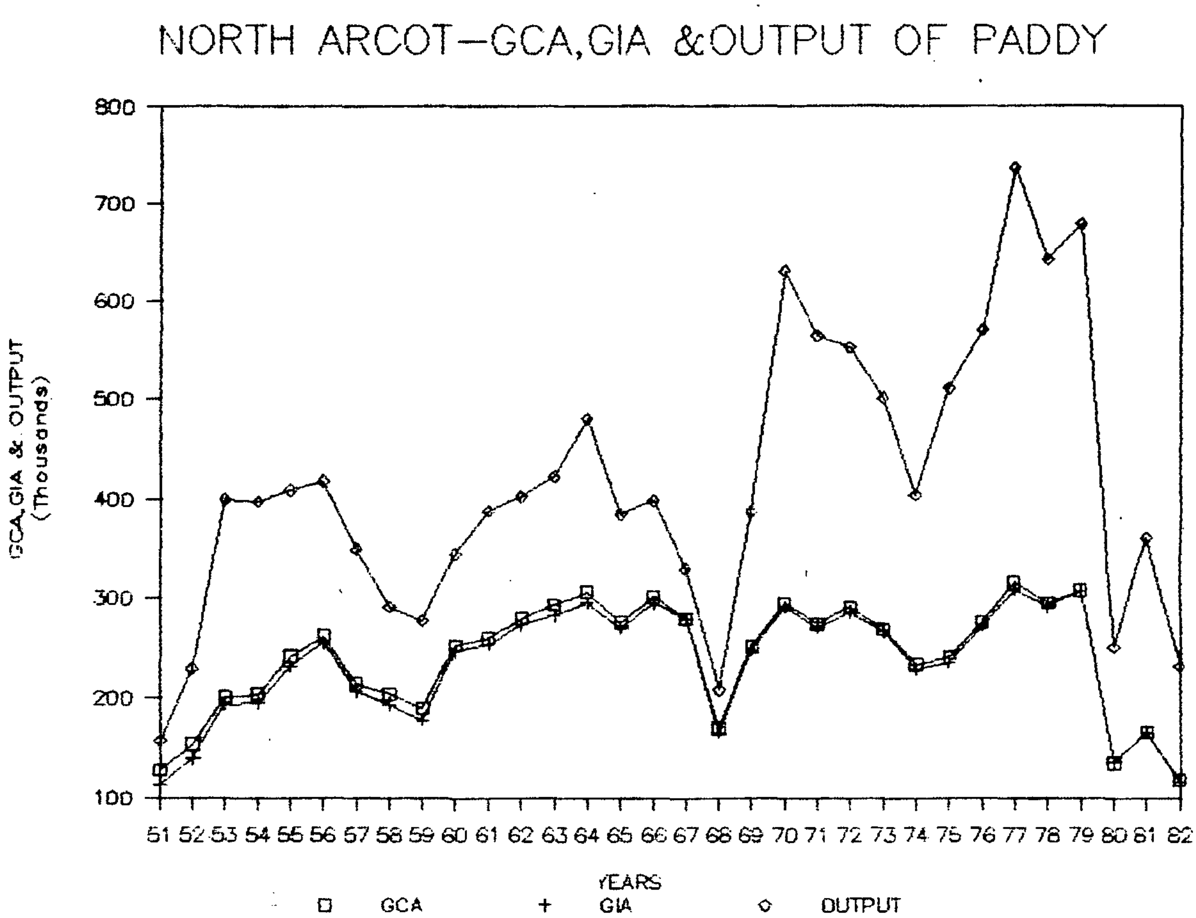


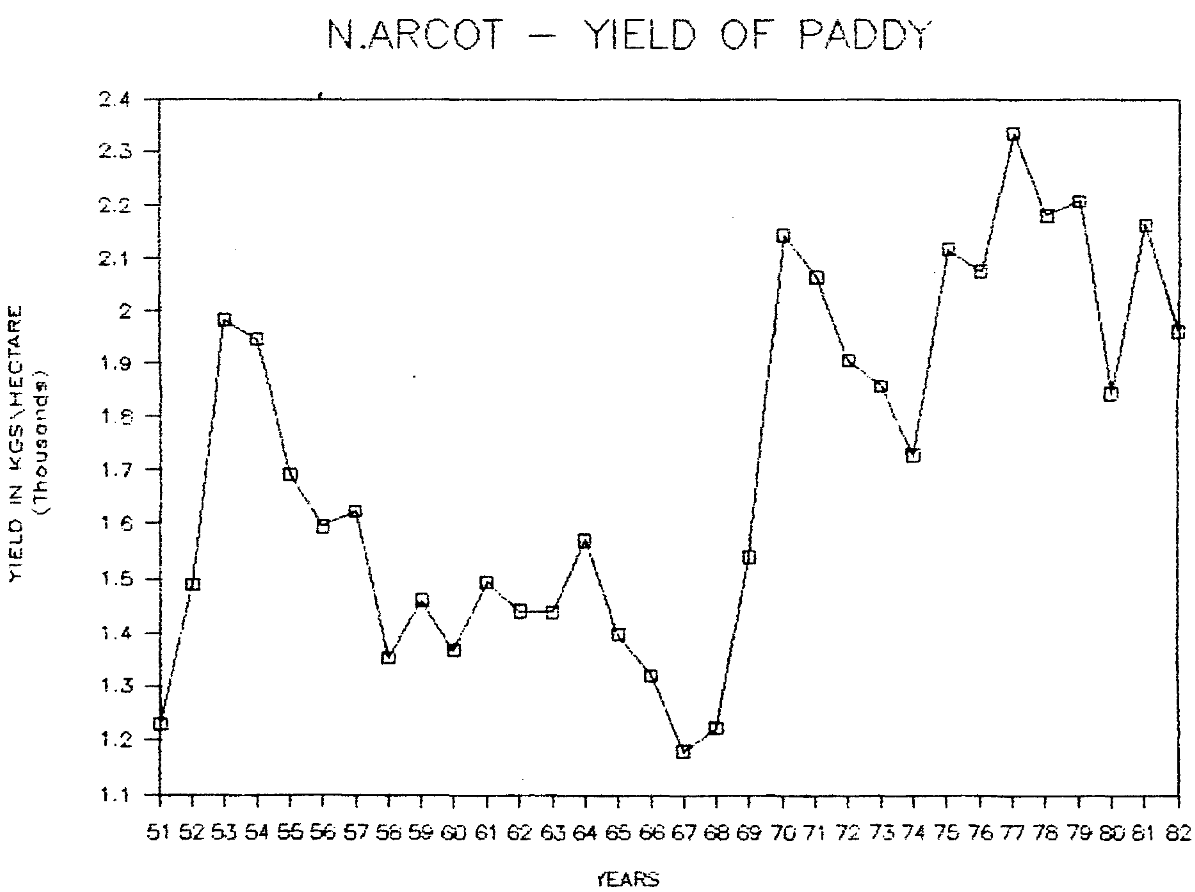
SOUTH ARCOT — GCA,GIA & OUTPUT OF PADDY



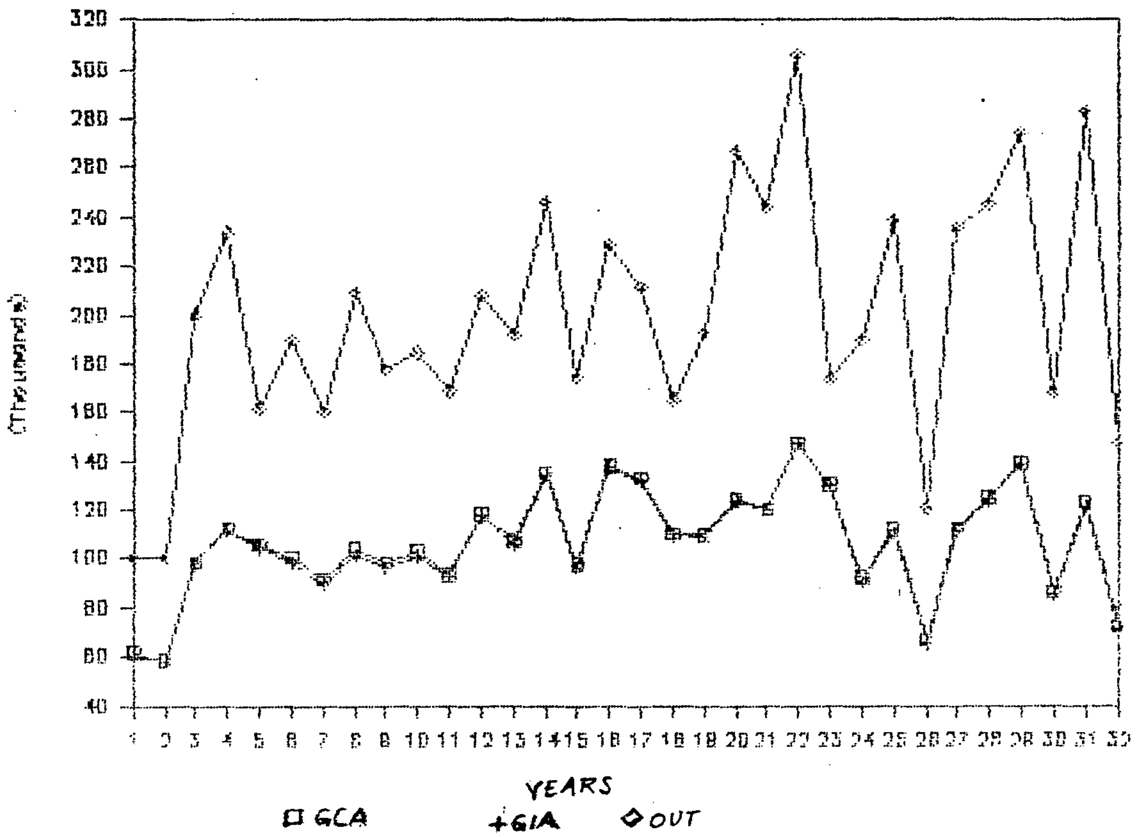
SOUTH ARCOT — YIELD OF PADDY



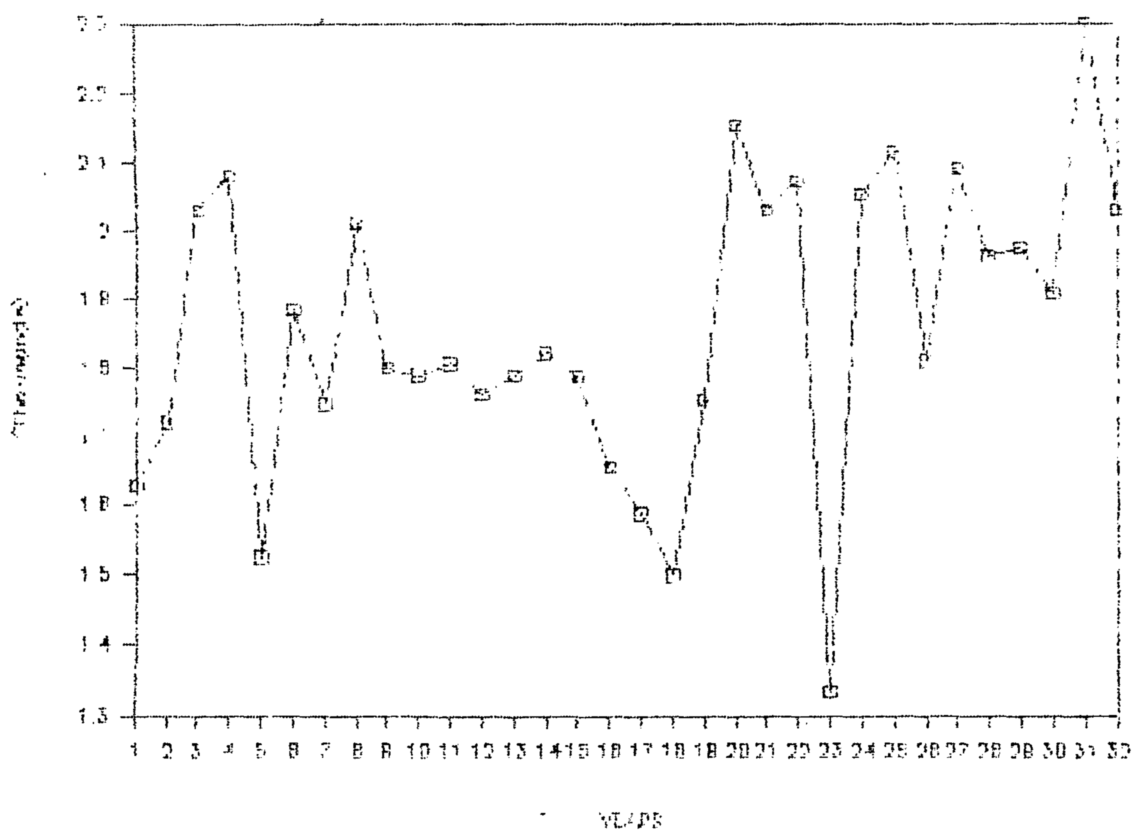

NORTH ARCOT—GCA,GIA &OUTPUT OF PADDY
GCA,GIA & OUTPUT (Thousands)
800
700
600
500
400
300
200
100
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS
GCA
GIA
OUTPUT


N.ARCOT — YIELD OF PADDY
YIELD IN KGS\HECTARE (Thousands)
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS

