THE INSTABILITY IN KARNATAKA AGRICULTURE
A TIME SERIES ANALYSIS
(1959-60 TO 1977-78)

Dissertation submitted to the Jawaharlal Nehru University
in partial fulfilment for the degree of
MASTER OF PHILOSOPHY

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We certify that the dissertation entitled " The Instability in Karnataka Agriculture: Time Series Analysis (1959-60 to 1977-78)", submitted by Miss Jaya Sharma in fulfilment of six credits out of the total requirement of twentyfour credits for awarding the Degree of MASTER OF PHILOSOPHY (M.Phil) of this University, is a bonafide work to the best of our knowledge and may be placed before the examiners for their consideration.

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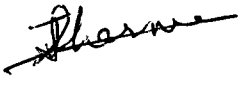
ACKNOWLEDGEMENT

I must place on record my indebtedness to my Supervisors, Dr. S.K.Thorat, Associate Professor and Dr. K.S.Sivaswami, Associate Professor, Centre for the Study of Regional Development, School of Social Sciences, Jawaharlal Nehru University, without whose help, thoughtful advice and constant encouragement, I would not have been able to complete the work of writing this dissertation. My sincere thanks are also due to Professor G.K.Chadda for his valuable suggestions from time to time. I would be failing if I also do not express my gratefulness to the assistance and advice I received from ICAR Library, Library of the Directorate of Economics and Statistics, Indian Meteorological Department and J N U Library.

Last but not the least, I will ever remember the constant encouragement shown by my parents. Finally I would like to sincerely thank Mr. P.R.Narayanan and my friends for their help and support.



JAYA SHARMA

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CHAPTER - I

INTRODUCTION

1.1 The Importance of Agriculture in Economic Development:

In the developing countries which are predominantly peasent economies, agriculture forms the major sector and, therefore, plays a very crucial and significant role in the over all economy. It provides employment to nearly three -fourth of the population and therefore still remains the main source of livelihood for nearly 80% of the population. It provides foodgrains, the basic necessity for the consumption of the population. Almost 90% of the food requirements are met from agriculture alone. A failure to expand food production in pace with the demand can seriously impede economic growth. Besides providing employment and food in its own right, it also provides a basic stand-in for the industrial sector. By supplying raw materials like [1] cotton, jute, sugar, oil, beverages and several others to the agro-based industries, it widens the horizon for the economic development of the industrial sector. Further it also releases a part of its labour force for industrial employment besides meeting the increasing food needs of population engaged in the non-agricultural sector.[2] Surplus labour available in the agricultural sector can itself be a big source of capital formation. For quite sometime, foreign exchange resources have also to be contributed largely by agricultural exports. Such resources are of critical importance for the import of capital goods and technical knowhow for initiating and

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1. B.F.Jhonson, J.W.Mellor, The Role of Agriculture in Economic Development, Reading in Economics of Agriculture(ed).
2. Ragnar, Nurkse, Problem of Capital Formation in Underdeveloped Countries, Oxford, 1956.

accelerating the process of industrialisation. This indeed has been the historical experience of the role of the agricultural sector in the developed industrial economies like UK, Japan and West Germany among a few.

In brief agriculture plays a very significant role by providing food, labour and capital to the non-agricultural sector, particularly in the earlier stages of economic development. The agricultural sector, however, would be able to perform the role in a more effective manner, provided the production of both food and non-food crops increases at a required rate. In a larger sense, agricultural development is almost a pre-requisite for the development of industrial sector in the developing countries.[3]

1.2 Focus on Growth and Instability:

A situation where the supply of food would be more than the demand or atleast close to the demand would make an ideal situation and cause no worry. In most of the developing countries, however, the demand and supply situation is not that bright. In these countries the population growth rate is quite high(around 2 - 3% p.a.). The high growth rate in population, associated with high income elasticity of demand for food (which is in the range of .60 to .90)[4] leads to a significantly higher demand for food which is in the range of 3 - 4% p.a.. Historically speaking, with the exception of very few countries like Japan it has been extremely difficult for the developing or underdeveloped countries

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3. William H Nicholls "The Place of Agriculture in Economic Development" in Agriculture in Economic Development, C.L.Eicher, L.W.Witt. Macgraw Hill 1964 pp 13.

4. J.W. Mellor, Economics of Agricultural Development, Vakils, Bombay, 1966

to achieve such a high growth rate (annual) in agricultural output. The imbalance in demand and supply situation therefore has created serious difficulties in the development of industrial sector of some of these countries including India. In order to catch up with the demand for food, major task before these countries, therefore, is to achieve at least a minimum growth rate of 3% per annum and above.

Apart from the question of growth rate, another problem the developing countries have to face is the problem of instability or fluctuation in the agricultural output of food as well as non-foodgrain crops, thereby causing annual ups and downs in the agricultural income of the people. From the point of view of general economic development, it is not enough to achieve a required growth rate in the agricultural output alone, but more than that, is to sustain or maintain the same or higher growth rate over a period of time. Stability in the growth rate in the agricultural output is, therefore, of utmost necessity. Annual fluctuation in the output is a common feature of agriculture in these countries, which cause periodic set backs to the process of general economic development. Hence the major thrust on objective of agricultural development. Programmes in these countries not only focus on the achievement of desirable growth rate alone, but also maintain a raising and stable increase in the output. The main concern has been the growth with stability as against the growth with instability. In this present study, our major focus is on the enquiry into the second problem of the agriculture namely the question of instability in agriculture output.

1.3 *Dimension of Instability:*

The main purpose in this study is to examine the problem of instability as experienced in agricultural sector and to identify some of its correlates in a regional context in India. Before looking into the various dimensions of uncertainities, we would like to be reasonably clear about the concept of risk and uncertainty, as understood by the economists. Both these terms have been used while applying them to the agricultural situation.[5] *Risk would refer to events which can be ascribed some probability of occurrence, whereas uncertainties refer to events which cannot be associated with any probability. Risk may be due to hazards like fire which can be predicted with reasonable probability so that some provisions could be made against those events. In other words risks are insurable and, therefore,losses on account of such events, could be included in the cost. Uncertainties on the other hand are highly unpredictable, uncertain and no estimate could be made about its occurrences and therefore, the losses in production cannot be insured. Thus the uncertainties are those phenomenon, which could not be insured and the farmer alone has to bear the loss in income. This differentiation between insurable phenomenon (viz. risk) and non insurable phenomenon has to be kept in mind, while studying the problem of instability in the agricultural sector.*

Instability in agricultural output (physical as well as value) arises mainly due to the unstable behaviour of environmental,technological and economic factors, that govern the agricultural production. Among the environmental factors, the instability in the physical

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5. B.V.S.Baliga, S.B. Tambad, "Risk and Uncertainty in Irrigated Crops", IJAE, Vol. XIX, 1964.

output arises primarily due to an excessive dependency on natural rainfall which is uncertain in nature(and less on artificial irrigation). Failure of rainfall at the critical stages of growth (particularly at the time of sowing and maturing period) could lead to the condition of drought and eventually crop failure. In the absence of controlled irrigation, the variation in the rainfall inject a considerable amount of instability in the whole process of agricultural operation.Thus it is no small wonder that farmers who have to face such unpredictable weather over time, try to overcome such vagaries in their own indigenous and experienced ways. Under such conditions, a high percentage of the land is put under drought resistant varieties, which are low costing to give low yields, as a safeguard against wholesale crop losses, due to deficient and unpredictable rainfall. The main concern of the farmer under such situation is to minimize the loss rather than to maximize the gain.

Apart from the environmental factors, the other factors which bring instability in farm output and over which farmers exercise least control are the economic and technological factors. In the former we may include the fluctuations in the prices of products and inputs and in the latter are included the sudden changes in inputs, techniques, etc. In order to have a fairly detailed idea about the three types of uncertainties namely (i) yield uncertainty, (ii)price uncertainty and (iii) technological uncertainty. We would examine each of them in some detail.