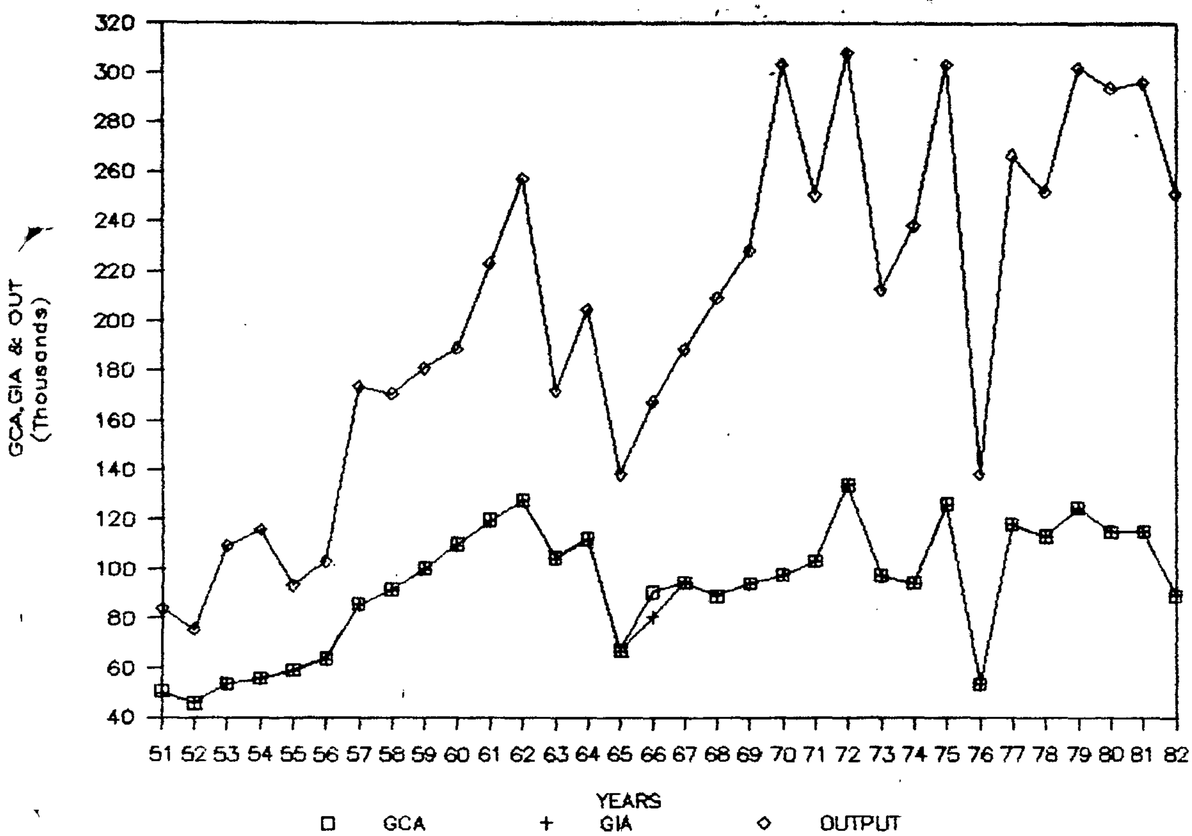
SALEM _ GCA,GIA & OUTPUT OF PADDY



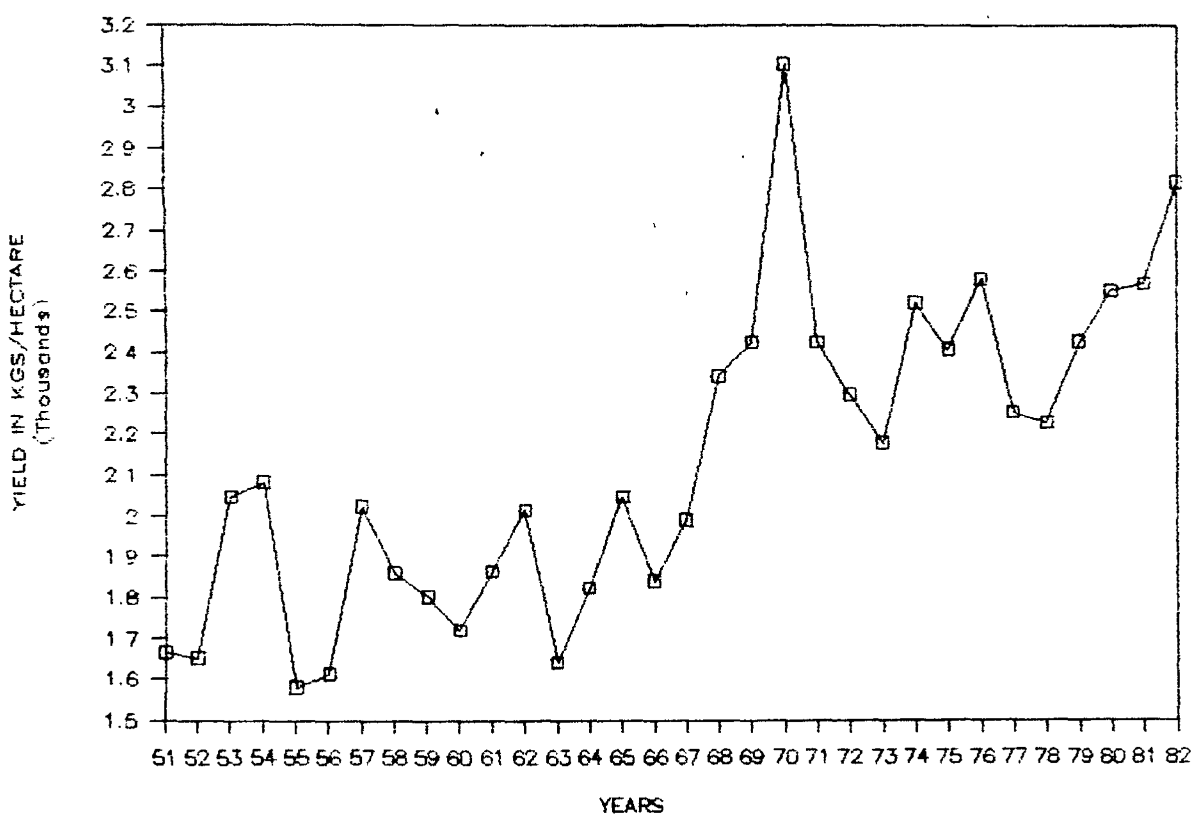
SALEM — YIELD OF PADDY



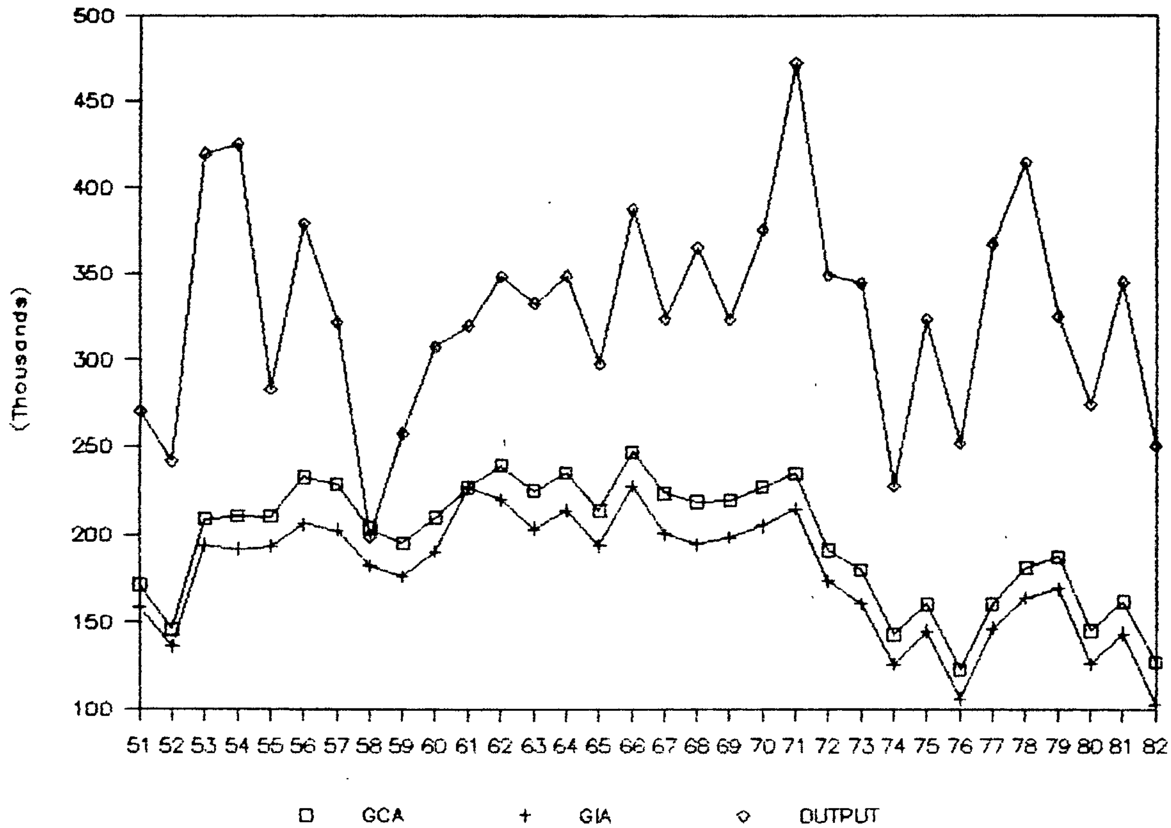
COIMBATORE — GCA,GIA & OUTPUT OF PADDY



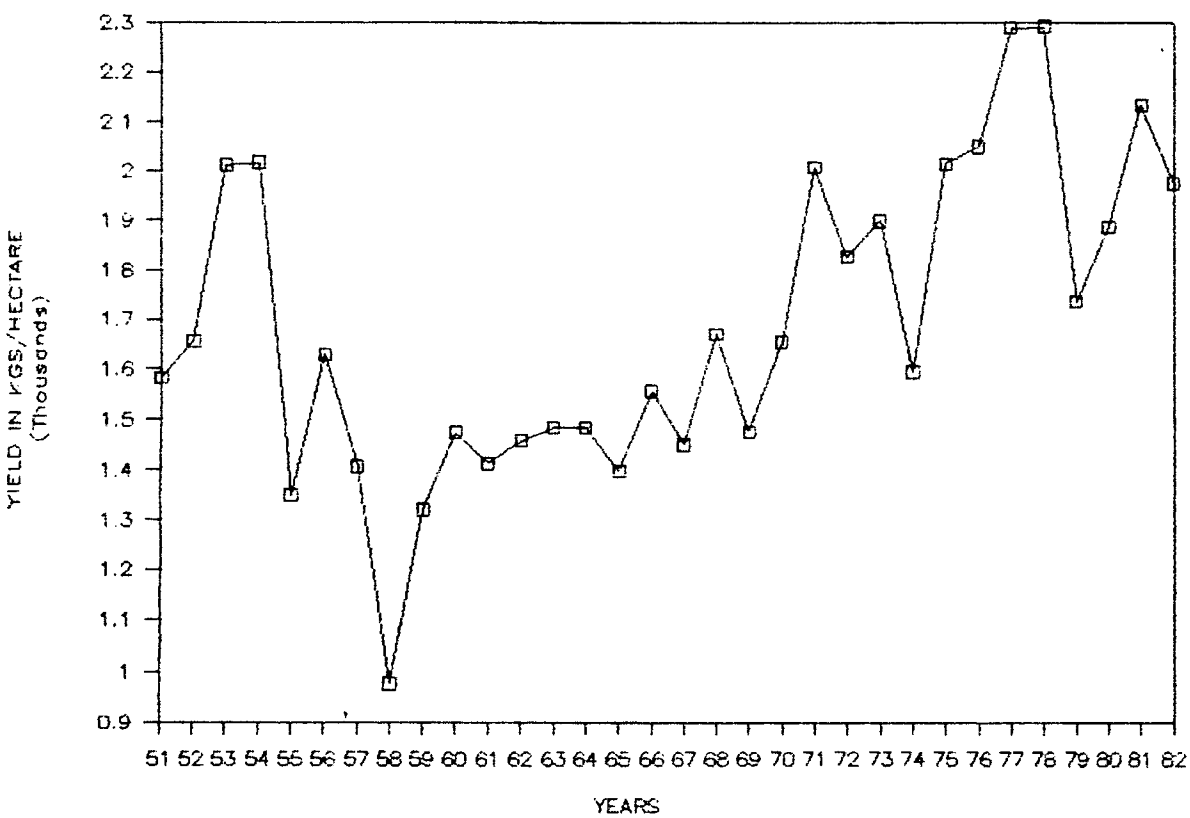
COIMBATORE — YIELD OF PADDY



TIRUCHY — GCA, GIA & OUTPUT OF PADDY

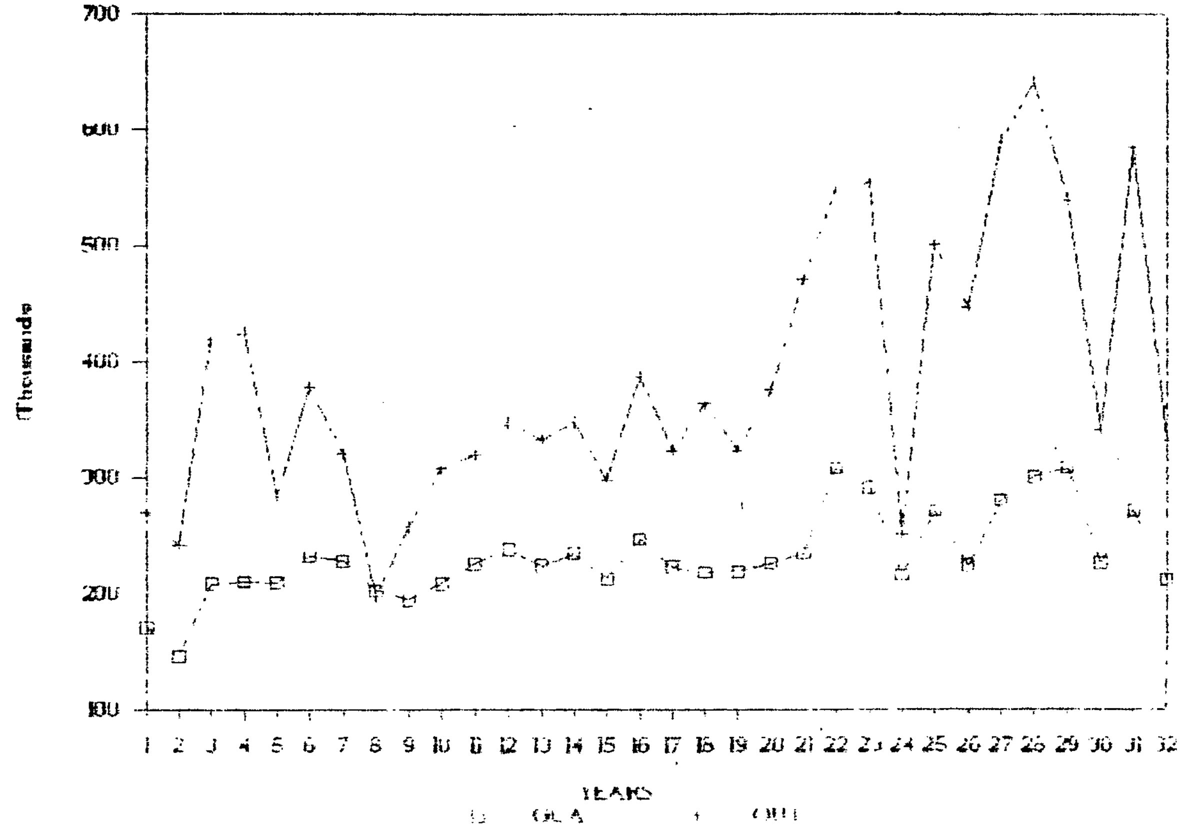


TIRUCHY — YIELD OF PADDY



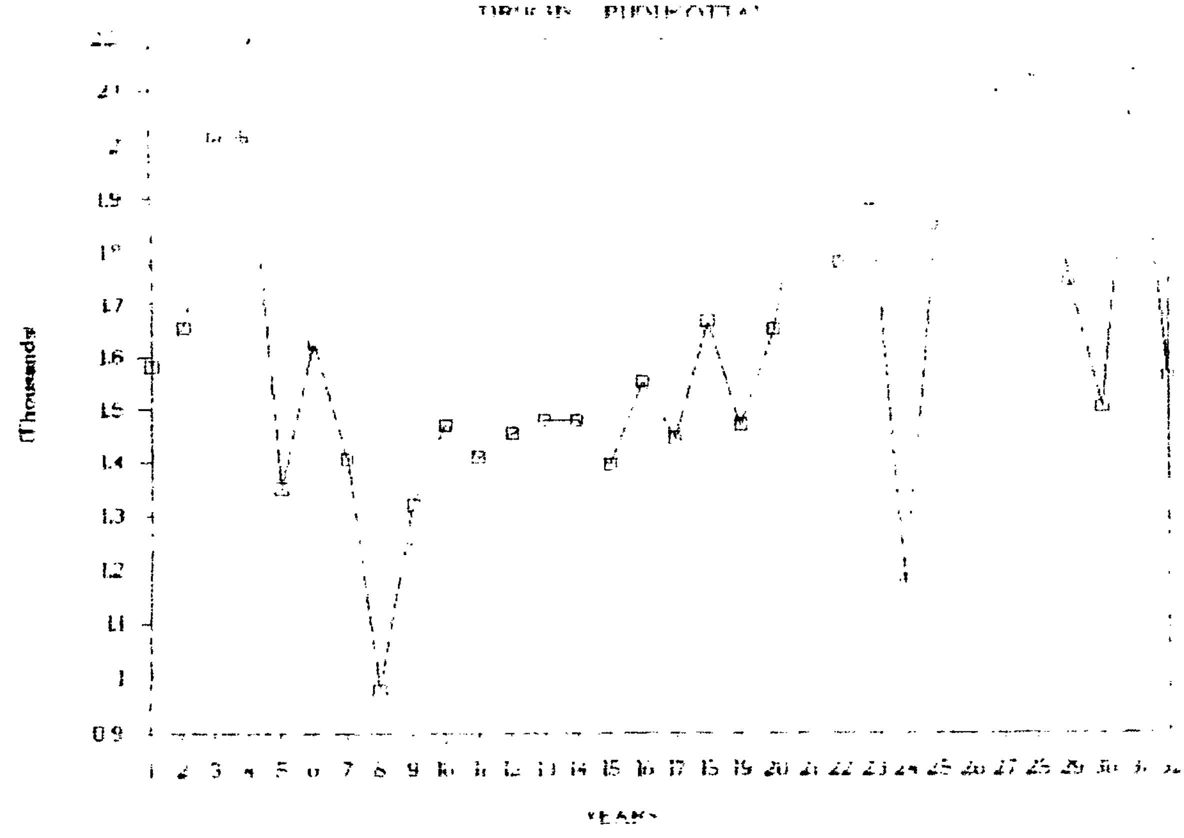
TIRUCHY – GCA & OUTPUT OF PADDY

TIRUCHY + PUDUKOTTAI

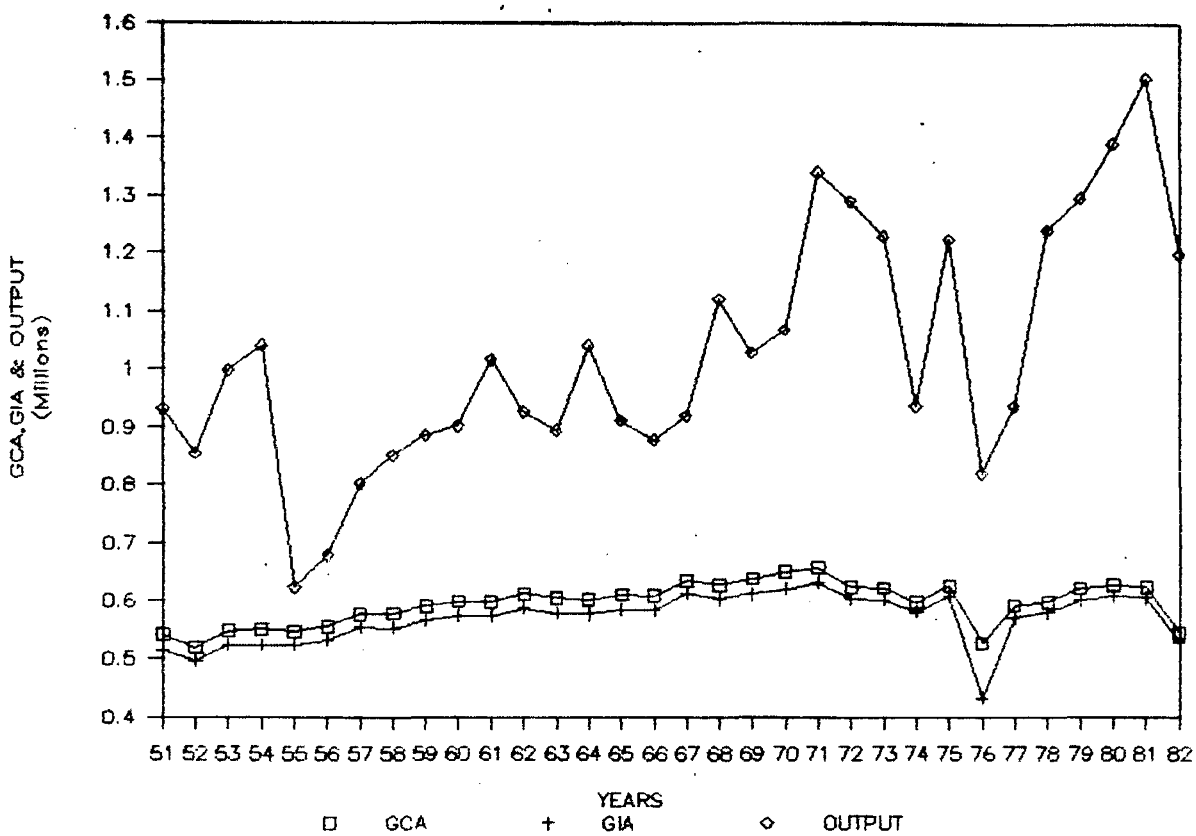


TIRUCHY – YIELD OF PADDY