1.4. Yield Uncertainty

As long as agricultural production cannot be completely insulated, from the occurrence of natural factors such as rainfall, temperature, humidity, precipitation, attack of pests and diseases, the uncertainty in the field is something which the farmer cannot avoid. In general the yield level depends on the factors which are controllable such as seed and its timely application, fertilization, irrigation, labour use, etc. and some others which are non-controllable - notably the weather observation including erratic rainfall. This latter set of factors always act as a limiting factor in determining the crop yield, particularly so in India, where there is maximum dependence on natural rainfall (till only 30 to 35% of area is under irrigation). A farmer cannot accurately predict the future outcome of his resource allocation and other entrepreneurial efforts. His prediction would be a subjective assessment of the future based on his and his predecessors experiences. In the absence of assured irrigation the variation in the yield is something which the farmers would not be able to overcome and will have to live with it. The farmers might take several steps to minimise the fluctuation in the yield which might restrict acreage under such crops which are most susceptible to the fluctuation in the yield. Under a given situation of soil,crops and climate complexes,rainfall is an important factor which affects the yield rate of crops. Therefore the producer is always faced with a problem of sorting out production plans and deciding the pattern of resource use.

Price Uncertainty:

Fluctuations in prices of products and of inputs, due to the introduction of commercial crops and the increased monetization of rural economy also brings uncertainty in monetary income of the farmers. Product prices are often of uncertain nature. It is not possible to predict their behaviour very accurately, because the factors which determine the prices are themselves subject to constant change. The examples are the changes in tastes and income levels of individuals over time and space, an almost continuous stream of changes in techniques of production and changes in external trading conditions.[6] *Instability in the prices of output hampers the smooth growth of the agricultural sector and the economy as a whole.*

Technological Uncertainty:

The problem of technological uncertainty is more common in agriculturally advanced regions. In such agriculture the technological aspect of various inputs and the method of application of the techniques keeps on constantly changing due to the ever growing know-how about inputs to which the farmers may not be able to adjust so soon. There is often a time lag in the introduction of the new techniques and its full understanding by the farmers. Therefore the changes in technology and the lack in its adoption by the farmer often leads to uncertainty in the production of both agriculture and non-agricultural sector. This implies that as far as possible, there should be a gradual and sensitive influx of new technology.

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6. *J.W.Mellor."The Functions of Agricultural Prices in Economics Development", IJAE, Vol. 23, 1966, No.1*

1.5 Agricultural Situation in India:

In India, even today the bulk of agriculture is a gamble in the monsoons. With only 30 to 35 percent of area under irrigation, the unreliable and erratic nature of rainfall even today dictates the conditions of agriculture. An overwhelming dependence on weather factors is of tremendous significance in view of the fact that agriculture provides employment to a very large sector of the population. The magnitude or size of the agricultural areas which are subject to a low and instable yield is very well brought out in the [7] Fourth Five Year Plan document (1969-74). It defines dry farming areas as those which receive an annual rainfall ranging from 375 mm to 1125 mm and which have very limited irrigation level. Areas where annual rainfall is below 375 mm are considered as absolutely arid and desert areas and need special attention and specified techniques in order to improve their production. Areas which receive annual rainfall above 1125 mm may be considered to have the same production potential as irrigated areas. Areas where annual rainfall varies between 375 to 1125 mm and possess very limited irrigation facilities, are the dry areas, which suffer from low and uncertain yield. There are as many as 128 districts in the country, each falling under the category of dry farming as defined above and account for nearly 68 million hectares or about a half of NSA of the country.

a) Of these 127 districts, 12 districts already have irrigation covering about 30 -50% of the cropped area. [8] The problem of these districts is no longer that acute.

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7. Govt.of India, Planning Commission, Fourth Five Year Plan 1969-75, pp 182-

8. Since these figures relate to the IV Five Year Plan, Number of districts with irrigation between 30-50% have increased by some number.

b) *Of the remaining, there is another group of 91 districts (spread out mainly in M.P, Gujarat, Maharashtra, A.P., U.P., Haryana and Tamil Nadu) whose annual rainfall varies between 750 - 1125 mm. The NSA occupied by these districts is estimated at about 42 million hectares of which about 5 million hectares are irrigated (11%).*

c) *But the remaining 25 districts in central part of Rajasthan Saurashtra region of Gujarat, and rain shadow regions of Maharashtra & Karnataka belong to a very high intensity dry farming areas wherein railfall ranges between 375 - 750 mm and irrigation is below 10%. These districts account for about 18 million hectares of NSA. Thus even now as we stand at the 4th decade, a sizeable portion of agricultural area is subject to the phenomenon of instability.*

Agriculture in these areas is faced with the twin problem of low yield and high uncertainty. Since the principle source of low and unstable yield invariability is moisture, the remedy is to increase output and minimize the instability by providing irrigation facilities. That irrigation to the extent possible, can be provided would give protection to many of these areas, is borne out by the experience of Punjab, Haryana and U.P., which were highly precarious tracts, frequently affected by farmers before they were provided with irrigation.

A more recent example is that of the Indira Gandhi Canal, formerly known as Rajasthan Canal, in Rajasthan which has transformed parts of Ganganagar,one of the intensely arid districts of the State into a prosperous tract. But unfortunately most of the drought prone areas in the country are unfavourably placed as regards their irrigation potential. Irrigation is a solution to the problem of low yield, does not hold much promise. Therefore, the alternative under such condition is to develop dry farming technology, which would elevate the yield rate and at the same time provide some stability to agricultural output.[9]

Instability being the crucial problem of a large magnitude, number of attempts have been made to study and examine this problem in the agriculture of India. Hence we propose to review some of the studies and note the findings to put our study in a proper perspective

1.6 Studies on Instability in India:

Numerous studies have been undertaken to enquire into the problem of instability in Indian agriculture specifically relating to the drier regions.

Existence of a causal link between growth and variability of agricultural output was first conceived by scholars early in the post-independence period, when growth was largely based on area expansion. S.R.Sen in an address to the 20th Conference of the Indian Society of Agricultural Statistics (1967) put forward

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9. **Govt. of India, Irrigation Commission Report, 1971.**

his dynamic hypothesis that variability increased as cultivation was extended to marginal lands, where production was more susceptible to the fluctuations of weather, and also as the use of fertilizers increased sharply.[10] C.H.H.Rao talking about the situation after mid-Sixties, noted that variability in yields per hectare tended to be far greater than that of area. Therefore, productivity based growth of Seventies has contributed to greater variability in output.[11] Shakuntala Mehra in her study on the instability in Indian Agriculture, points out that there should be more emphasis laid on those elements of a production strategy, that may reduce the conflict between growth and stability (like irrigation). Barker, Gabler and Winkelmann put forward the view point that " **While irrigation** may potentially reduce moisture stress, it is frequently associated with an intensification of crop production and input use which is destabilizing." Their study shows that only expansion of irrigation does not result in greater yield stability. Other inputs must also be given equal importance.

Jatar who has attempted a general analysis of the role of risk and uncertainty in agriculture has tried forcefully to make the point that both elements do not enter into the calculus of most farmers in India, since their production is primarily for home consumption.[12] He sees the relevance of these elements only to the decisions of a wholly commercial farmer (the richer landlords of Punjab, Haryana or Tamil Nadu, dealing in cash crops like sugarcane) producing wholly for the market.

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10. C.H.H.Rao, Technological Change and Distribution of Gains in Indian Agriculture, MacMillan, New Delhi 1975.

11. Shakuntala Mehra, "Instability in Indian Agriculture, Research Report 25, International Food Policy, Research Institute, July'81.

12. S.N.Jatar, Nature and Role of Risk and Uncertainty in Agriculture, IJAE, Vol.XIX, 1964.

An interesting study was made by D.P.Apte in the village Kartaka from Osmanabad district of Maharashtra. He has tried to find out the relation between the crops cultivated and the rainfall, prices of agricultural produce and certain factors peculiar to individual situations which influence the decisions of the farmers regarding the crops to be cultivated. Area under study belongs to the jowar-cotton-groundnut tract. It was noticed that sample cultivatiors made their decisions primarily on two basic considerations. First to achieve as far as possible, self sufficiency in respect to jowar and secondly depending upon the availability of seed to take groundnut or other cash crops. The element of uncertainty in the final result was taken care of by the mixture of urad-mung-bajri-ambedi, which seemed the object of diversification. Another study based on 100 villages in Bangalore district showed that farmers have followed diversification as a means of reducing income variability [13] (Baliga and Tambad).