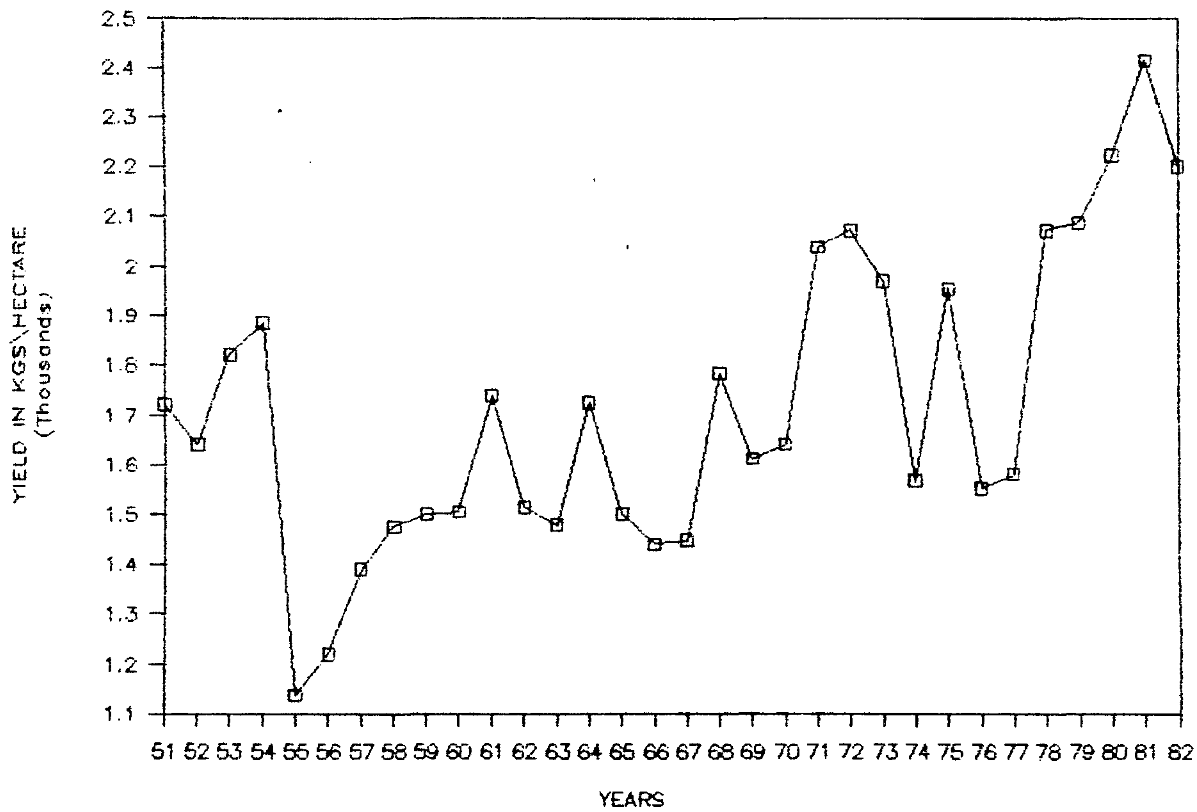
TIRUCHY + PUDUKOTTAI



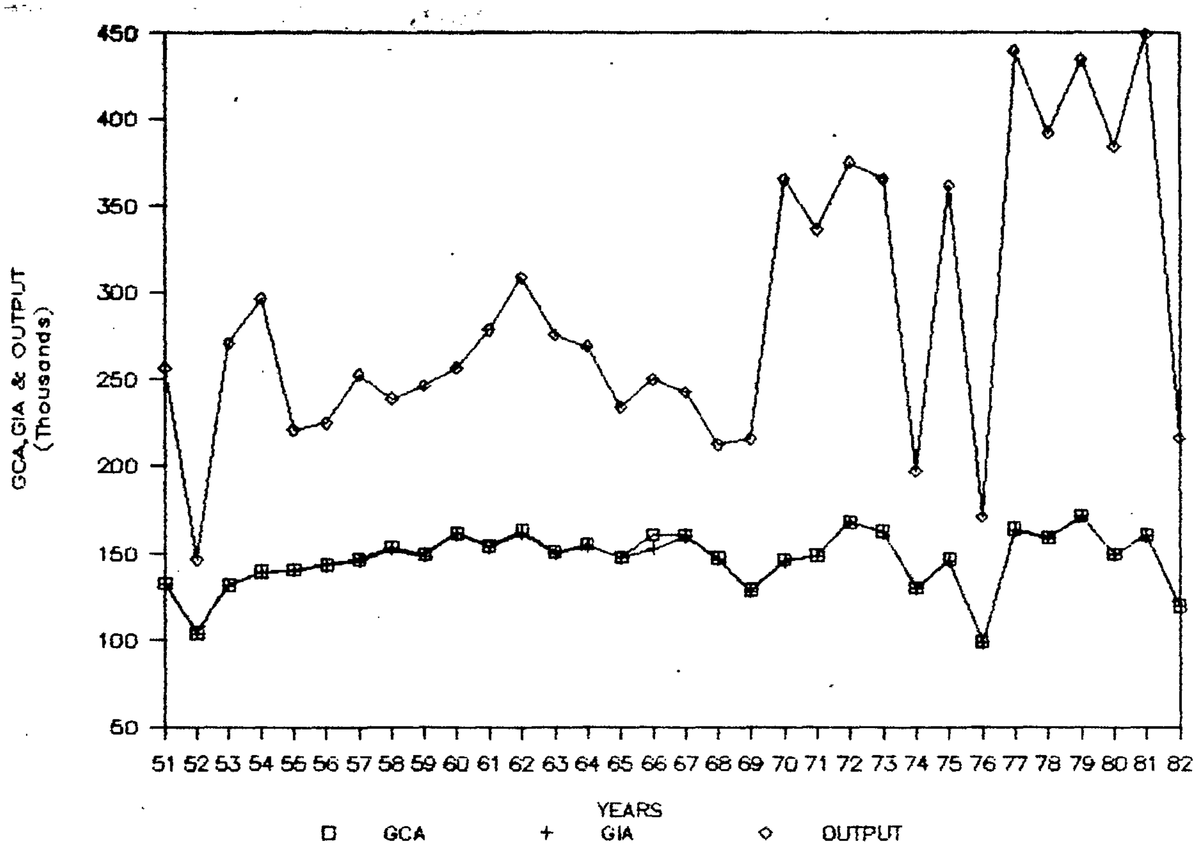
THANJAVUR- GCA, GIA & OUTPUT OF PADDY



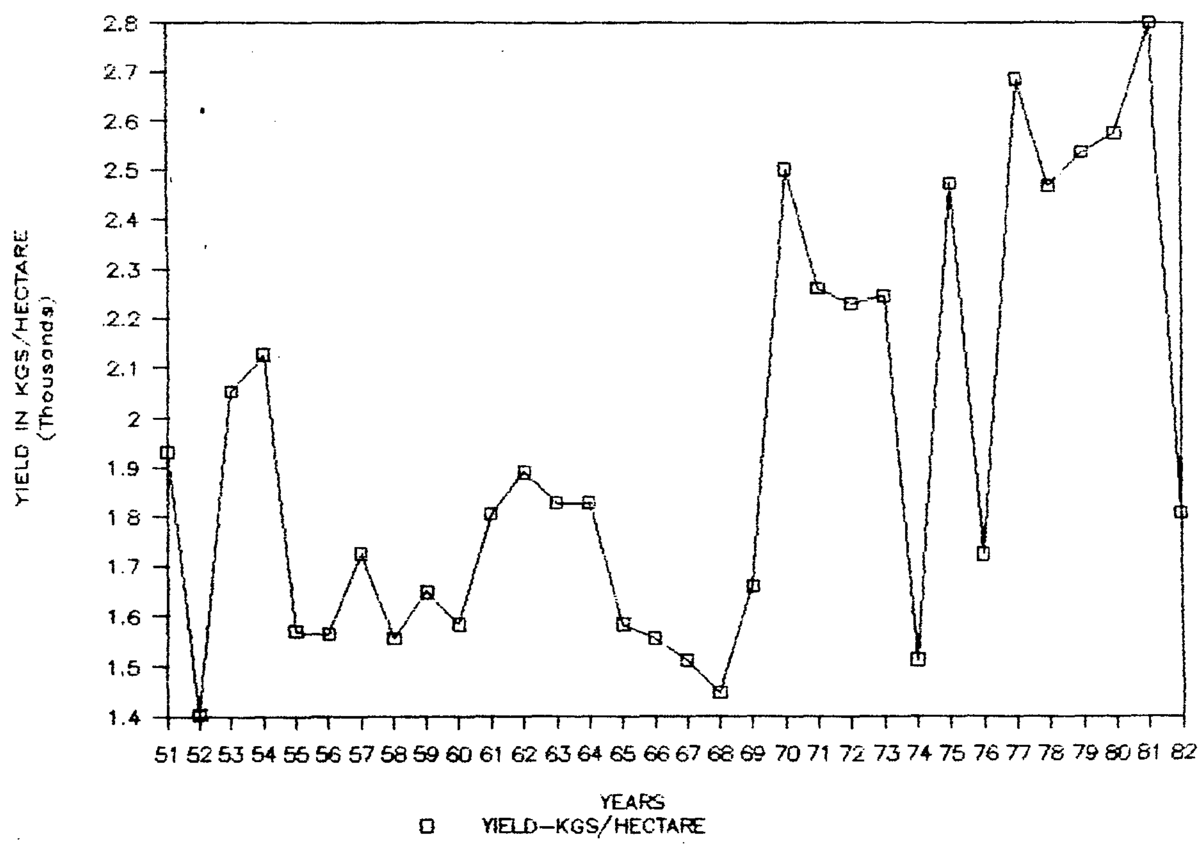
THANJAVUR-YIELD OF PADDY

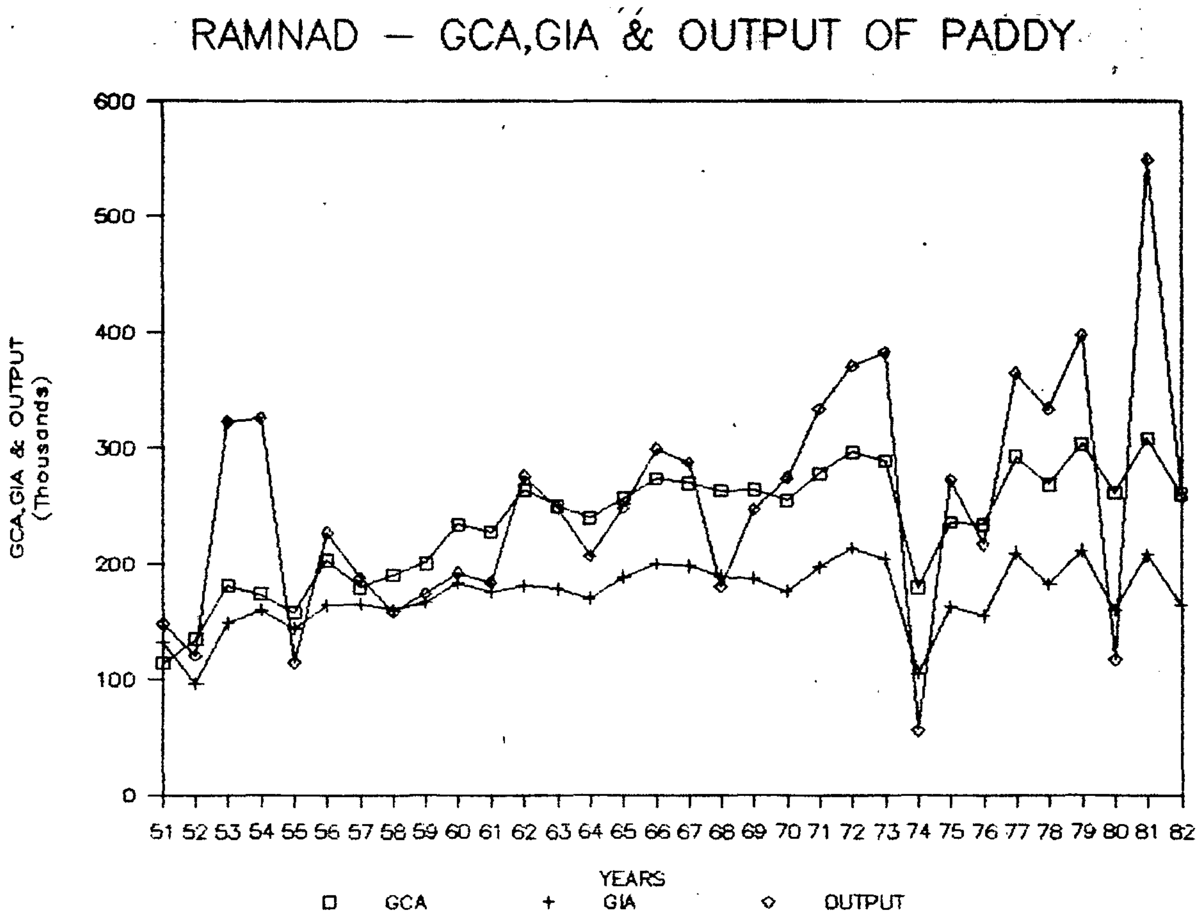


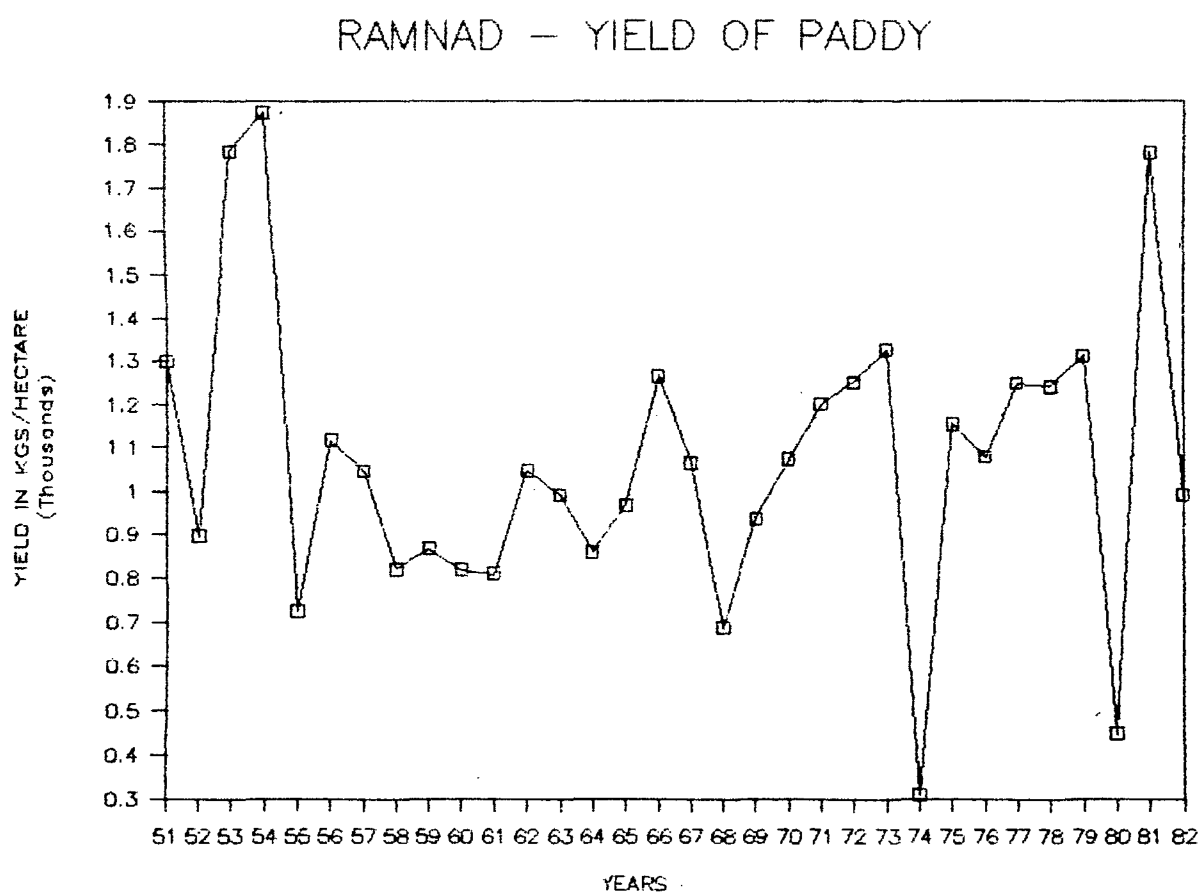
MADURAI-GCA,GIA & OUTPUT OF PADDY



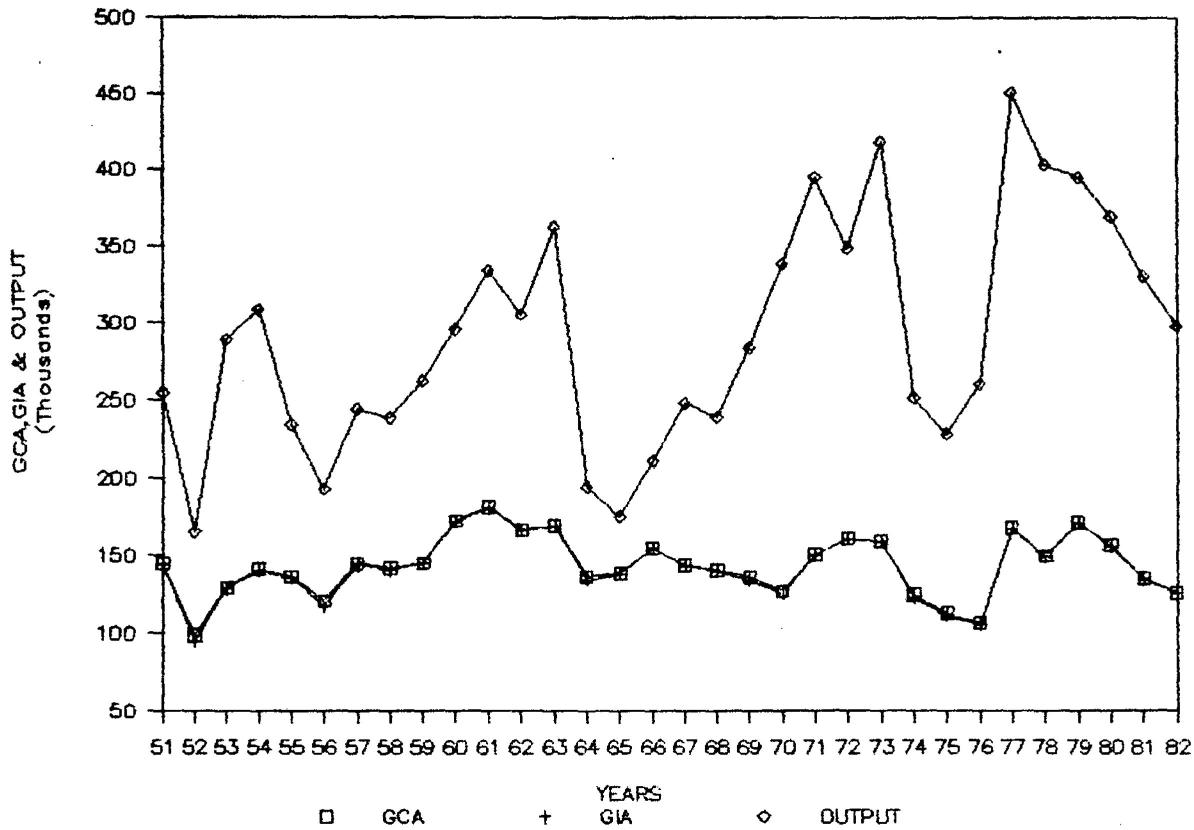
MADURAI-YIELD OF PADDY



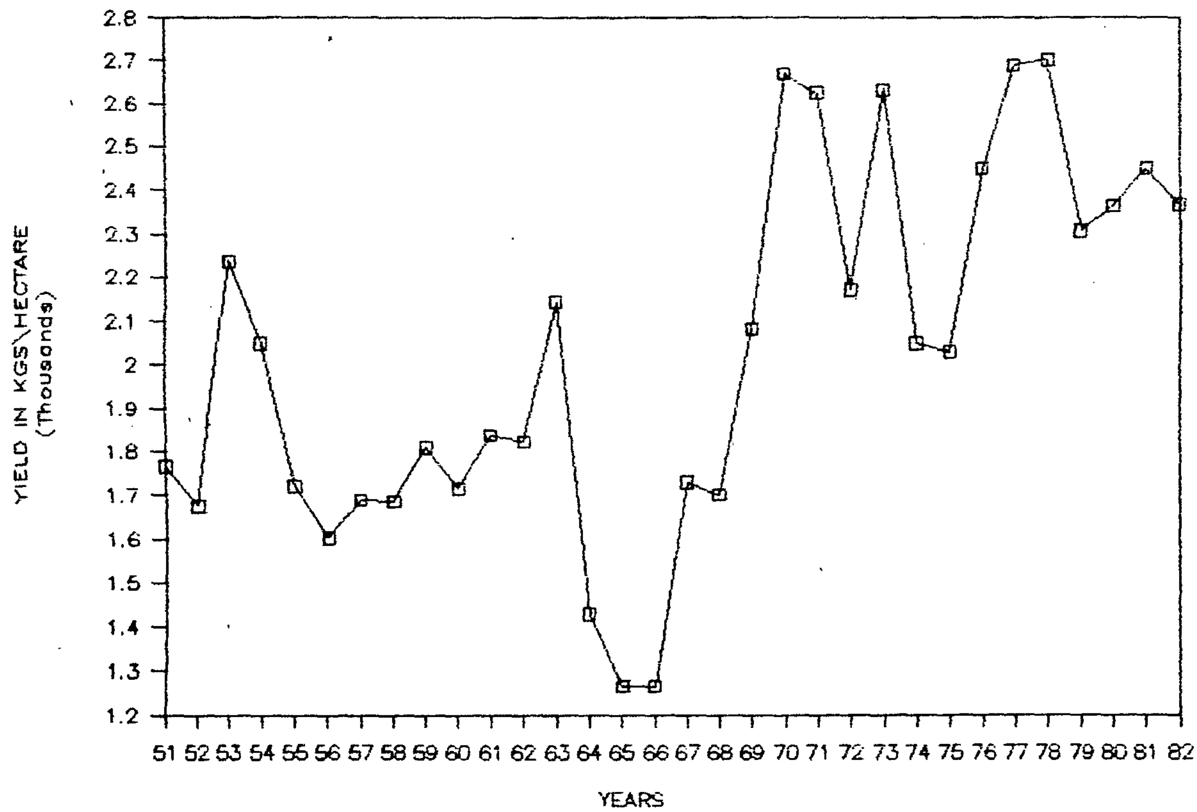

RAMNAD — GCA,GIA & OUTPUT OF PADDY
600
500
400
300
200
100
0
GCA,GIA & OUTPUT
(Thousands)
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS
GCA
GIA
OUTPUT