Factors Minimizing Instability:

Besides studying the incidences of uncertainty in agriculture output,area and yield some studies have also examined the factors causing uncertainty in agricultural output.[14] Misra et al have indicated number of reasons for uncertainties in agricultural production which mainly includes (a) complete specialization and absence of diversification in agriculture, (b) too much dependence on rainfall for its successful production and failure of monsoon results in

13. B.V.S.Baliga, S.B.Tambad, op.cit.
14. Misra, Baidyanath, Dasgupta, M.K.Mishra, Jagannath, "Risk and Uncertainty in Agricultural. Production in Cuttack", IJAE, Vol. XIX, 1964.

drought and crop failures, (c) occurrence of floods in deltaic regions of coastal districts, (d) intensification of maladies in absence of a stable enterprise in the farm plan and (e) selection of more suitable supplementary stable enterprises like dairy, poultry, etc.

As regards the factor promoting stability it is suggested that controlled irrigation would provide stability in agricultural production by ensuring regular and timely water supply. The effect of irrigation on output however would vary from one source to another depending on the efficiency of the water supply. Some sources have a greater degree of stability than others. C.H.H. Rao who has examined the differential impact of various sources of irrigation has observed that water from perennial sources like canal and tube-well which ensure assumed water supply provide more stability in output and yield. While the irrigation through tanks and wells and rainfed water reservoirs which depend on uncertain rainfall lead to more fluctuations in output and yield. Inputs like fertilizers and improved seeds if used under conditions of assured irrigation, accelerate growth with stability, while the rainfed irrigation in low and uncertain rainfall areas could increase the output but also increase variability. In other words, well and canal irrigation(in high and assured rainfall areas), which ensure large quantity of water with assured supply would stabilize the effect of variability on crop production.

On an optimistic note, S.N.Sen, points out that a certain amount of instability is unavoidable in agricultural production even in the regime of upto date technology and efficient resource

use behaviour of farmers. This is because agricultural production can never be completely isolated from the operation of weather hazards. In other words a fair degree of stability in agriculture can be created by providing adequate means of irrigation, provision of marketing facilities and credit institutions, putting farming on a sound economic footing through establishment and improvement of cooperative organisation, improvement in physical supplies of superior inputs of production.

1.7 Instability as an Important Feature in Karnataka Agriculture:

The state of Karnataka which is the area of our study is chosen for few specific reasons. The agricultural economy of Karnataka is still largely governed by the natural rainfall which is low and highly variable over large parts of the State.The low and uncertain rainfall accompanied with low level of irrigation has made Karnataka a typical example of unstable agriculture in India The irrigation facilities cover only 15% of the cultivated area as against 78% in Punjab,46% in Tamil Nadu and about 27% of an area in a country as a whole. In the absence of adequate availability of irrigation the dominant factor which affects the agricultural economy is the rainfall in its regime amount and variability. In the regional distribution the districts on the windward side of Western Ghats have maximum rainfall whereas those on the leeward side loose out on the bulk of moisture. Interior Karnataka is plagued with low rainfall and also low irrigation. Apart from the regional variation in the annual rainfall equally important is the seasonal regime of rainfall in Karnataka. Bulk of the total rainfall occurs during the month of June to September and the

rest is received in part between November to January. The periodic character put great restriction on the cropping pattern of the State. Yet another vital aspect of the rainfall in Karnataka is its sharp variability, the rainfall does not arrive on time and it often ends too early or abruptly. There are prolonged breaks and the annual amount varies markedly from year to year. This is the main factor that really gives instability to Karnataka agriculture especially in the drought prone part of the State. As a matter of fact Irrigation Commission of 1972 had identified as many as 88 taluks of 12 districts (out of the total 19 districts) as drought prone area in the State which covers a sizeable portion of geographical area and population of the Karnataka State.[15] Thus the low and highly variable character of rainfall with a low level of irrigation which is also dominated by less efficient sources (of irrigation) such as rainfed tank and well, has injected a considerable amount of instability in the agricultural economy of the Karnataka State and therefore made it an amicable and interesting case for the study particularly from the point of view of instability. In view of this our main purpose in the study is to examine in greater detail the phenomena of instability in agricultural output yield and area in the State of Karnataka.

1.8 Objective of the Study:

The specific objectives of the study are as follows:

a) To examine the annual fluctuation in the aggregate output

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15. Ministry of Irrigation & Power, New Delhi " Report of the Irrigation Commission 1972, Vol.I, page 166."

area and yield at the state and regional level and to bring out the regional differences over a period of eighteen years viz.1958-59 to 1977-78.

b) To examine the fluctuation in output area and yield of few important crops in the State and the regions.

c) And finally to find out association between the area and yield some of the environmental and technological correlates (factors) at State, region and at the level of the individual crops.

1.9 Methodology and Statistical Techniques:

As mentioned earlier the main purpose of the present study is to examine the fluctuation in output area and yield and to find out the possible environmental and technological and other correlates of fluctuations. Keeping in view this objective an appropriate methodology and statistical techniques have been developed and used in order to bring out the meaningful results.

Forming Homogeneous Region:

The annual fluctuation in various elements of agriculture cannot be properly studied at state level alone, mainly because of the inter-district variation in the rainfall within the State. The spatial variation in the amount, regime and variability of rainfall within the State had led to diverse regional structure with regard to instability in the State. Therefore, a regional analysis which is essential under such situation would be meaningful provided we formulate the regions which would be fairly homogeneous units with respect to level of the rainfall. Analysis based on such a homogeneous unit would eventually bring out the variation in fluctuation between the regions (particularly between low and high rainfall region) and also provides information

regarding the variation within the region. Karnataka State comprises of nineteen districts wherein the normal rainfall varies from 225 mm in order to 3500 mm in South Kanara. For the reasons stated above, these nineteen districts are grouped into four sub-regions based on the normal rainfall.

The regions thus formed are as follows:

* Region I	Rainfall	less than 600 mm
* Region II	Rainfall	600 mm to 1000 mm
* Region III	Rainfall	1000 mm to 2000 mm
* Region IV	Rainfall	2000 mm and above.

As per the scheme of regionalisation based on **rainfall** comes under Regions I, II, III and respectively.while the region I which is described as areas of lowest rainfall(600 mm) lies mostly in the north-eastern part of the State; the Region II which encompasses areas between 600 mm and 1000 mm of normal rainfall lies specifically in the southern belt. Region III (1000 mm to 2000 mm) covers the north-southern part and the Region IV which is described as highest rainfall area (2000 mm and above) covers the coastal belt, that is track on windward side of the western ghats.

1.10 Statistical Methods

Keeping in view the nature of the analysis, a package of relevant statistical techniques has been used. As mentioned earlier, the purpose of the study is two fold, namely (1) study the fluctuation in the area, output and yield and (2) to find out the association between the fluctuation in area, output and yield in the factor such as rainfall, irrigation, sources of irrigation, fertilizers use, etc. In addition to estimation of level of variability with the help of standard deviation

and coefficient of variation. We have also derived the trend deviation in area, output and yield. In brief,it is essentially a term series analysis intended to examine the fluctuation and changes over eighteen years period, starting from 1959-60 to 1977-78.

Measurement

The trend deviation which are also called as short term deviation and depict the yearly ups and downs are deviation between annual values and trend values, the trend value being the three year moving averages of each series. The absolute trend deviation and the same in percentage form are calculated as follows:

Absolute trend deviation = Trend value - Annual value

$$\text{Percentage deviation from trend} = \frac{\text{Annual values} - \text{Trend value}}{\text{Annual values}} \times 100$$

It may be noted that the trend deviation are calculated for aggregate output, area and yield for the state as a whole, for the region and for the individual crops in the State and in each of the regions.