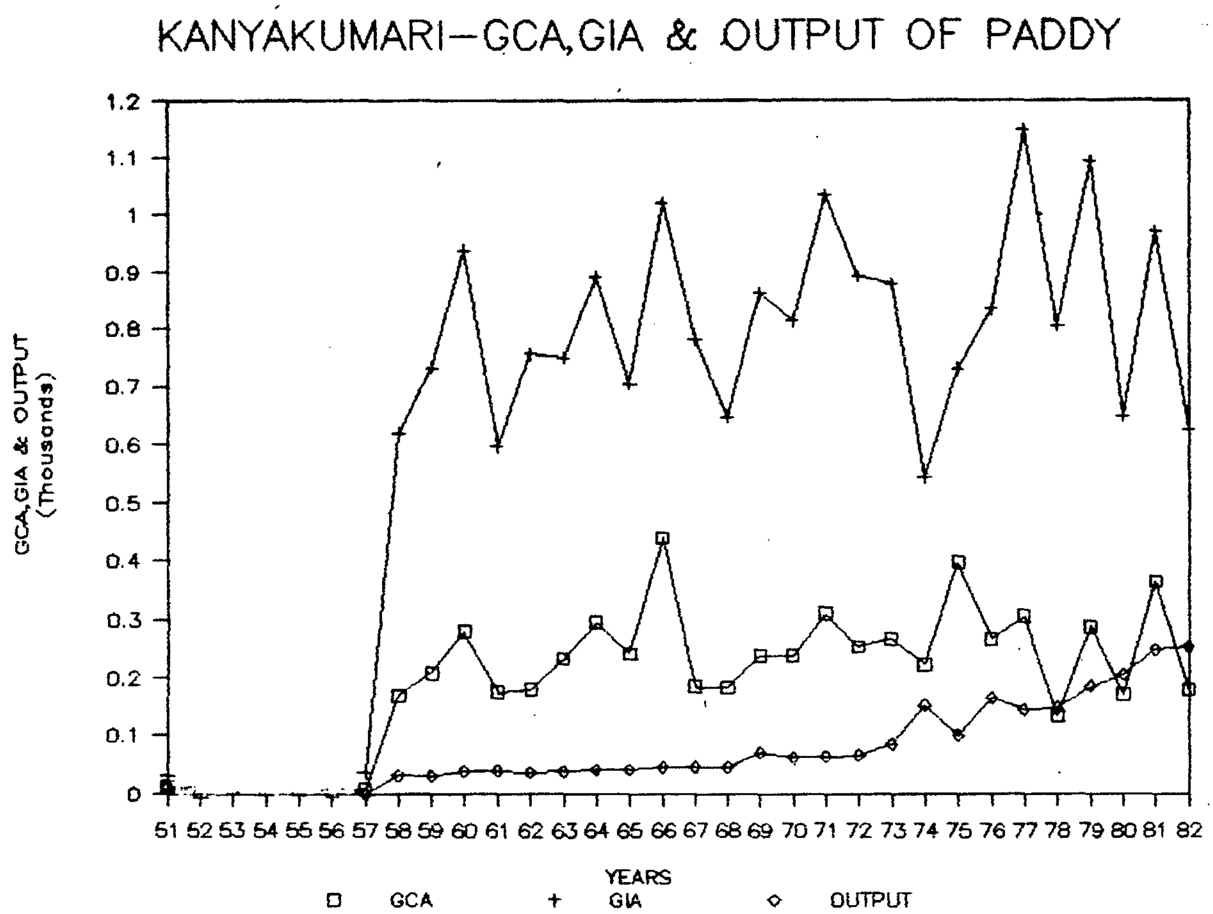

RAMNAD — YIELD OF PADDY
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
YIELD IN KGS/HECTARE
(Thousands)
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS

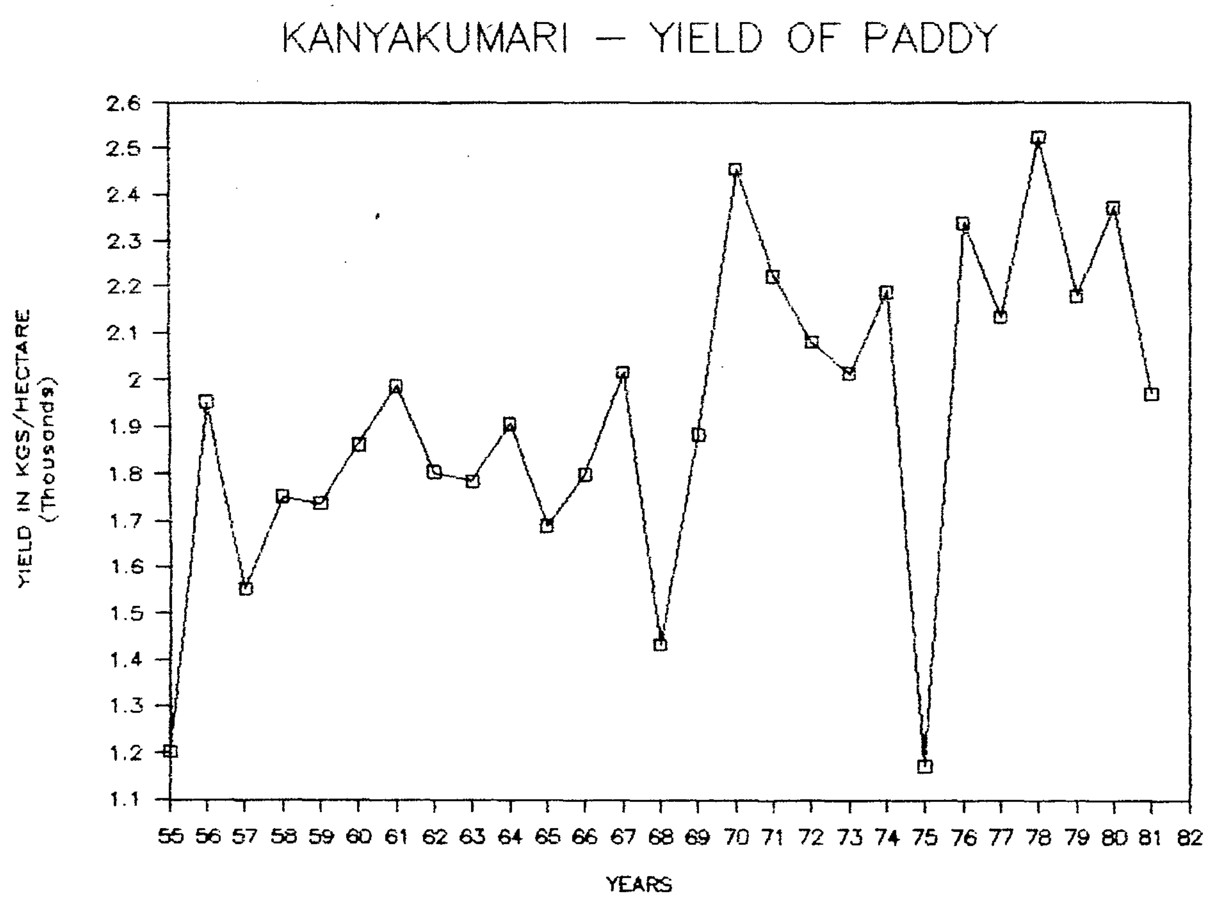
TIRUNELVELI – GCA,GIA & OUTPUT OF PADDY



TIRUNELVELI – YIELD OF PADDY

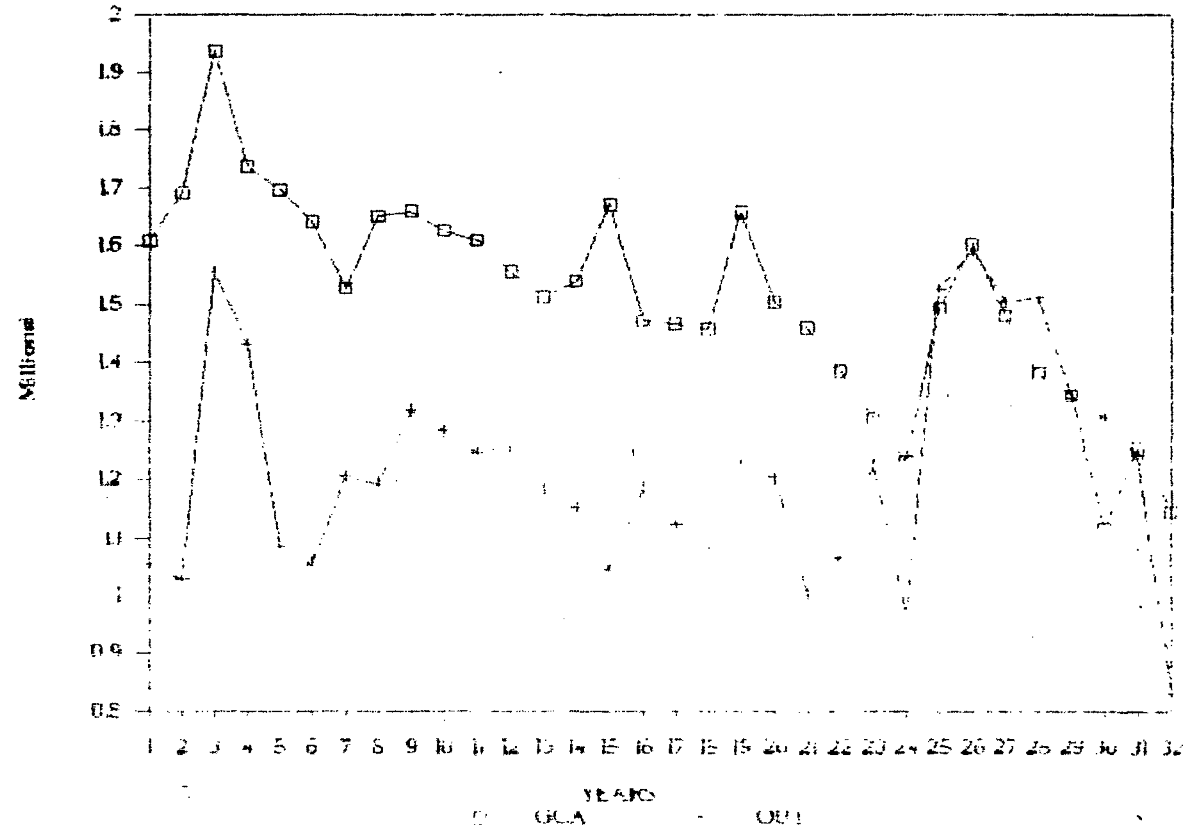



KANYAKUMARI-GCA,GIA & OUTPUT OF PADDY
GCA,GIA & OUTPUT (Thousands)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS
GCA
GIA
OUTPUT

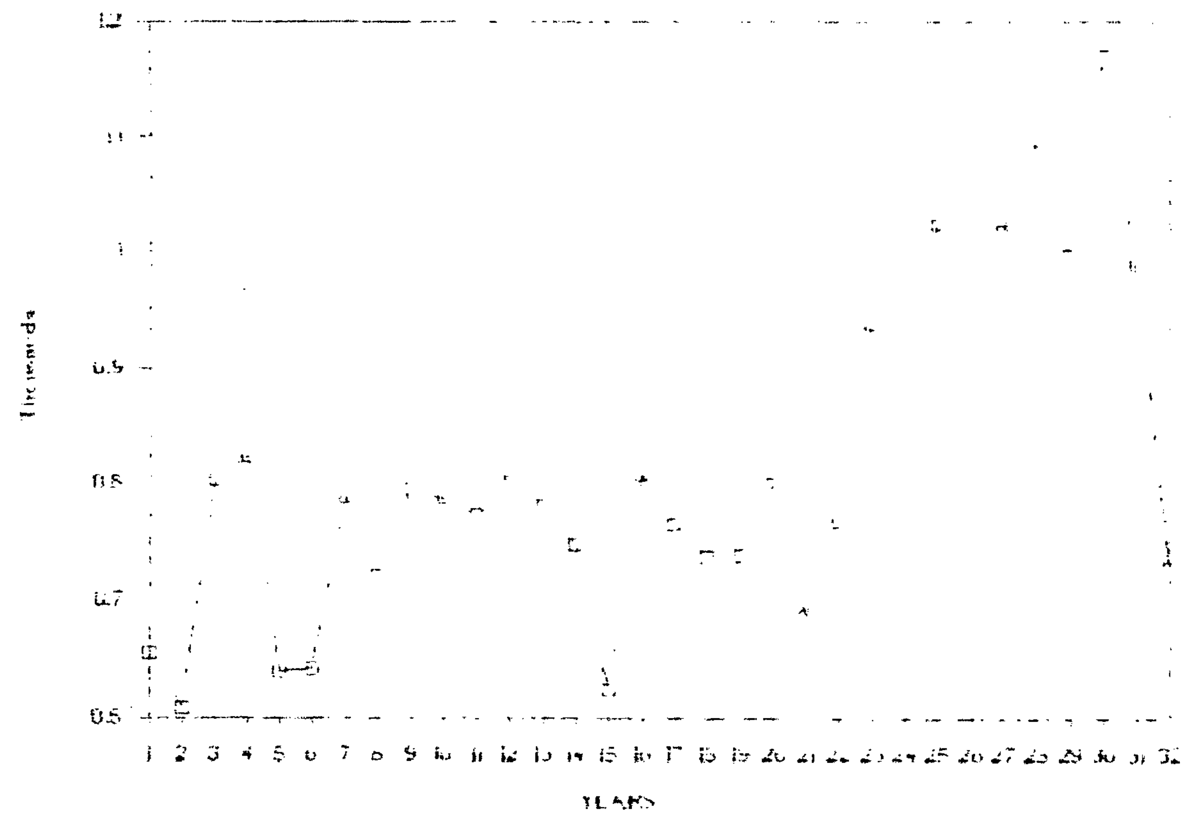

KANYAKUMARI - YIELD OF PADDY
YIELD IN KGS/HECTARE (Thousands)
2.6
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEARS

APPENDIX-2

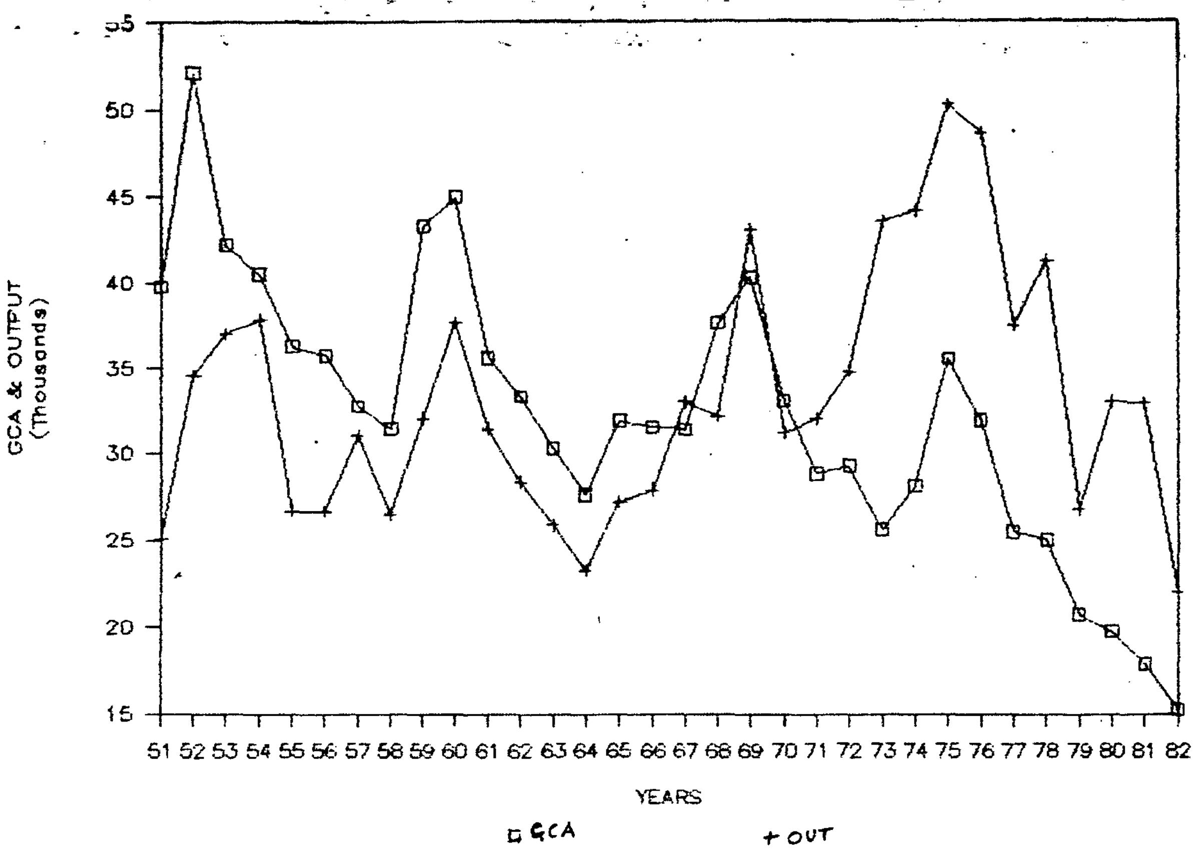
TAMIL NADU -GCA & OUTPUT OF MILLETS



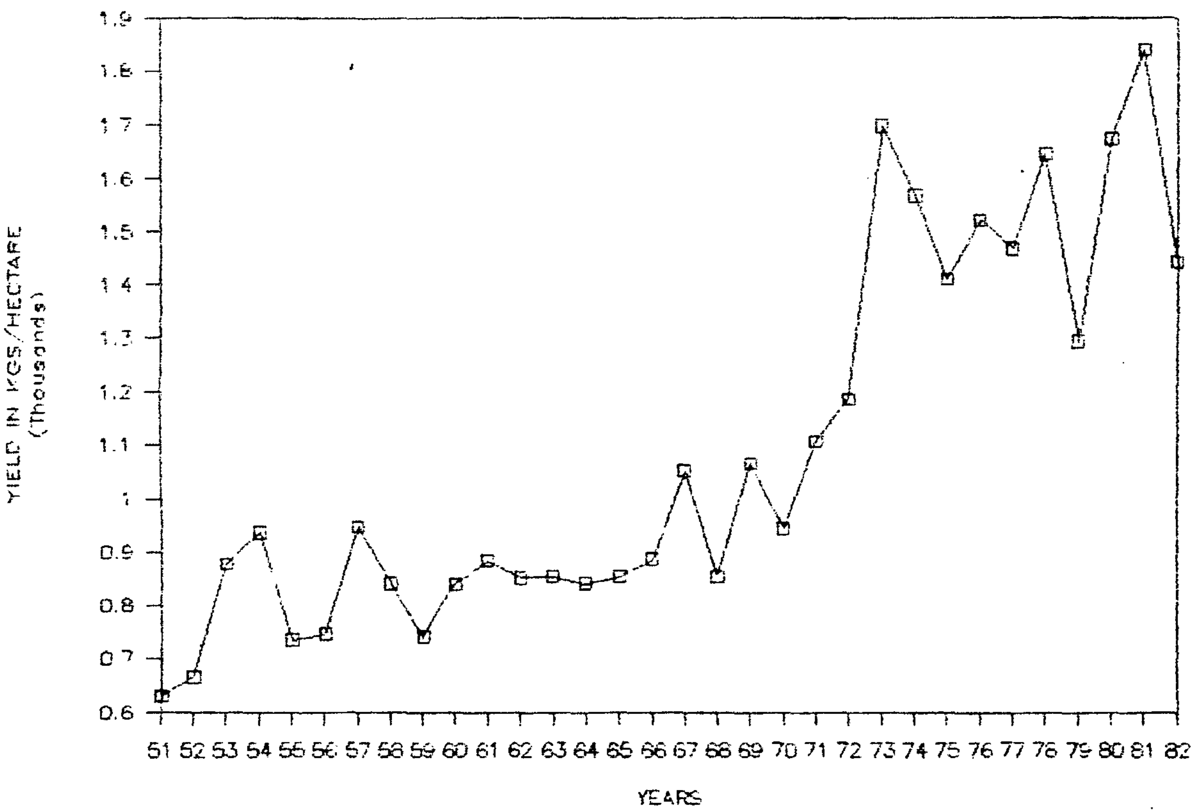
TAMIL NADU - YIELD OF MILLETS



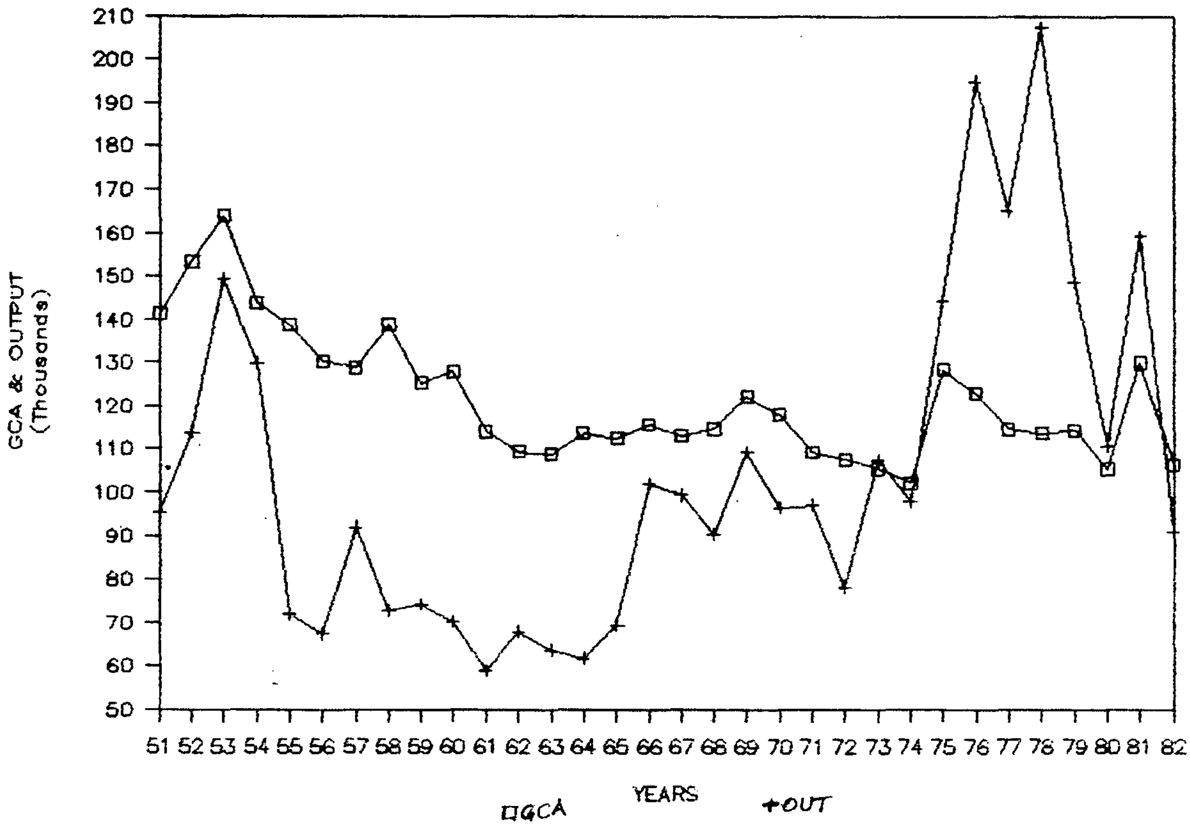
CHINGLEPUT — GCA & OUTPUT OF MILLETS



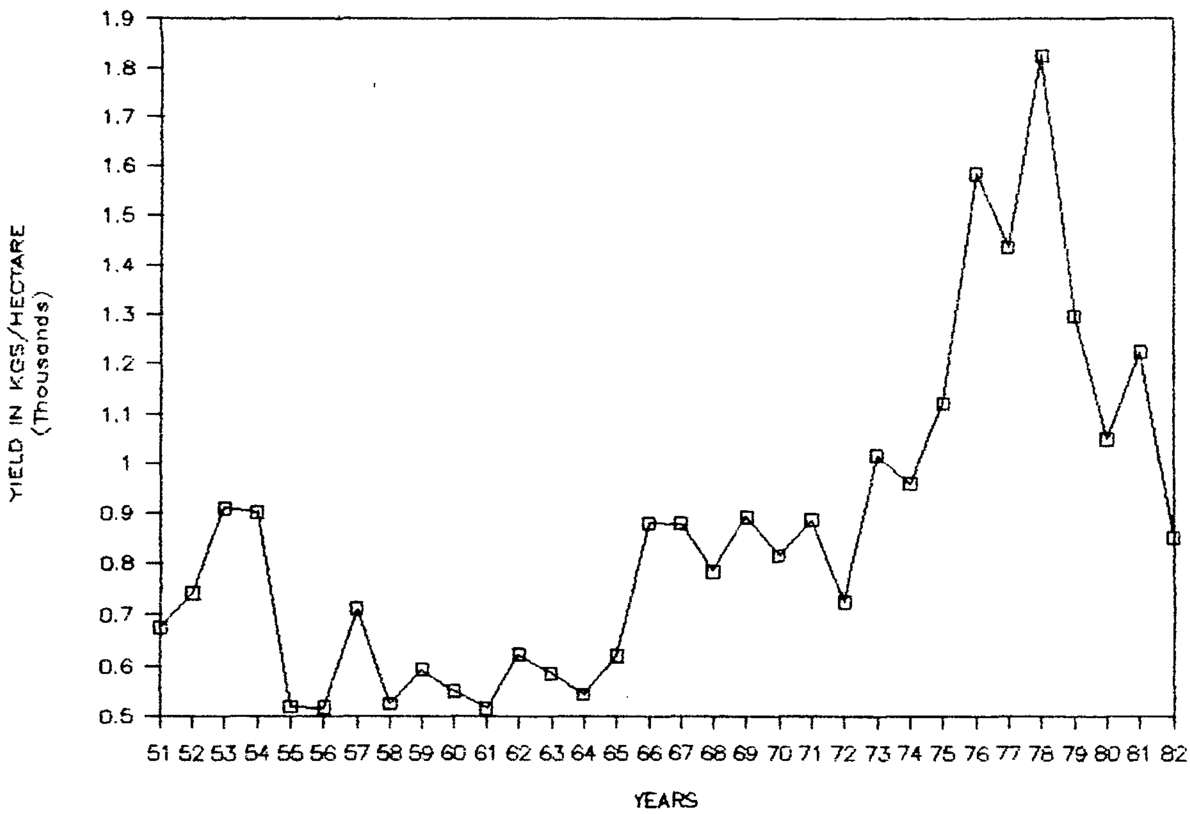
CHINGLEPUT — YIELD OF MILLETS



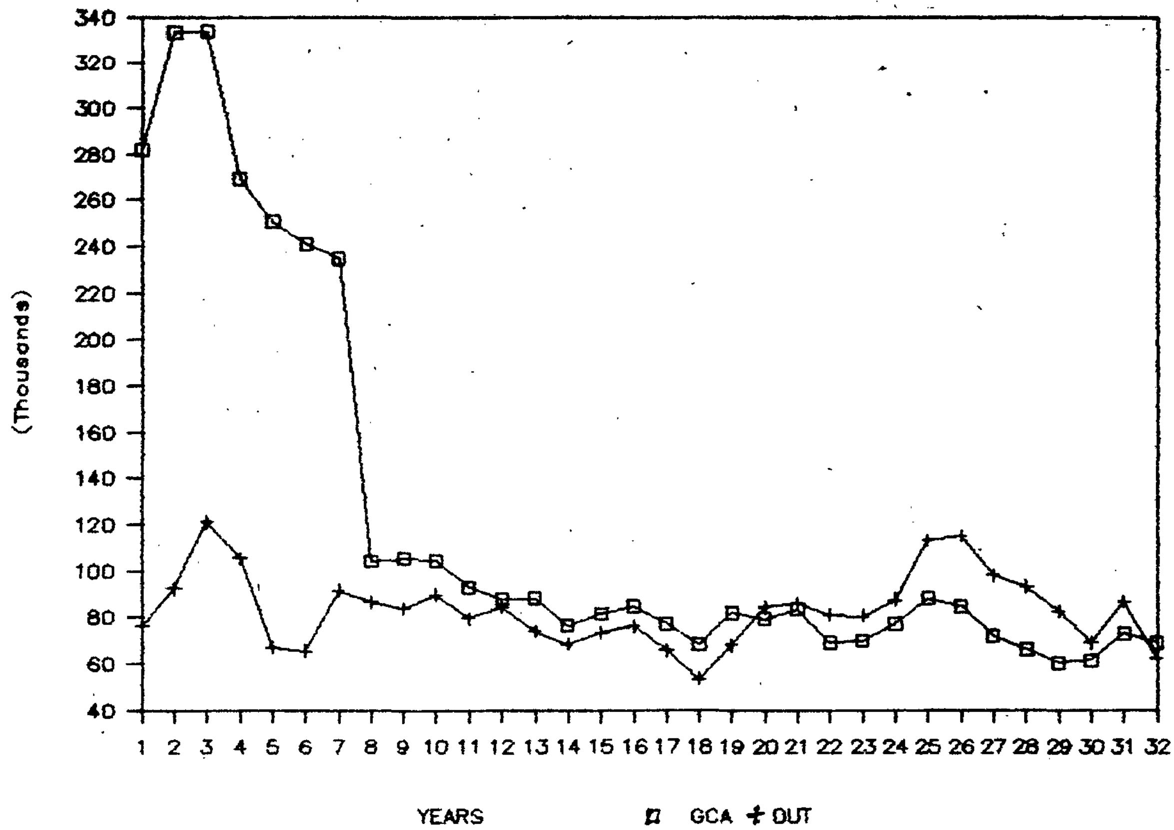
S.ARCOT-GCA & OUTPUT OF MILLETS