Correlation Analysis

As mentioned earlier, to find out the association between the fluctuation in the output, yield and area and some relevant inputs is one of the objectives of the present study. To work out the association between two sets of variables depending on the availability of data, the following variables are finally selected for the purpose of analysis:

1. Annual rainfall	Absolute annual rainfall in mm
2. Irrigation level	Percentage of area under irrigation

3. Source-wise irrigation	%-age of area under canal to gross area irrigation
	%-age of area under well to gross area irrigation
	%-age of area under tank to gross area irrigation.
4. Fertilizer	Consumption of chemical fertilizer per hectare.
5. Area under HYV	%-age of area under HYV seed

The variables number 2 - 4 are calculated separately for the state, the regions and the individuals crops.

1.11 Data Base

The study is based on secondary data, published by different officials and agencies. Major publications consulted were as follows:

1, Statistical abstract of Karnataka published by the Government of Karnataka.

2. Season and Crop Reports of Mysore State published by the Government of Karnataka.

3. Fertilizer Statistics published by Fertilizer Association of India.

CHAPTER II

AGRICULTURAL ECONOMY OF KARNATAKA

In this Chapter, we attempt to study some of the important agricultural aspects concerning instability in Karnataka State, which mainly includes the agro-climatic frame work and temporal behaviour of certain relevant parameters. The present enlarged State of Karnataka came into existence on the Ist of November 1956, under the States Reorganization Act. Karnataka in particular is one of the oldest parts of the earth's encrustations, the rest of India being comparatively recent. This State is situated in the Western part of the Deccan Plateau and is a maritime State. Stretching between 11.5^{0} and 19^{0} north latitudes and 74^{0} and 78^{0} east longitudes. Karnataka can be said to be a typically tropical area. With a total area of 1,92,204 sq.kms. and a population of 3,70,43,451 (1981), Karnataka is the 6th largest State in terms of area and 8th in terms of population. The State is bounded by Maharashtra in the north and Goa and Arabian sea in the west.Its southern and eastern boundaries are defined by Kerala, Tamil Nadu and Andhra Pradesh.

2.1 PHYSIOGRAPHY

Karnataka has been termed as a rocky rhomboidal structure. It is a table land situated in the angle, where the eastern and western ghat ranges converge into the group of Nilgiri hills. Mysore plateau or the Maidan lies on this table land, the monotony of which is broken by a central chain of hills.

Western ghats or an unknown wall of precipitous hills and extend for about 400 kms. along the Arabian sea coast. The ghats have a steep scarp facing the coast and gentler slopes to the east. A set of isolated hills running in the north-east direction forms the eastern ghats. A set of hills running in the north-south direction forms the central ranges, also called Ramragh-Rayadurga Range, runs for about 400 kms.

Physiographically the State may be divided into 3 regions - (i) Coastal Plain, (ii) Malanad and (iii) Maidan.

Coastal Plain

This lies in the extreme west of the State. Width of this plain varies from 12 64 kms.from north to south. It is about 320 kms. long. Elevation of the plain barely reaches 120 mts. This low land region of the western coast is traversed by several transverse ridges and spurs of the western ghats. Soils are laterite except in isolated stretches near the sea where alluvium is found. Region receives very heavy and assured rainfall which exceeds 2500 mm. Dominant crop is rice.

Malanad

It is essentially a hilly country and forms the eastern boundary of the coastal plains. It extends all the way from north-south and varies in width from 45 - 100 kms. Southern half is distinctly different in physiography from the plateau and reaches elevation varying from 940 mts - 1250 mts. At places a height of 1275 to 1950 mts is not uncommon. Terrain is mostly undulating, broken up by chains of rocky hills and scarred by deep ravines. This region is known for its

luxurious vegetation evergreen and colourful as usual as productive plantation. Heavy rainfall, heavier on the western slopes and far lower on the leeward eastern slopes, come in prolonged heavy showers specially in July - August. Western slopes get around 2500 mm of rainfall and declines to about 1000 mm on the eastern slopes. Variability of rainfall is more than 25%. Soils are latenitic and are leached, nevertheless they are of average fertility. Main cfop is rice.

Maidan

Extends from Bellary in the north to Mysore in the south and is not a plain as the term Maidan implies. It constitutes a gently undulating plateau criss crossed by innumerable non perennial valleys, flat and broad. In between these are the summit plains (erosional remnants of the still higher ridges and mountains). There are however marked differences between the northern and southern halves of the regions.

(a) **Northern Maidan** lies to the east of Malanad and stretches to the northern and eastern boundary of the State. It is extensively a sloping eastwards. Area is drained by Krishna, Bhima and Tungashardna along with their tributaries. Annual rainfall varies from 400 mm in the north to 900 mm in the northeast. Rainfall is not dependable and the prevalence of droughts and scarcity conditions is a rule rather than an exception. Whole area specialises in dry farming except in areas where new irrigation facilities have now been made available. Landscape is covered with rich black cotton soil. Soils have retentive moisture character and are of average fertility. Jowar and cotton are the main crops of the region.

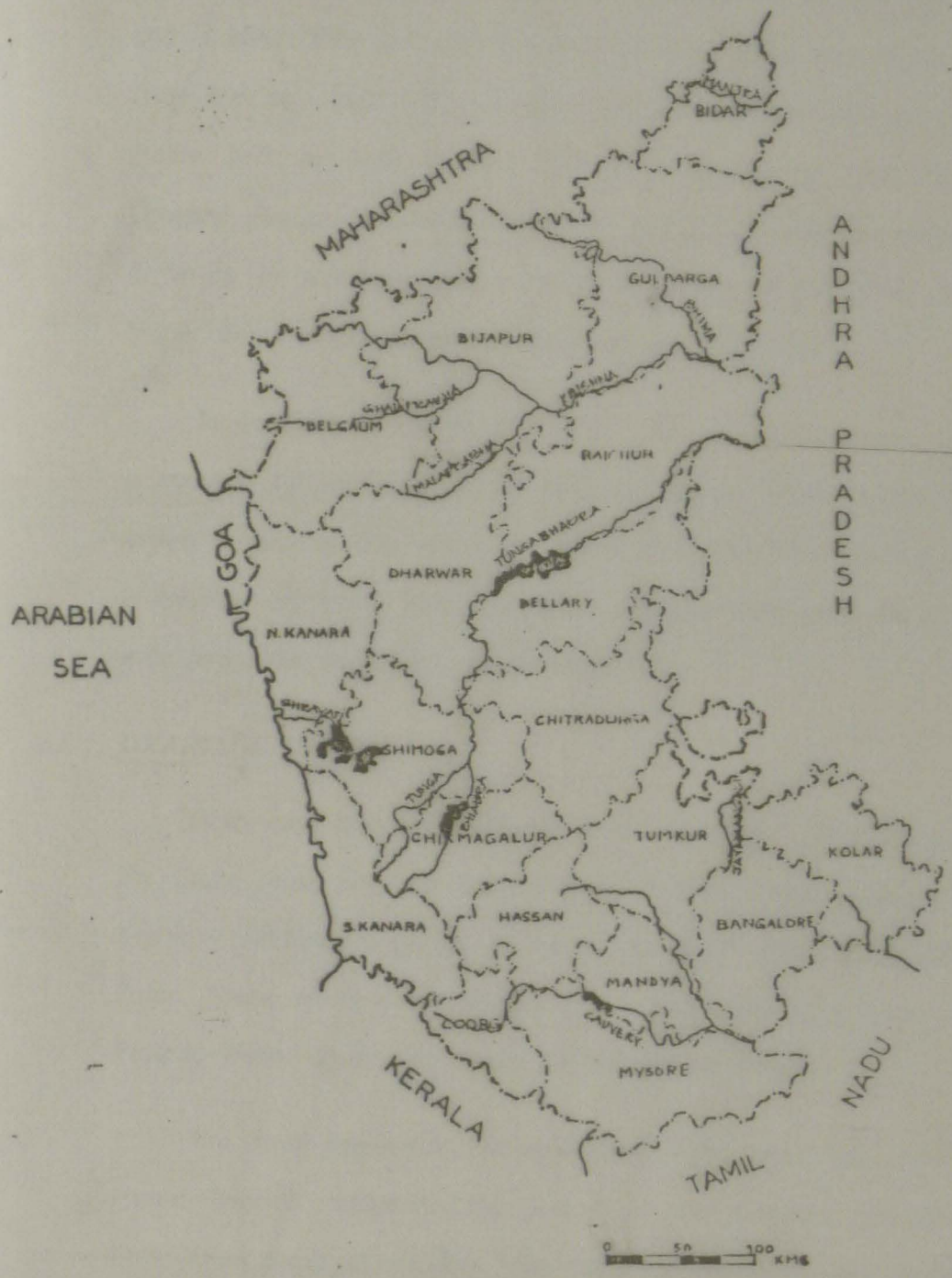
KARNATAKA : Drainage.
MAHARASHTRA
ANDHRA PRADESH
GOA
ARABIAN SEA
KERALA
TAMIL NADU
BIDAR
GULBARGA
BIJAPUR
BELGAUM
RAICHUR
DHARWAR
BELLARY
N.KANARA
CHITRADURGA
SHIMOGA
CHIKMAGALUR
TUMKUR
KOLAR
S.KANARA
HASSAN
BANGALORE
MANDYA
MYSORE
0 50 100 KMS

FIG.-2.1

*b) **Southern Maidan** forms the core of the State and consists of the original 9 districts of the erstwhile State of Mysore. Northern part of this sub-region is more monotonous than the southern part and is about 690 mts. Western and southern parts are higher generally from 905 to 1125 mts. There is an uninterrupted but clearly identifiable belt of high ground. Region dissected by the Tungabhadra, Cauvery, Pennar and Palar rivers. Divided into nemerous valleys, widely differing in size and shape. Rainfall is around 600 mm. Only some higher parts in the west and south get over 750 mm.*

In contrast to the black soils of the northern Maidan, this region is marked by red soils, which are less fertile. Ragi is the main crop grown (requiring less water than rice but more than jowar), groundnut is another dry crop. Wet crops like rice and sugarcane are grown, wherever irrigation facilities are available.

2.2 DRAINAGE SYSTEM

Both east and west flowing rivers from the drainage. System of the State, east flowing rivers can be further divided into a drainage basins - Krishna, Cauvery, Godavari, North Pennar, South Pennar and Palar. There are 3 water divides in the State, Western Ghats, Southern Plateau water divide and North Eastern Water divide.

The first separates the regions of the west and east flowing rivers. Second separate the waters of the Cauvery and Pennar and Palar from those of Krishna. The last one separates the Krishna from the Godavari basin. Nevertheless the Krishna and Cauvery dominate the scene to the east of western ghats.

The main tributaries of Krishna in Karnataka are Bhima, Kusua and Tungabhadra, Cauvery is perhaps the first river in terms of the utilisation of water for irrigation and Pennar development. Important west flowing rivers are the Kali and Sharavathi. The latter rises in Shimoga, crossing the crest line of the western ghats, giving rise to the famous Jog falls. In the extreme northeast Godavari cuts Bidar to flow into Andhra Pradesh.

Cauvery with all its 6 tributaries drains the southern part of the State and in fact forms the economic life stream of the southern region. Canal irrigation in this part of the State is the result of the perennial flow of water in Cauvery.

2.3. CLIMATE

Climate exercises a profound influence on farm work as well as crop growth. Success of family is very intimately linked up with the prevailing climatic conditions. Karnataka is a moderately rainy State. The success of agriculture in this State depends mainly on the timely onset, proper amount and suitable distribution of monsoon rains in the season. Rainfall in Karnataka is rather uneven. It varies from 552.8 mm in Bijapur to 3932.4 mm in South Kanara. On the whole, the coastline and Malanad receive heavy rains.

Karnataka receives rain from the south-west monsoon between June and September. It strikes the coast and brings heavy rainfall. Relief plays a vital role in the distribution of rain in this season. Monsoon winds after crossing the ghats, have to desend and hence their capacity to hold moisture increases. As a result the rainfall on

KARNATAKA: Regions.

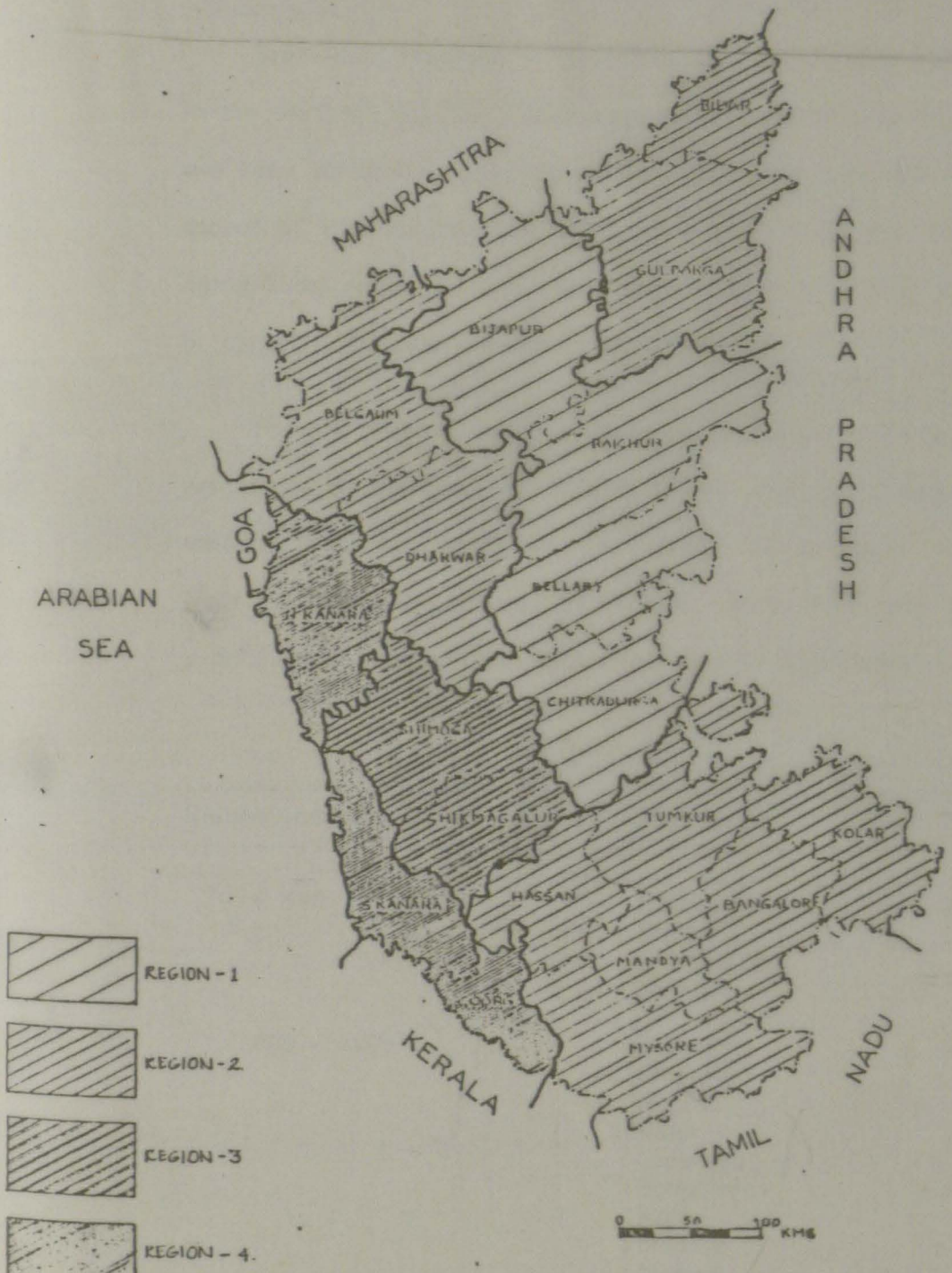

FIG-2.2

the eastern slopes and beyond to the east decreases rather rapidly. Mangalore (south Kanara)gets 3870 mm of annual rainfall, while Hassan on the other side of the ghats gets only 1070 mm. Rainfall in the southern part of the coastal and Malanad regions is heavier.