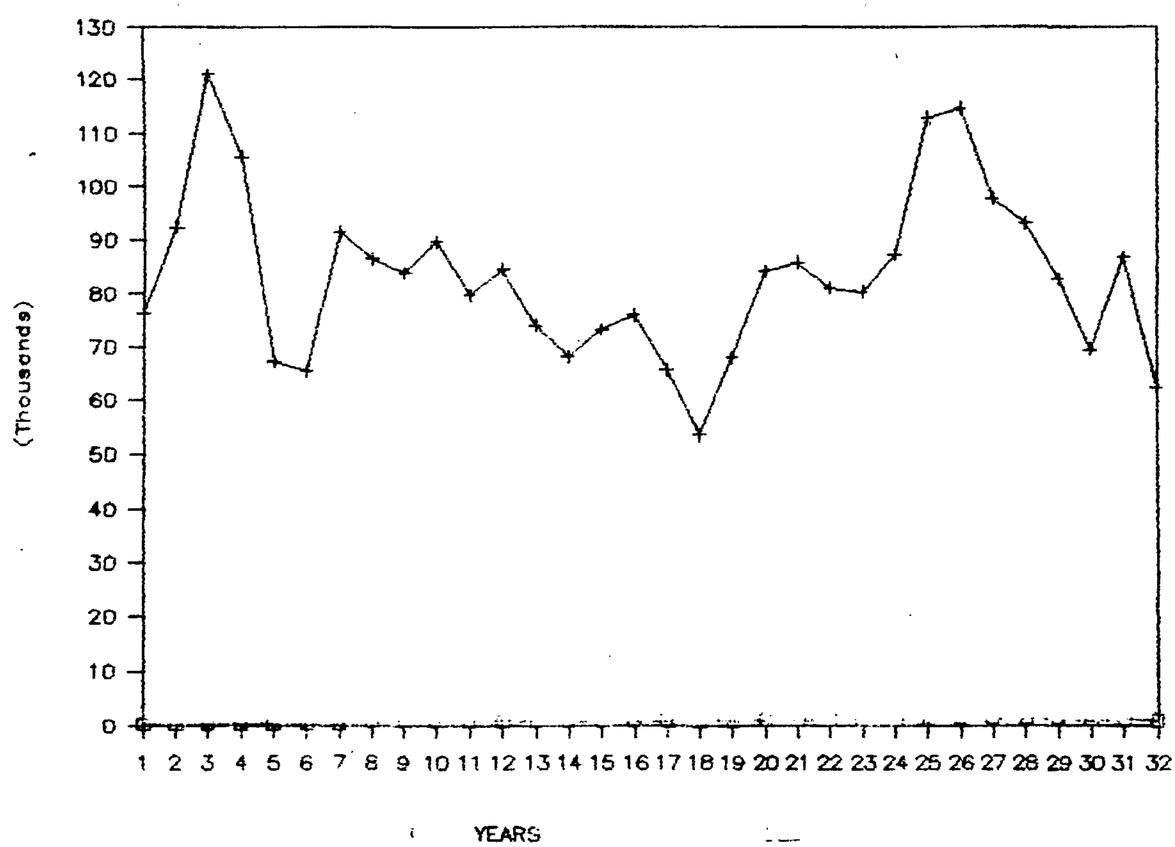
S.ARCOT – YIELD OF MILLETS



NORTH ARCOT — GCA & OUTPUT OF MILLETS

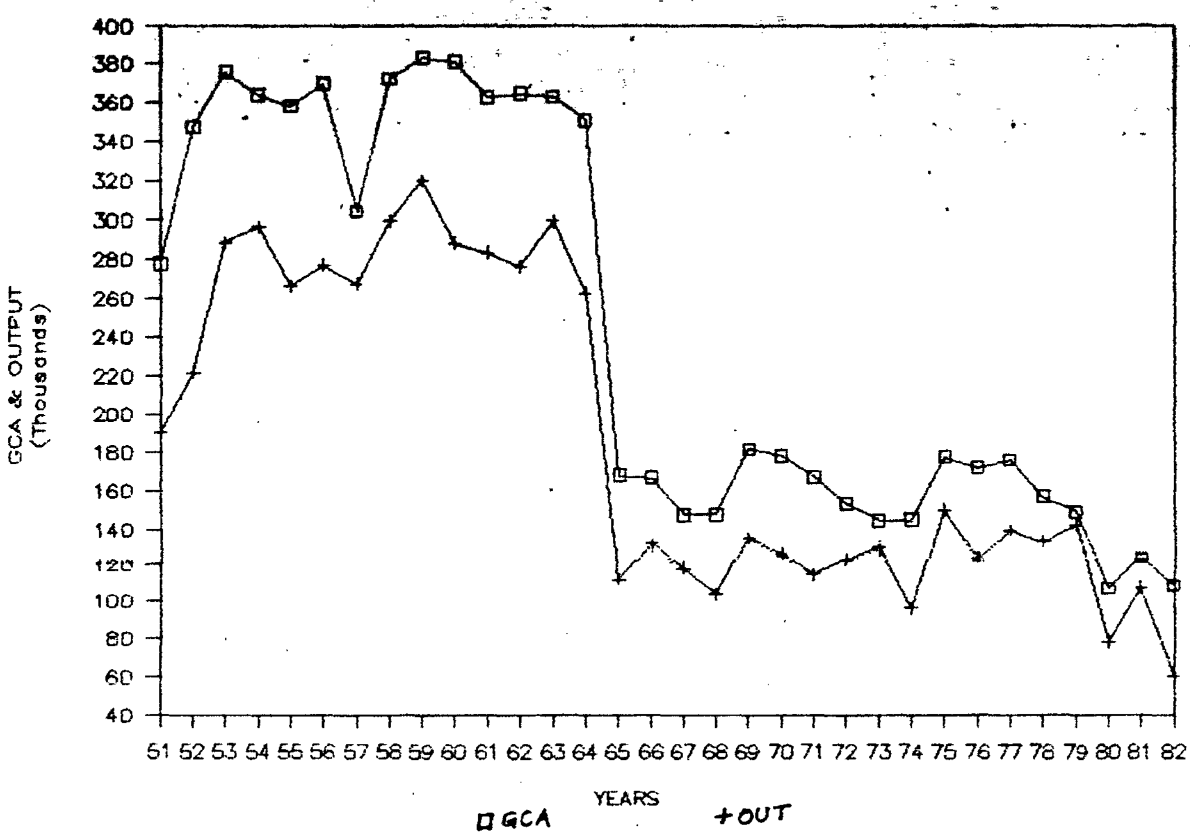


NORTH ARCOT — YIELD OF MILLETS

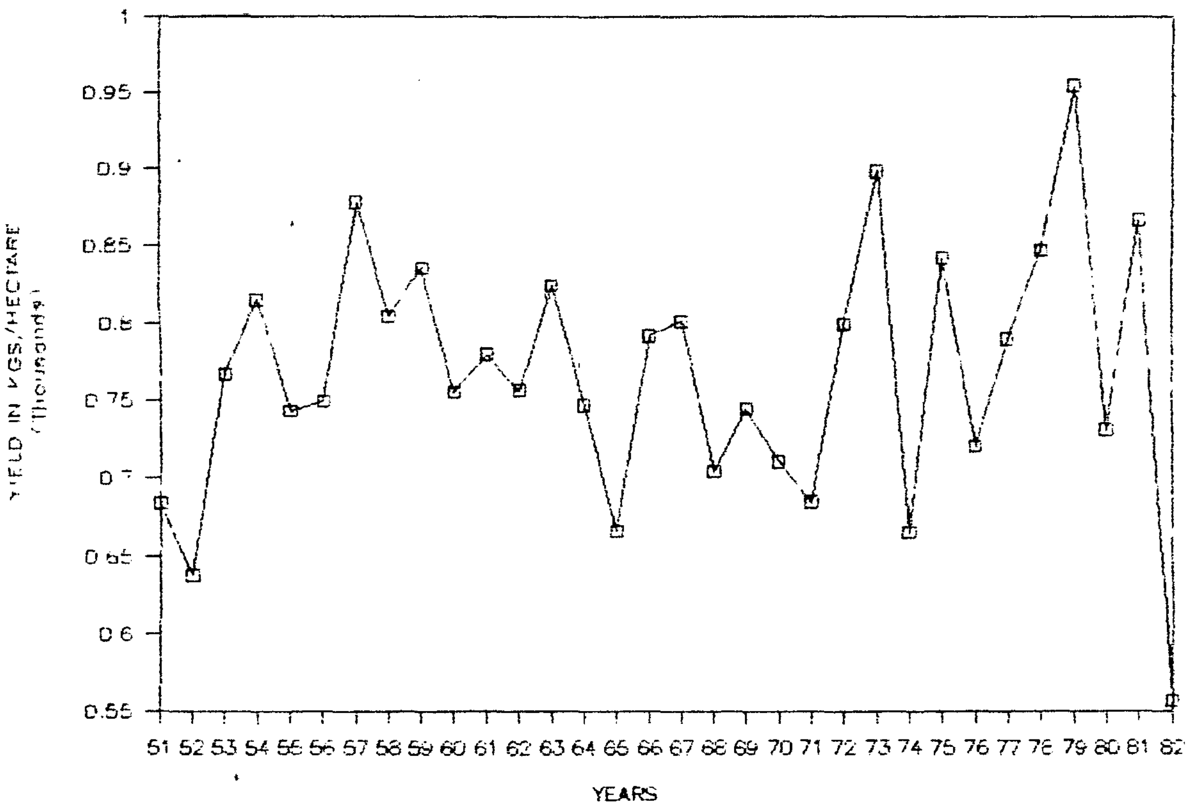


SALEM – GCA & OUTPUT OF MILLETS

EXCLUDING DHARMAPURI

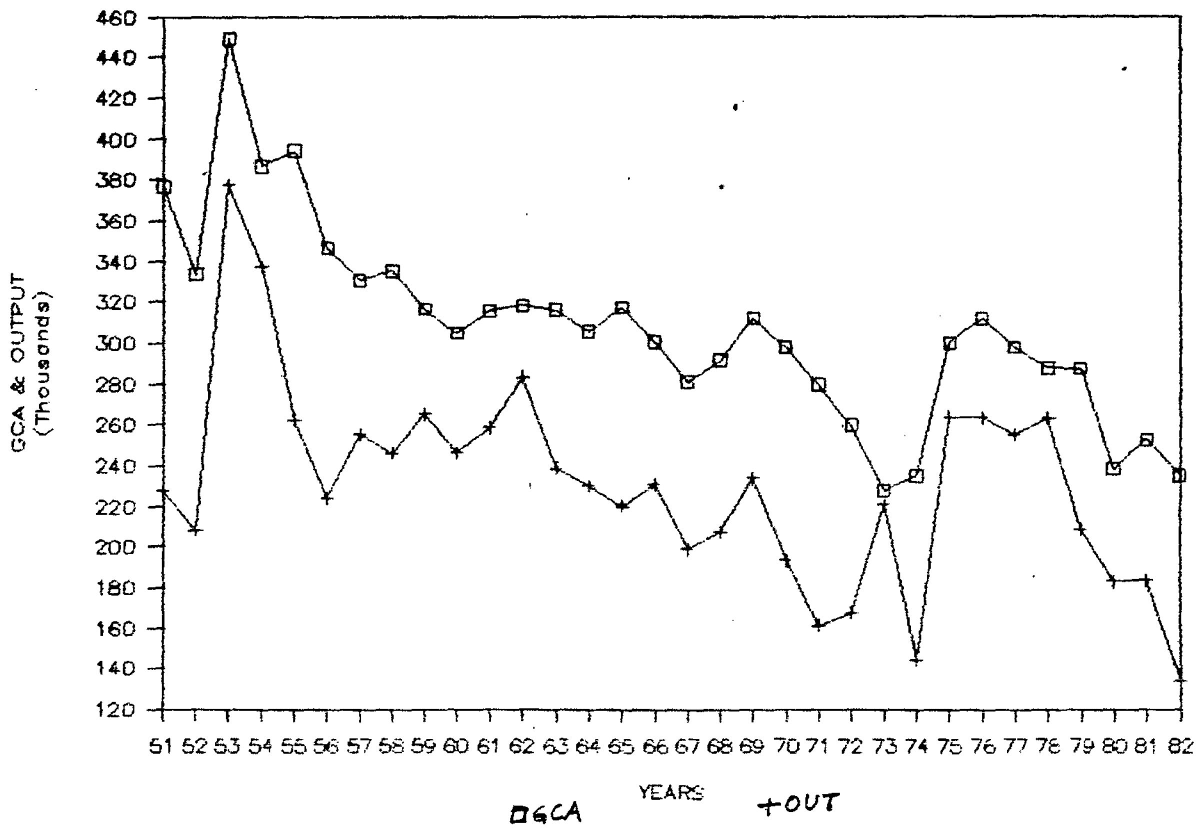


SALEM – YIELD OF MILLETS

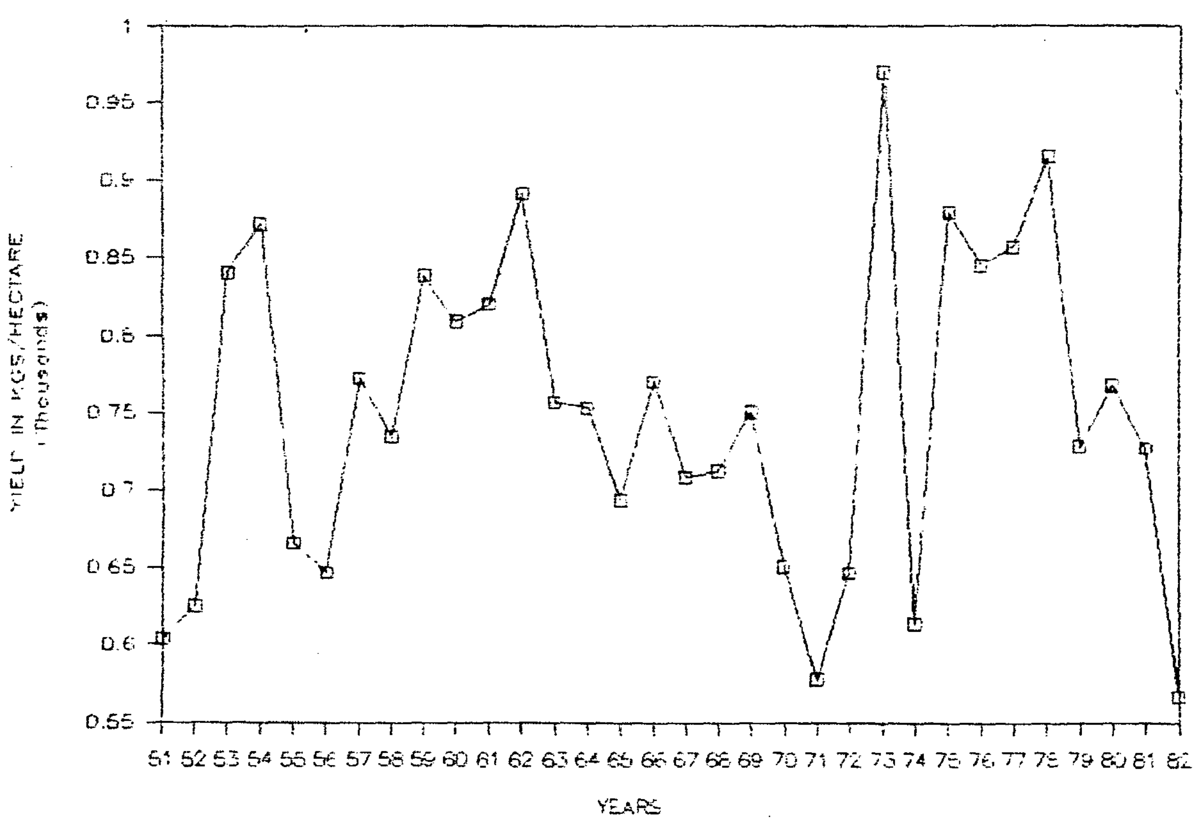


se tp.m
VARIABLES IN S:STAT FILE ARE:

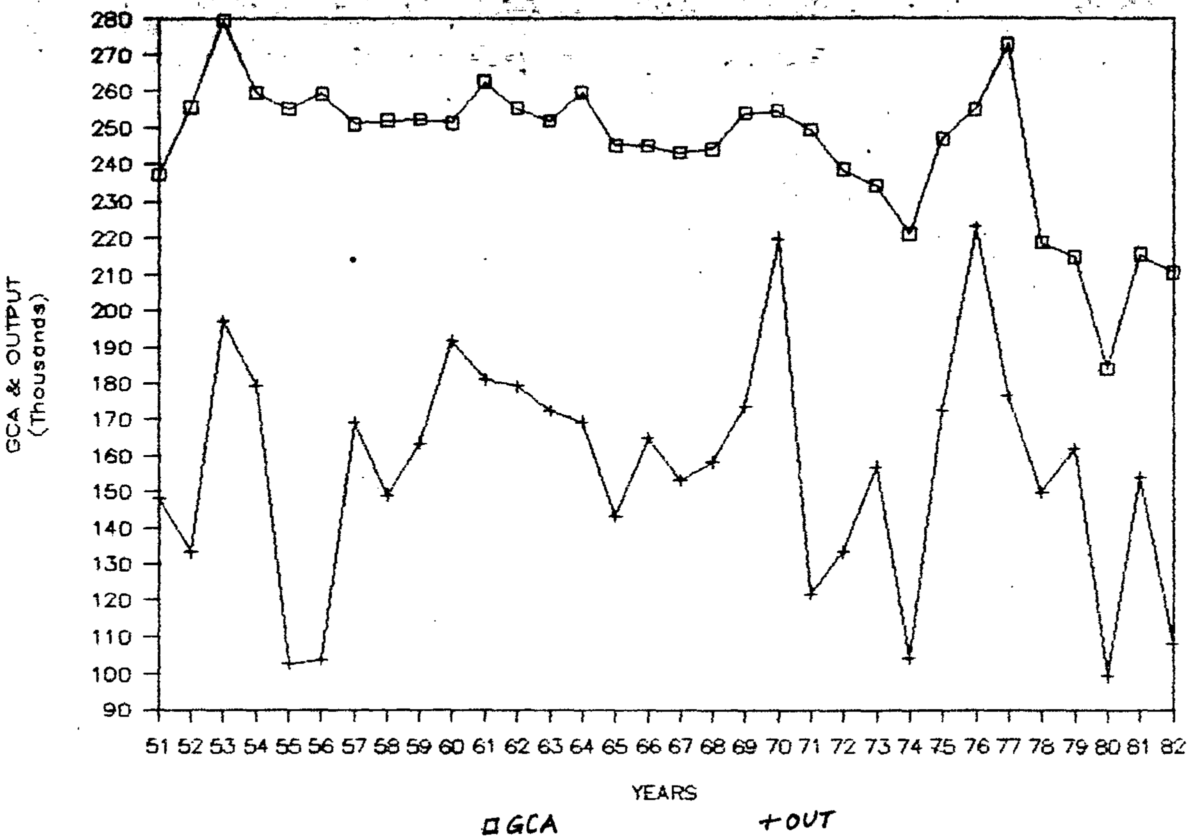
COIMBATORE — GCA & OUTPUT OF MILLETS



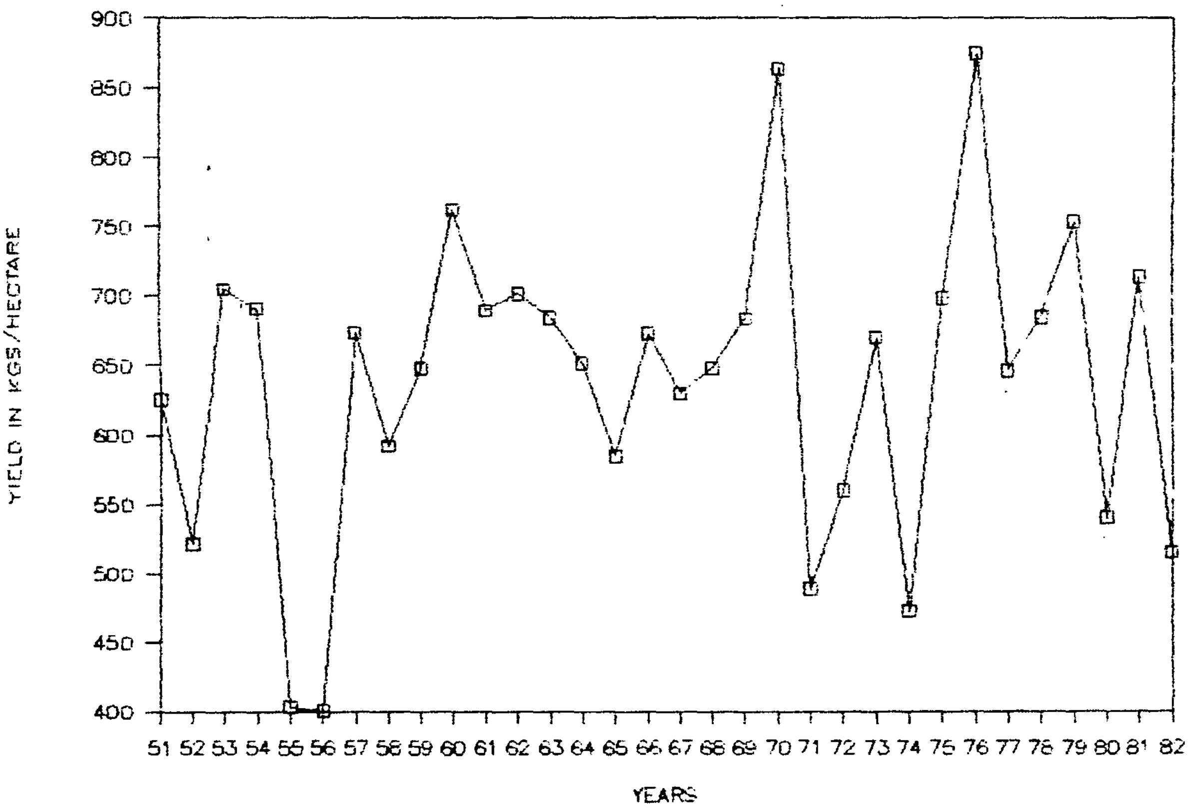
COIMBATORE — YIELD OF MILLETS



TIRUCHY — GCA & OUTPUT OF MILLETS

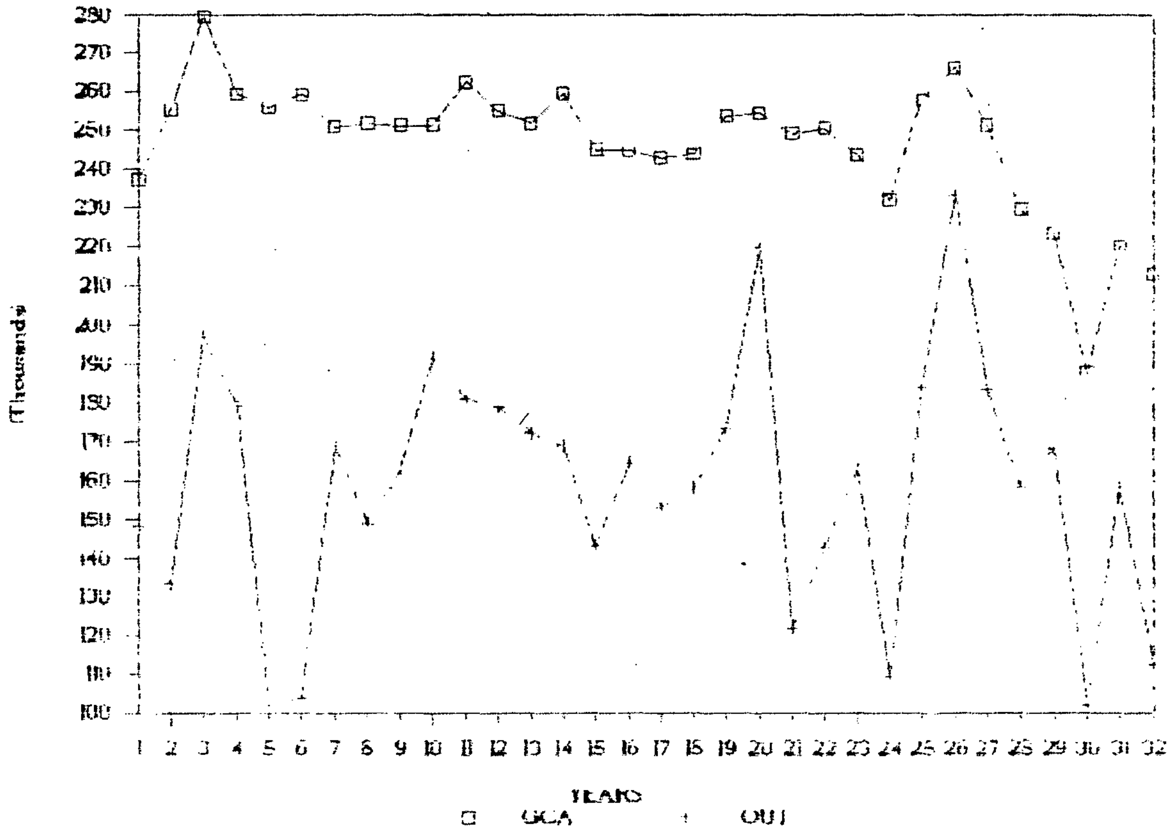


TIRUCHY — YIELD OF MILLETS



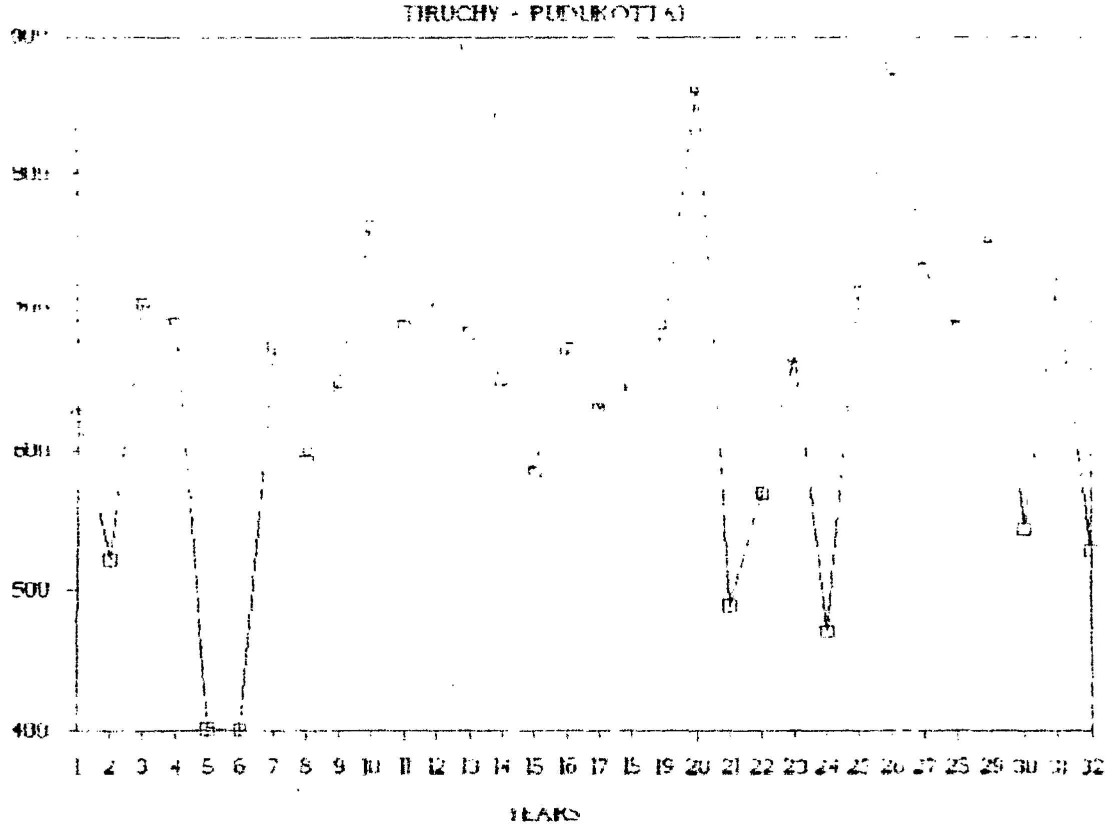
TIRUCHY – GCA & OUTPUT OF MILLETS

TIRUCHY + PUDUKOTTAI

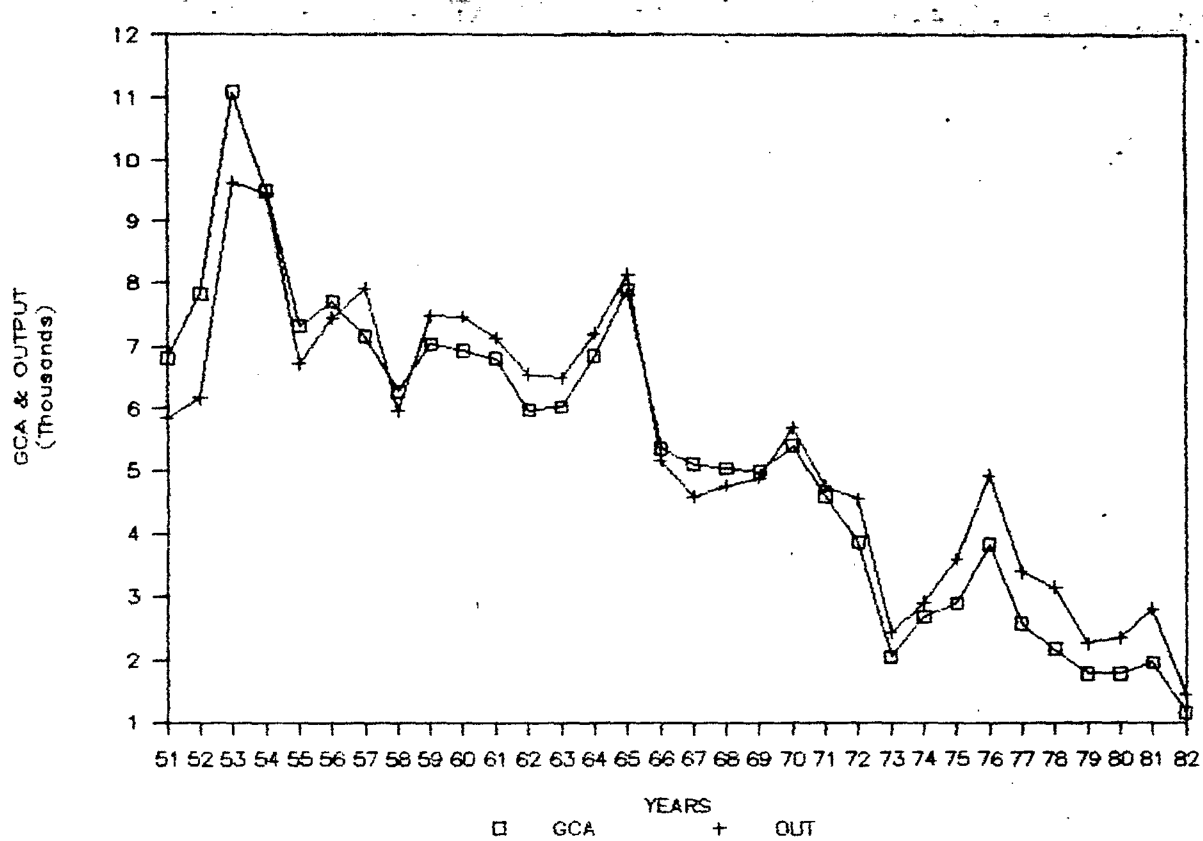


TIRUCHY – YIELD OF MILLETS

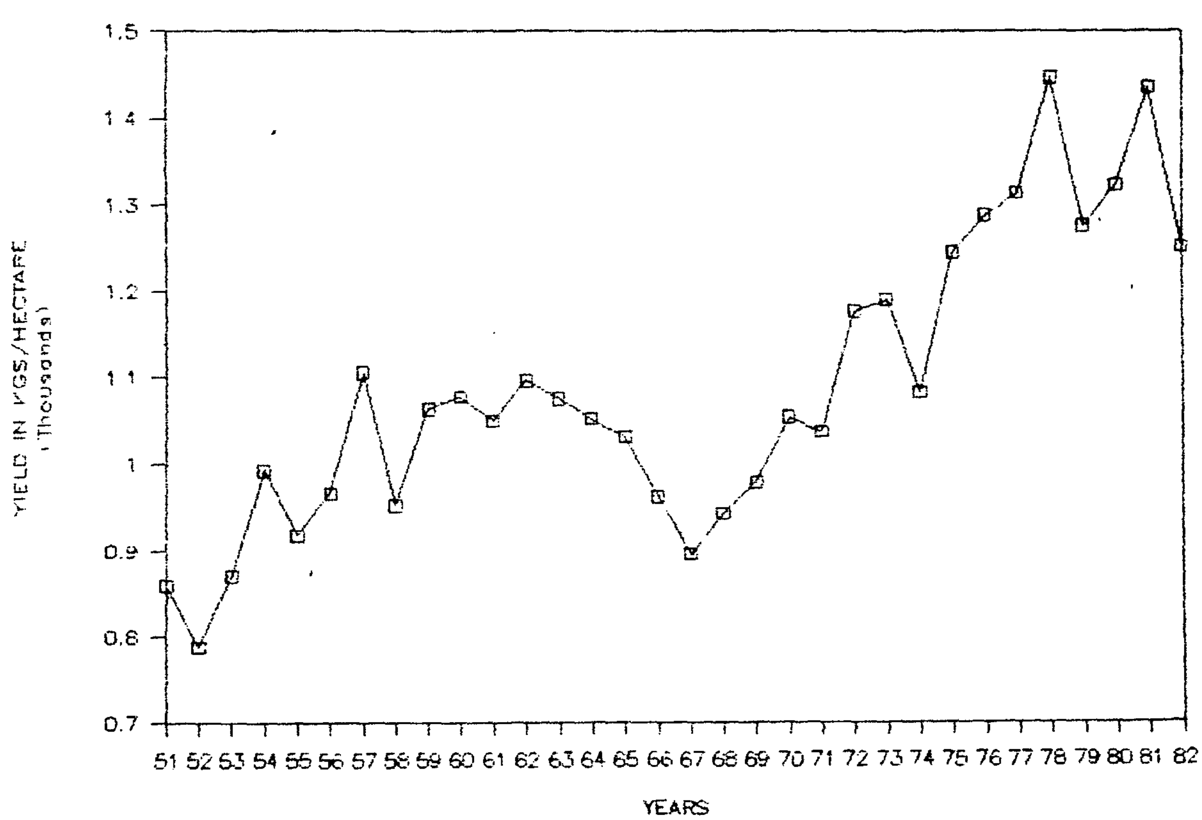
TIRUCHY + PUDUKOTTAI



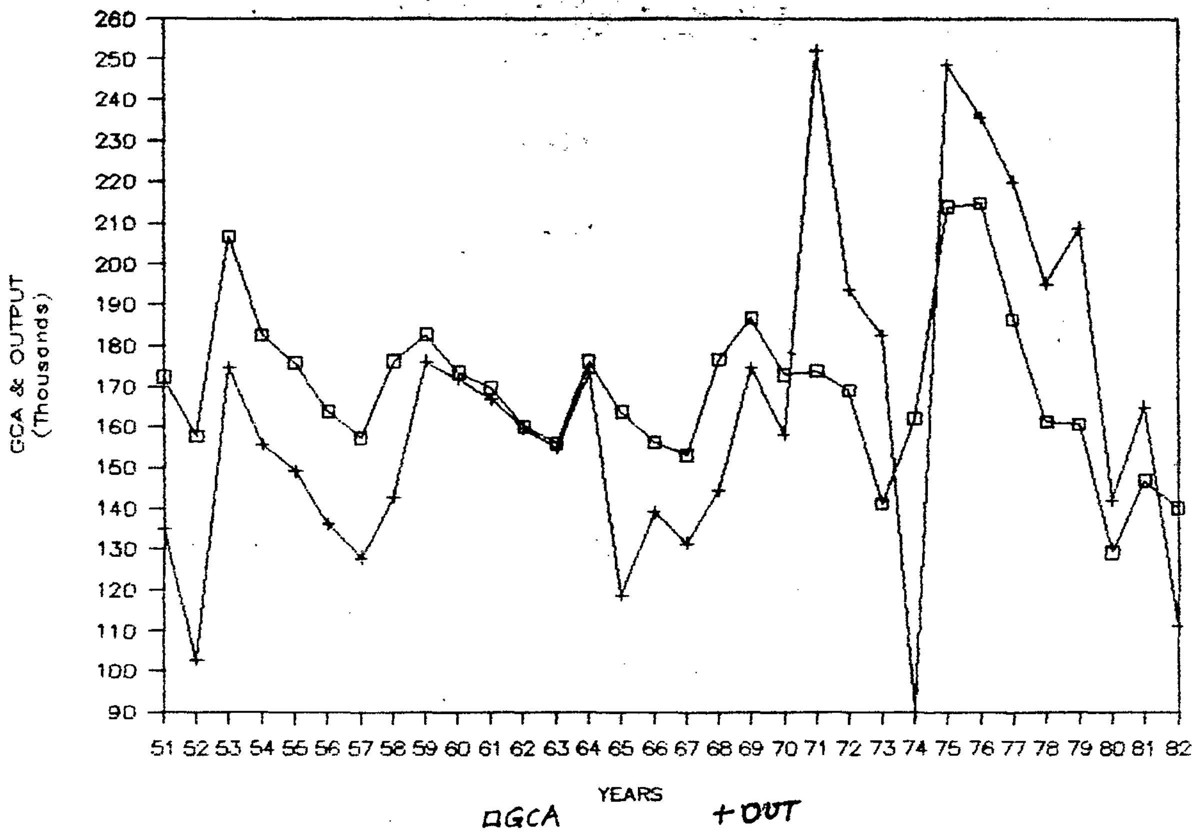
THANJAVUR – GCA & OUTPUT OF MILLETS



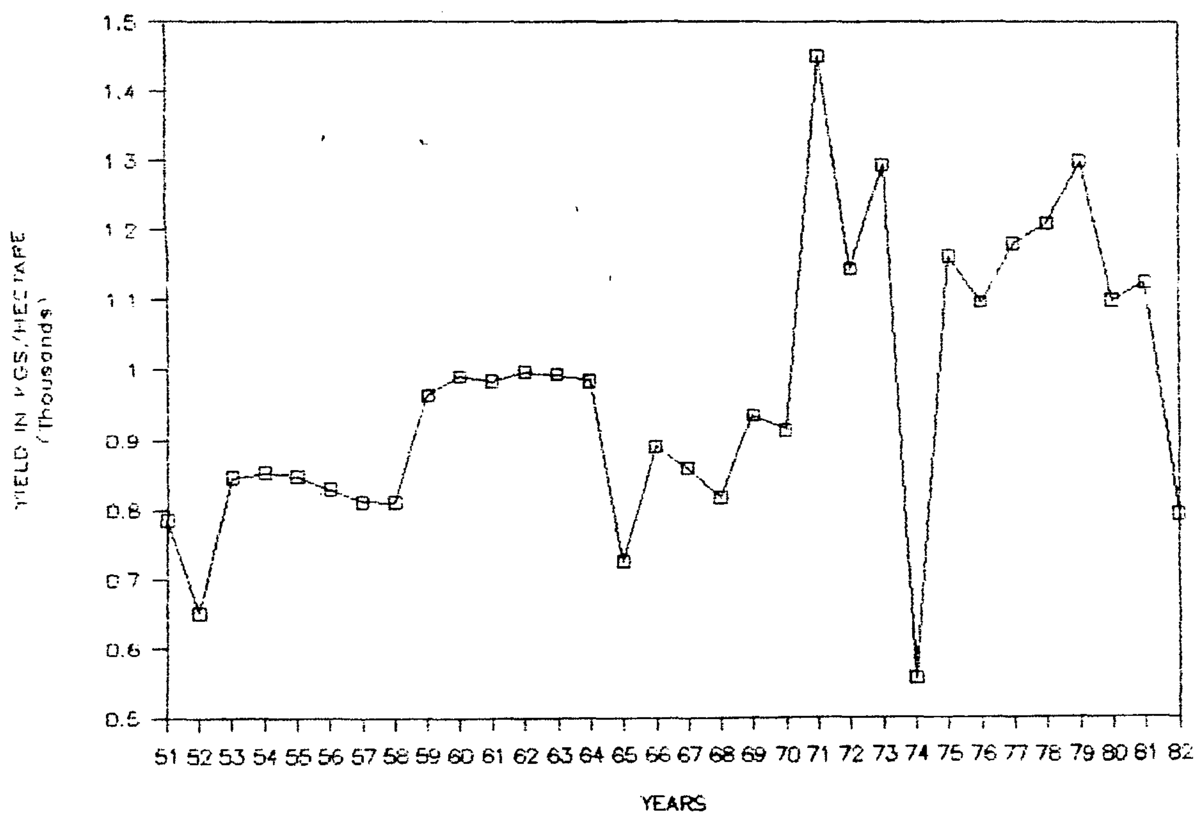
THANJAVUR – YIELD OF MILLETS



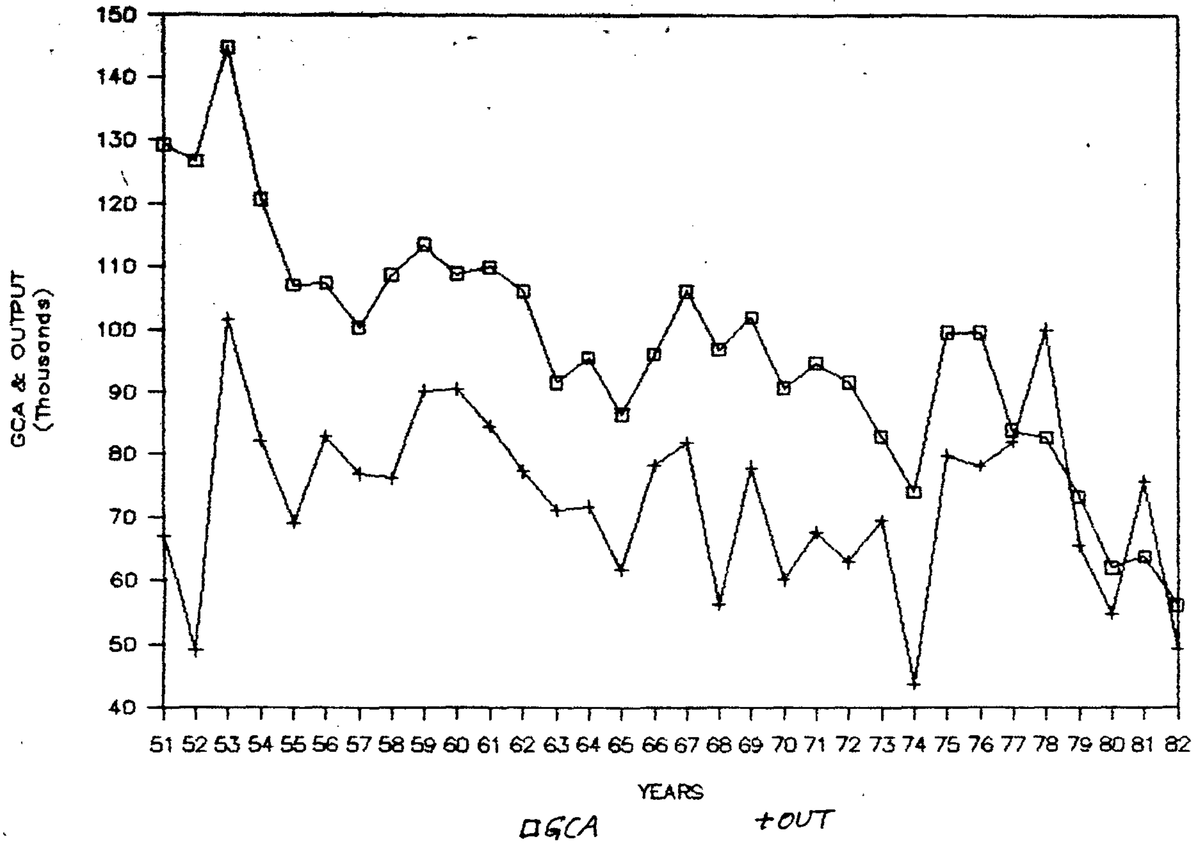
MADURAI – GCA & OUTPUT OF MILLETS



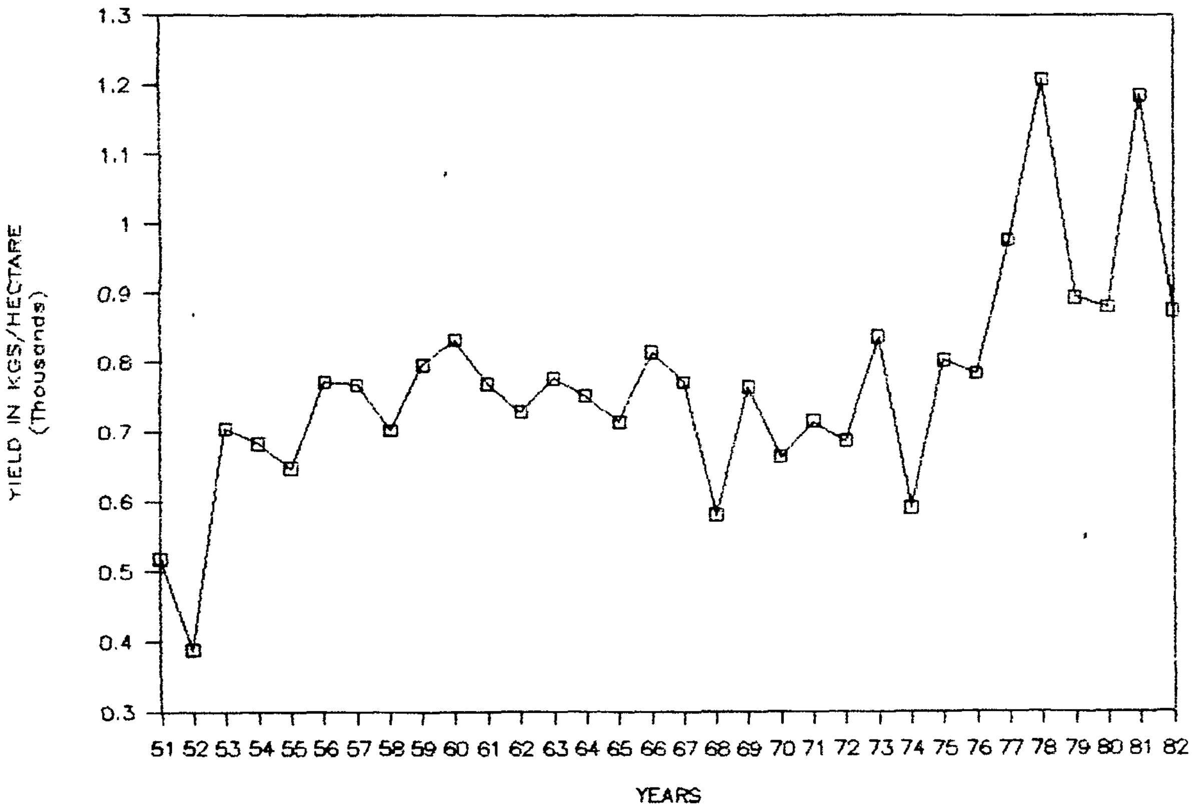
MADURAI – YIELD OF MILLETS



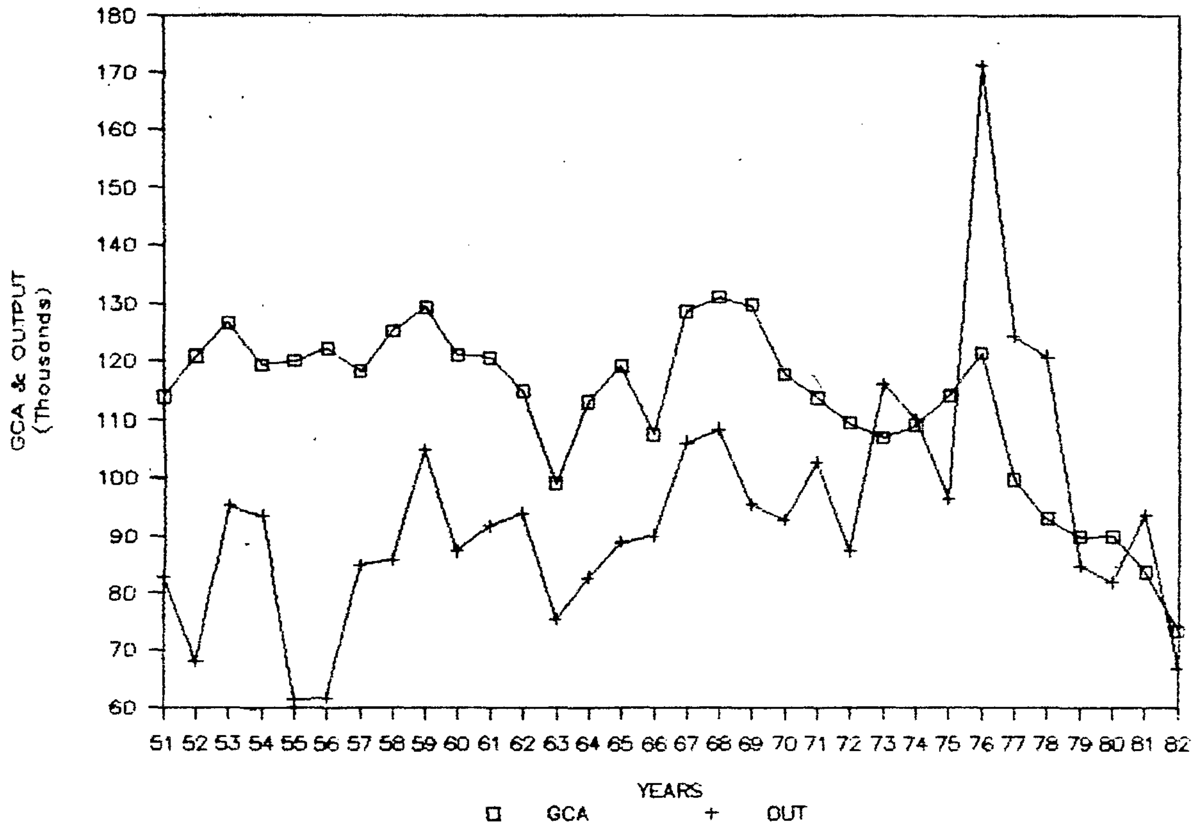
RAMNAD — GCA & OUTPUT OF MILLETS



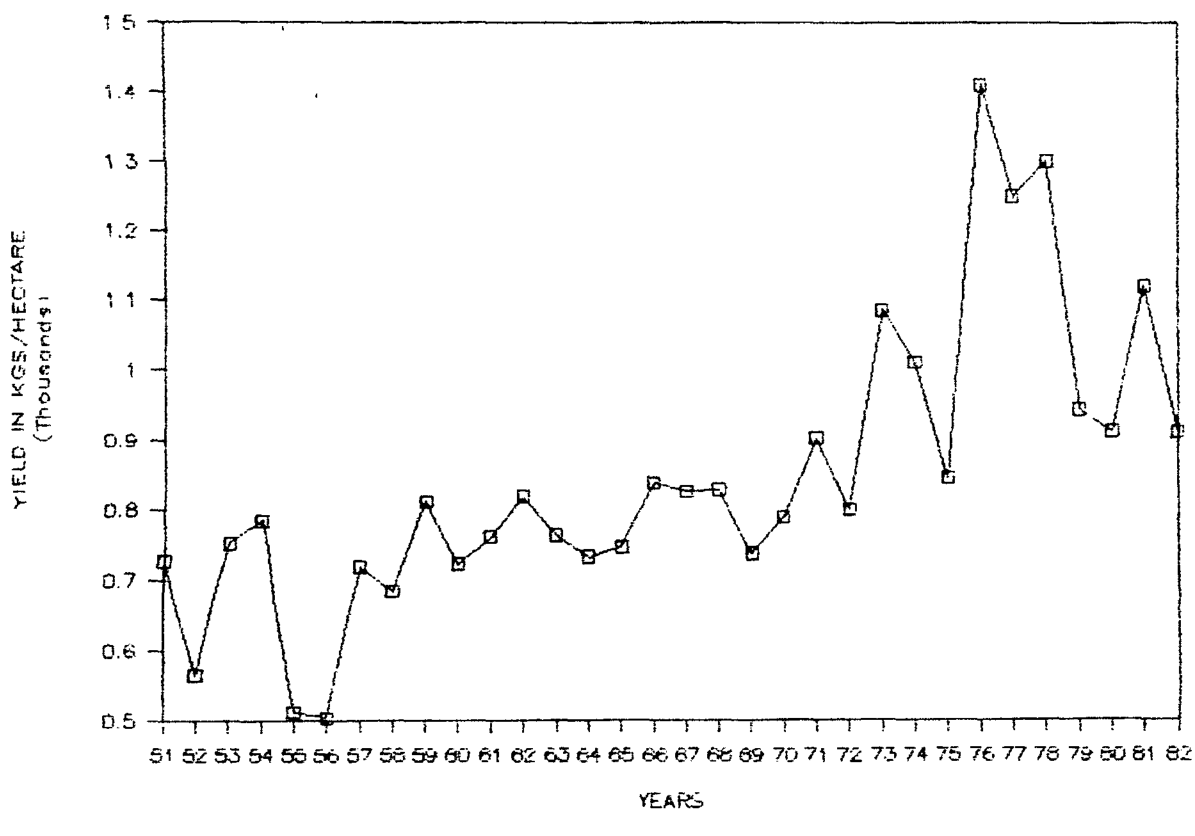
RAMNAD — YIELD OF MILLETS



TIRUNELVELI — GCA & OUTPUT OF MILLETS



TIRUNELVELI — YIELD OF MILLETS



APPENDIX - 3

AVERAGE ANNUAL RAINFALL IN MILLIMETRES.

		(1951/52 - 1982/83) 32 years	(1951/52-1964/65) 14 years	(1965/66-1982/83) 18 years
1.	Chingleput	1130	1080	1168
2.	South Arcot	1088	1044	1122
3.	North Arcot	967	928	996
4.	Salem	825	819	830
5.	Coimbatore	692	703	683
6.	Tiruchy	819	768	858
7.	Thanjavur	1095	1062	1120
8.	Madurai	815	789	836
9.	Ramnad	793	783	801
10.	Tirunelveli	747	687	794
11.	Kanyakumari	1357*	1264**	1400

* Refers to the average of 27 years only viz. 1956/57-1982/83.

** Refers to the average of 9 years viz. 1956-57-1964/65.

Source computed from the data on rainfall from Season & Crop Reports of Tamil Nadu.

APPENDIX - 4

AVERAGE PERCENTAGE OF PADDY AREA IRRIGATED.

	1951/52-1982/83	1951/52-1964/65	1965/66-1982/83
1. Chingleput	81.4	78.08	83.99
2. South Arcot	93.33	91.83	94.49
3. North Arcot	97.32	95.52	98.71
4. Salem (including Dharmapuri)	98.84	98.47	99.13
5. Coimbatore	99.46	99.73	99.24
6. Tiruchy (including Pudukottai)	90.33	99.61	89.34
7. Thanjavur	95.74	95.75	95.72
8. Madurai	99.35	99.35	99.35
9. Ramnad	75.1	82.92	69.02
10. Tirunelveli	99.27	98.96	99.51
11. Kanyakumari	90.97*	72.94**	99.99

* Refers to the period 1956/57 - 1982/83

** Refers to the period 1956/57 - 1964/65

Source : Computed from the irrigation data available in Season & Crop Reports of Tamil Nadu.

APPENDIX - 5

AVERAGE* PROPORTION OF PADDY AREA UNDER HYVS

1.	Chingleput	72.5%
2.	South Arcot	81.75%
3.	North Arcot	73.9%
4.	Salem (including Dharmapuri)	60.56%
5.	Coimbatore	99.46%
6.	Tiruchy (including Puddukottai)	77.38%
7.	Thanjavur	93.31%
8.	Madurai	89.44%
9.	Ramnad	46.33%
10.	Tirunelveli	73.79%
11.	Kanyakumari	43.63%

* average of the years 1976-77 to 1982-83 (data not available for 1980-81)