South-east monsoon in November produces widespread rain mostly in the southern Maidan. These rains are, however, not very dependable and their variability increases as one goes from south to north. Another aspect of vital concern is the sharp variability of the rainfall in the agricultural season.It does not arrive in time and may end too early or abruptly. Prolonged breaks are common.

For the present study we have regionalised the State of Karnataka essentially on the basis of rainfall (along with other agriculture parameters). This has been done by taking the averagxe rainfall values from the period of 1952-53 to 1977-78, i.e. a time span of twentyfive years. The following table shows the rainfall distribution:

Table 2.1

Rainfall amount (mm)	District	Region
C 600	Bellary Bijapur Chitradurga Raichur	I
600 - 1000	Belgaum Dharwar Hassan Bidar Gulbarga Bangalore Kolar Mandya Mysore Tumkur	II

1000 - 2000	Chikmagalur Shimoga	III
> 2000	Coorg N. Kanara S. Kanara	IV

According to this scheme of regionalisation four districts fall under Region I, which lie to the east of the State particularly in the areas of northern maidan. Region II comprises of 10 districts which have rainfall between 600 - 1000 mm. This include Belgaum, Dharwar and Hassan and part of the north maidan(lowest rainfall in this category). The rest of the 5 districts formulate the south Maidan and have moderate rainfall. In this category areas closer to 1000 mm of rainfall are covered in Malanad.

Chikmagalur and Shimoga are situated in the border areas of south Malanad and have heavy rains between 1000 - 2000 mm. These two distrits constituting region III have been separated from the 3 districts of region IV, mainly so due to the heavy amount of rainfall viz. more than 2000 mm, sometimes going beyond 3800 mm in south Kanara. These three districts constitute the coastal plains and lie on the windward side of the west ghats, thus coming under the direct influence of the southwest monsoon, before it crosses the western ghats.

2.4 SOIL

Karnataka possesses 5 main groups of soils from the point of view of agriculture:

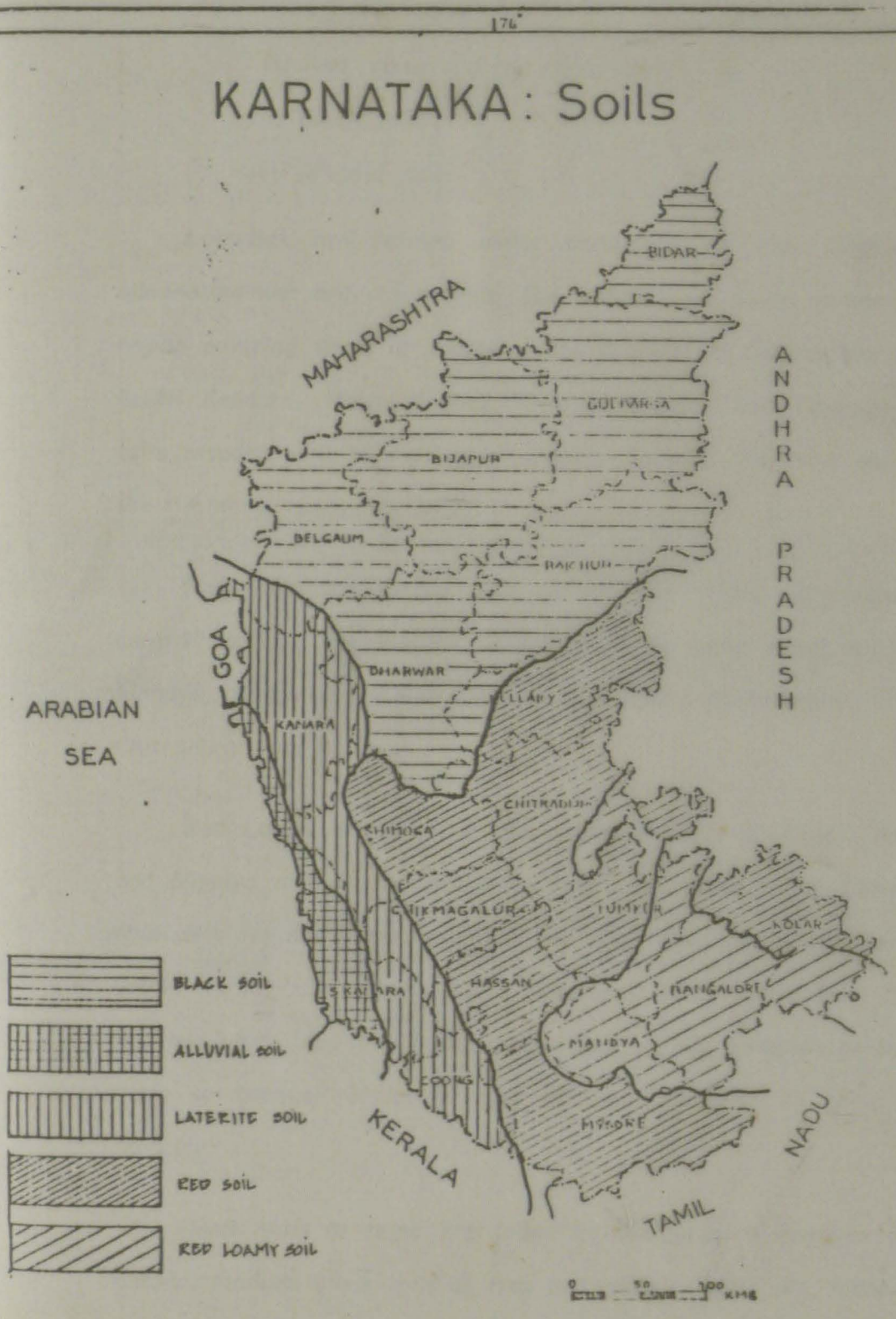
KARNATAKA : Soils
MAHARASHTRA
ANDHRA PRADESH
BIDAR
GULBARGA
BIJAPUR
BELGAUM
RAICHUR
GOA
DHARWAR
BELLARY
KANARA
CHITRADURGA
SHIMOGA
CHIKMAGALUR
TUMKUR
KOLAR
HASSAN
BANGALORE
MANDYA
MYSORE
KERALA
TAMIL NADU
ARABIAN SEA
BLACK SOIL
ALLUVIAL SOIL
LATERITE SOIL
RED SOIL
RED LOAMY SOIL
0
50
100 KMS

FIG-2.3

i) Laterite soils

ii) Red loams and red sandy loams

iii) Black soils

iv) Alluvial soils

Laterites are formed under conditions of high rainfall with alternating wet and dry periods. The laterites are found in the Malanad region covering whole or poarts of the districts of Chikmagalur, Shimoga, South Kasnara, North Kanara, Coorg, Belgaum and Dharwar. These soils respond well to cultivation, mainly because they are porous and their mineral content is high.

Red Soils are spread over almost the whole of southern and central parts of the Maidan. Districts falling under these are Mysore, Mandya, Bangalore, Kolar, Tuamkur, Hassan, Chikmagalur, Shimoga, Chitradurga and Bellary.

Red Loams are found in the southern parts of Kolar, Bangalore and Mandya and on the eastern margins of Tumkur and Chitradurga. Red soils are not water retentive and allow the moisture to evaporate rather rapidly. In many places, specially where irrigation facilities are available, they can match any other soil in productivity but it is more so because of better soil management than of their natural fertility.

Black soils or regur are found in the northern districts of Karnataka. Medium black soils of trap and gnassic origin are found extensively in the districts of Bidar, Gulbarga, Bijapur, Belgaum, Dharwar and Bellary and also in Chitradurga, Tumkur, Mysore and Mandya.

Regurs or deep black soils of the valleys are found in Krishna and Tungabadra valleys in the districts of Bijapur, Raichur and Dharwar. These soils are fertile and give a good yield of cotton, jowar, wheat and chillies. With an assured water supply, they can well support the cultivation of rice as well as sugarcane. They give good yields despite continued cultivation without propoer manuring.

***Alluvial soils** are found in the valleys of the Krishna, Tungabadra and Cauvery valleys and also in the coastal plains. These soils are mostly transported and contain alternate layers of sand and silt. They are extremely fertile and yield good crops of paddy, sugarcane and cotton, vegetables and fruits, where irrigation and proper manuring are practised the crop out turns are high saline and sandy soils are found in parts of north and south Kanara.*

2.5 OUTPUT AND INPUT USE

Agricultural growth forms an integral part of a continuous process of economic development of Karnataka's economy. The total geographical area of the State is about 192 lakh hectares of which about 113 lakh hectares (viz.60%) is available for cultivation in 1970-71. We noticed , however, significant variations in the land use pattern among the different regions of the State. Relatively speaking, the ratio of land under cultivation to total area is higher in north maidan than in any other region. The Malanad and coastal regions have less land under cultivation and the southern maidan falls somewhere in between these two extremes. Forested land is more in Malanad and coastal regions. Thus it appears that in these regions there is only a marginal scope for bringing additional land under cultivation.

TABLE 2.2

('000 hec)

CROPPING PATTERN IN KARNATAKA(3 year averages)

	1960-61		1975-76		% age change
	Area	%	Area	%	1960-61 to 1975-76
Total geographical area(Reporting)	18925	-	18924	-	-0.005
Net sown area (% to TGA)	10228	54.04	10013	52.91	-2.10
Gross cropped area(% to TGA)	17037	58.32	11302	59.72	2.40
Cropping intensity	107.91	-	112.87	-	4.59
Wheat	283	2.57	371	3.28	31.09
Rice	1115	10.11	1318	11.67	18.21
Jowar	3005	27.23	2703	23.92	-10.05
Ragi	779	7.06	899	7.96	15.02
Bajr a	760	6.89	717	6.38	-5.65
Foodgrains	6449	58.43	6148	54.39	-4.66
Cotton	1131	10.01	1091	9.89	-3.54
Sugarcane	96	0.84	128	1.13	33,33
Groundnut	927	8.39	954	8.44	2.91
GCA	11037	100	11302	100	

Source: 1. Seasons and Crop Reports of Karnataka (1959-60, 1960-61, 1961-62) Published by Govt. of Karnataka
2. Statistical Abstract of Karnataka (1974-75, 1975-76, 1976-77) published by Govt. of Karnataka.

Cropping Pattern

Table 2.2 shows the area under different crops and also the changes in their area during two periods of time namely 1960 and 1976. In 1960 (Period I) about 10,228 thousand acres was put to agricultural use (i.e. about 54% of geographical area). Between 1960 and 1975 the net sown area, both in absolute and percentage term has not shown much expansion. The gross cropped area however has increased by about 2.40% during the period under study. Due to the near stagnency in the net sown area, more emphasis appeared to have been placed on intensive rather than on extensive cultivation. This fact is very well brought out by increase in the cropping intensity which has gone up from 107% in 1960-61 to 112.87% during 1977-78 (by about 4.89%).

The cropping pattern of the State is mainly dominated by a few foodgrain crops along with a few non-food grain crops. Important among the foodgrain crops are rice, jowar, wheat, ragi and bajra which take up almost 54% of the existing area under foodgrain crops. During period I (1960) jowar accounts for maximum area under cultivation (27.23%), followed by rice (10.11%), ragi (7.06%) and bajra at (6.89%), wheat occupy a smaller proportion of area(2.57%). Among the cashcrops, cotton occupied about 10.10% of the total cropped area, followed by groundnut and sugarcane.

During the second period (viz.1977) relative importance of the crop has not changed much, jowar continues to occupy the maximum area followed by rice, bajra,ragi, and cotton and groundnut among the cash crops. However, between 1960-61 and 1977-78 some important changes have taken place in the proportion of area occupied by

few crops. For instance, the proportion of area under foodgrain crops has experienced a decline from 58.43% in Period I to 54.39% in Period II, indicating an overall decrease by 4.66%. This decline was mainly caused due to the fall in the area under jowar and bajra, the decline in the case of jowar was, however, quite pronounced. Among the cash crop, cotton, has also witnessed some decrease in its cropped area. As against this wheat , rice, ragi and sugarcane and groundnut among non-food grain crops have experienced a substantial increase under their area. This increase was particularly high in the case of wheat (31.09%), sugar cane (33.33%), followed by rice (18.2%) and ragi (15.2%) while an increase in the case of groundnut was marginal.

Thus during 1960-61 and 1976-77 wheat, rice and ragi among the foodgrain crops and sugarcane among the no-food grain crops have shown a significant expansion in their area than other crops. Obviously an increase in the area under these crops has a crushing effect on the area under jowar. From this result, it is clear that there has been a gradual tendency of increase in areas under the crops which have come under the influence of new technology such as HYV and a decline in the area of traditional crops such as jowar and bajra. In the case of cash crops it appears that area under sugarcane has been expanding at the cost of other important crops mainly cotton.

Input use in Karnataka Agriculture

Agricultural development in the State would depend on the enhancement of yield rate from the existing land mainly through the use of irrigation and other new inputs such as fertilizers and high

('000 hec)

TABLE 2.3

GROSS CROPPED AREA, GROSS IRRIGATED AREA, PERCENTAGE OF GROSS IRRIGATED AREA TO GROSS CROPPED AREA IN KARNATAKA

Yer	GCA	GIA	%
1959-60	11033	159	1.41
1960-61	11035	203	1.84
1961-62	11043	306	2.77
1962-63	11073	449	4.05
1963-64	11113	553	4.97
1964-65	11135	617	5.54
1965-66	11177	932	7.38
1966-67	11167	1166	10.44
1967-68	11189	1256	11.22
1968-69	11212	1442	12.86
1969-70	11239	14.89	13.25
1970-71	11258	1539	13.67
1971-72	11243	1622	14.42
1972-73	11214	1631	14.54
1973-74	11201	1821	16.25
1974-75	11301	2053	18.16
1975-76	11314	2116	18.70

Source: 1. Season and Crop Report of Mysore State, Govt. of Mysore (1959-60 to 1965-66)
2. Statistical Abstract of Karnataka (66-67 to 77-78)

yielding varieties of seeds. Over the last twenty years, in order to raise the production level and to provide stability to agriculture, the state has tried to expand the irrigational facilities and the use of other inputs. Irrigation being the crucial input (as the larger portion of land is covered with low and erratic rainfall), we would first examine the development of irrigational facilities in the State.

Irrigation

Irrigation increases the yield per hectare, changes the cropping pattern in favour of cash crops, allows the land to be used for raising more than one cropo in a year and all these put together increases in the income of the farmers. High variability of rainfall and occurrence of frequent droughts demand extensive use of irrigated water in Karnataka.

From table 2.3 one can get a clear idea as to the level as well as progress of both gross cropped area (GCA) and gross irrigated area (GIA) in the State. The government of Karnataka had decided to bring at least 25% of the area under irrigation by the end of this period. The percentage of gross cropped area clearly brings out an increasing trend from as low a figure of 1.4% in 1960-61 to 18.70% in 1975-76.(There was a marginal increase in irrigated area thereafter) indicating nearly eighteen times increase over the eighteen years. The irrigation intensity has also enhanced from 150.20 in 1960-61 to 174.47 in 1975-76. Notwithstanding this progress in irrigation base yet the figure of 18.70 was much below the targeted level of 25% and in fact it was nowhere near to the national average and for

TABLE 2.4. ('000 hec)

IRRIGATION IN KARNATAKA AT STATE LEVEL FOR 2 PERIODS

	1960-61		1975-76		% age changes
	Area	%	Area	%	
Gross cropped area(GCA)	11037	-	11303	-	2.41
Gross irrigated area(GIA)	222	2.00	1996	17.70	799.09
Net irrigated area(NIA)(% to NSA)	146	-	1144	11.42	683.56
Irrigation intensity(II)	150.20	-	174.47	-	16.16
Sources ofirrigation					
Canal	46	31.50	435	38.06	845.65
Tank	63	43.83	350	30.59	455.55
Well	24	16.43	281	24.63	1070.83

Source: Season and Crop Report of Mysore State, Govt. of Mysore(1959-60,1960-61 and 1961-62)
Statistical Abstract of Karnataka, Govt. of Karnataka(1966-67 to 1977-78)

TABLE 2.5

NEW INPUT USE : FERTILIZER AND HYV AT STATE LEVEL

	Fertilizer consumption		HYV/area			% of HYV to foodgrains		
	Total	per hec	Total	Rice	Jowar	Total	Rice	Jowar
1968-69	102	9.11	32	21	11	0.49	1.88	0.36
1976-77	146	12.95	952	491	461	1.54	37.25	17.05
%-age change	43.13%	42.15%						

Fertilizer ('000 tonnes) total , consumption per hectare - kgs/hec.
HYV area in/'000 hec

Source: Fertilizer Statistics of India 1966-67 to 1977-78

State like Punjab, Haryana and Uttar Pradesh. Due to this low irrigation base, most of the agricultural area continues to depend on natural rainfall which is low and uncertain on most of the part of Karnataka State.