Source : Season & Crop Reports of Tamil Nadu.

APPENDIX 6

PADDY - GROWTH RATES - ALTERED TME PERIODS

DISTRICTS		OUTPUT		ACREAGE		YIELD	
		Period I	Period II	Period I	Period II	Period I	Period II
1. CHINGLE-PUT	a	4.1	1.4	3.9	-0.7	0.6	2.2
	b	3.7	1.1	3.5	-0.6	0.4	1.8
2. S. ARCOT	a	1.8	-0.5	2.8	-1.8	-1.0	1.3
	b	1.8	-0.1	2.7	-2.0	-0.9	0.9
3. N. ARCOT	a	3.7	0.3	4.5	-2.8	-0.9	3.0
	b	3.3	1.4	4.4	-0.6	-1.0	2.1
4. SALEM	a	3.1	-0.4	3.1	-1.9	0.0	1.5
	b	3.2	-0.3	3.3	-1.8	-0.2	1.5
5. COIMBA-TORE	a	6.7	2.0	6.2	0.9	0.5	1.1
	b	5.9	1.4	5.5	0.8	0.4	0.6
6. TIRUCHY	a	0.2	1.8	1.8	0.8	-1.6	1.1
	b	0.7	1.9	1.9	0.8	-1.2	1.0
7. THANJA-VUR	a	0.8	1.7	1.1	-0.5	-0.3	2.2
	b	0.6	1.4	1.0	-0.6	-0.4	2.1
8. MADURAI	a	1.5	2.4	1.8	-0.4	-0.2	2.7
	b	1.2	2.4	1.7	-0.2	-0.4	2.6
9. RAMNAD	a	2.1	0.7	5.0	0.2	-2.9	0.3
	b	2.6	1.1	4.8	0.3	-1.9	0.9
10. TIRUNEL-VELI	a	0.5	2.2	1.9	-0.1	-1.3	2.5
	b	0.0	1.6	1.7	0.0	-1.8	1.6
11. KANYA-KUMARI*	a	2.3	-0.5	-0.6	-1.8	2.9	1.4
	b	1.3	-0.8	-0.7	-2.0	2.0	1.2
TAMIL-NADU	a	2.1	1.3	3.3	-0.6	-1.2	1.9
	b	2.0	1.3	3.1	-0.6	-1.1	1.9

a - Period I - 1951/52-1965/66, Period II - 1966/67-1982/83
b - Period I - 1951/52-1966/67, Period II - 1967/68-1982/83
* Kanyakumari - a - Period I - 1956/57-1965/66
b - Period I - 1956/57-1966/67

APPENDIX 7

PADDY-COEFFICIENT OF VARIATION-ALTERED TIME PERIODS

DISTRICTS		OUTPUT		ACREAGE		YIELD	
		Period I	Period II	Period I	Period II	Period I	Period II
1. Chinglеput	a	12.99	27.42	06.73	13.60	12.78	18.01
	b	13.57	27.64	07.96	14.06	12.53	18.02
2. South Arcot	a	13.14	23.34	06.10	13.24	10.98	14.32
	b	12.69	23.01	06.16	13.87	10.76	13.80
3. North Arcot	a	19.01	33.50	11.49	22.16	12.39	13.09
	b	18.91	34.12	11.44	23.71	12.22	13.65
4. Salem	a	19.18	23.18	14.87	17.82	07.75	11.18
	b	18.29	23.94	14.44	18.51	07.77	11.42
5. Coimbatore	a	22.58	18.00	20.85	17.31	09.27	10.67
	b	25.52	17.55	23.65	17.69	09.00	09.93
6. Tiruchy	a	19.19	23.83	09.00	13.11	14.64	14.54
	b	18.95	24.36	08.65	13.45	14.65	14.87
7. Thanjavur	a	12.75	14.62	01.52	04.74	12.93	11.27
	b	12.44	14.61	01.65	04.70	12.60	11.30
8. Madurai	a	13.67	26.13	06.47	12.53	11.33	17.49
	b	13.52	26.72	06.41	12.87	11.21	17.88
9. Ramnad	a	29.65	37.37	07.70	11.09	27.43	30.83
	b	28.78	38.56	08.20	11.37	28.16	31.54
10. Tirunelveli	a	21.96	20.44	11.99	12.83	12.75	14.16
	b	22.14	20.08	11.78	13.10	13.39	12.23
11. Kanyakumari*	a	12.35	19.92	06.71	06.39	10.33	15.63
	b	12.70	19.94	06.45	06.08	10.79	15.85
TAMILNADU	a	11.50	16.88	06.20	09.10	13.03	09.55
	b	10.98	16.88	06.13	09.55	12.70	09.10

a - Period I - 1951/52-1965/66, Period II 1966/67-1982/83
b - Period I - 1951/52-1966/67, Period II 1967/68-1982/83
* - Kanyakumari a) Period I - 1956/57-1965/66
b) Period I - 1956/57-1966/67

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