Situation with regard to the sources of irrigation is also not comfortable. During Period I (table 2.4),tank irrigation accounted as much as 43.83% of grossed area under irrigation, followed by canal (31.50%) and well (16.43%). The tank irrigation is typically of drier areas and snipped to less efficient source of irrigation in farm time and amount of water available,. During Period II, however, canal irrigation indicated slightly higher percentage of area under irrigation (38.06) than tank(30.59) and well accounted about 24.63% of grossed irrigated area. So tank irrigatiaon still continued to share about one third area and to an extent it lifts the agriculture to water uncertainties which are associated with this source of irrigation.

Use of new inputs

a) Fertilizers use

In the State there is an increasing awareness of the importance of chemical fertilizers for boosting agricultural production. But the level of consumption of fertilizers is still very low as compared to national average. Table 2.5 gives a picture regarding the fertilizer consumption in Karnataka over two periods of time. Year 1966-67 has been taken as the initial period as use of chemical fertilizers and HYV came to the State only when these new agricultural input were first put to use in that year.

The consumption level in terms of nutrient (NPK) has increased from 102 thousand tonnes in 1966-69 to 146 thousand tonnes in 1974-77, showing a percentagxe change of 43.13%. Similarly the poer hectare consumption in the State has increased from 9.11 kgs in 1966 to 12.95 kgs in 1976-77 which is less than the national figures of 11.40 kgs and 17.93 kgs per hectare in the respective years.

It is thus clear that though there has been some increase in the use of fertilizer per hectare since 1966 the level is still low and below the national average and hence the State has a still long way to go as far as use of this very crucial input is concerned.

b) High Yielding Varieties

Importance of HYV for increasing agricultural productivity per hectare has been well recognised in the State. So far only HYV of rice and jowar have been actually tried since 1966. Other crops have also switched over to the use HYV seeds but it occupied a very small proportion in their cropped area.

Table 2.5 shows the acreage and percentage of area under HYV for jowar and rice in the State. These two crops constitute almost 95% of total area under HYV in the State. In 1967-68 about 1.88 and 0.36 percentages of area was put to HYV use under rice and jowar respectively. In 1977-78 this pcrcentage has gone up to 37.25 and 17.05 for wheat and jowar respectively. Thus the increase in the area under HYV seed was much larger in the case of wheat compared with jowar. Table also indicates that although there has been a rapid expansion in the areas under HYV nonetheless the actual coverate is very small especially compared with the national average

TABLE 2.6

CHANGES IN AREA, OUTPUT AND YIELD FOR THE STATE AT 2 PERIODS OF TIME

Crops	Area('000 hec)		Out ('000 tonnes)		Yield kgs/hec		Percentage charges		
	Pd.I	Pd.II	Pd.I	Pd II	Pd.I	Pd.II	Area	Output	Yield
Rice	1115	1318	1393	2197	1249	1667	18.20	57.71	33.46
Jowar	3005	2703	1148	1508	382	557	-10.05	31.35	45.81
Ragi	779	899	792	1016	1124	1124	15.02	27.65	10.63
Bajra	760	717	112	262	147	365	-5.65	31.25	148.30
Wheat	283	371	170	241	247	649	31.09	41.76	162.75
Foodgrain	6449	6148	3974	6815	616	1108	-4.66	71.49	79.87
Cotton	1131	1091	410	1627	362	1491	-3.54	296.83	311.87
Sugarcane	96	128	5158	9586	5372	7489	33.33	85.84	39.40
Ground nut	927	954	479	559	516	586	2.91	16.70	13.56

and with some of the State like Punjab, Haryana and Western UP. Due to low level of HYV use, which was constrained by meagre availability of irrigation, the net impact of this on the total output in the State has been marginal.

Changes in Area, Output and Yield

Having examined the pattern of input use, let us now look at the changes in area, output and yield in the State over two periods of time.The changes in area have already been discussed in the section on the croping pattern, nevertheless in order to relate the changes in area with those of output,even at the cost of repetition,we would briefly mention about the same. Table 2.6 shows the changes in area, output and yield between 1960-61 and 1977-78. As noted earlier the area under rice, ragi and wheat among food-grains has increased, while that under jowar and bajra has experienced a significant decline. The decline in area under these two crops was so significant that it lead to a overall fall in the total area under food-grain crops Among the non-food grain crops, sugarcane and to some extent ground nut has gained in area but it did so at cost of loss of area under cotton.

Coming to yield rate, the analysis of change would essentially bring out the role of yield affecting factors, specific to certain crops. Table 2.6 indicate that among the foodgrain crops, the percentage changes in the yield rate was significantly higher for wheat and bajra, followed by jowar and rice and low in the case of ragi. The rate of increase was strictly high under wheat and bajra, being 162.75% and 148.30% respectively. The percentage increase was 45.81, 33.46 and 10.63 for jowar, rice and ragi respectively Among the non-foodgrain crops, the percentage increase in yield rate was remarkably

higher for cotton, followed by sugarcane and groundnut. It may be noted that none of the crops has experienced a decline in its yield rates during the period under study.

The performance of agriculture in any State is essentially reveal by the progress on output front. Table 2.6 bring out some interesting aspects regarding the changes in the output of different crops. As is clear from the table the foodgrain crops has indicated a considerable increase in their output. However, the main increase in output seems to have come from rice and wheat which is followed by jowar and bajra. It is particularly important to note that the rice and wheat which have come under the influence of new agricultural technology have shown a better performance with regard to increase in output. The output under rice and wheat has increased by 57.71 and 41.76% respectively during 1960-61 and 1977-78. It is definitely high compared with jowar and bajra which have shown about 30% rise in their outpout level during the whole poeriod of eighteen years.

Among the nonfood grain crop, the percentage increase is remarkably high in the case of cotton, almost four times higher than the output level of 1960-61. Increase in the output of sugarcane was also noteworthy. Output rise in the case of groundnut was, however, very marginal. On the whole, it appeared that the minor crops like rice, wheat, cotton and sugarcane has shown a better performance compared with the main and traditional crops of the States such as jowar, bajra, ragi and groundnut.

Having examined the changes in area, yield and output, it would not be out of place to inter-relate the changes in output with

those of area and yield. Strictly speaking our results could indicate or estimate the relative share of area and yield in the growth of outpout , however, we could definitely describe the direction of change in the output in relation to the direction of changes in area and yield rate in the different crops. From the table 2.6 it is clear that increase in the output of jowar, bajra and cotton has been only due to increase in the yield rate alone as the area under these crops has declined. As against this, the increase in the output of rice, wheat, groundnut, sugarcane and ragi has been due to both the expansion of area and yield, the rate of increase in the yield however has been more strong and pronounced than area under rice, wheat, groundnut and sugarcane. The area and yield effect seem to be nearly the same under ragi and sugarcane.

From the foregoing analysis it is clear that the level of development in the State is fairly low. The productivity level in the State is often punctuated by wide year to year fluctuation. Further, there has not been much progress in the front of new technology, the areas under HYV (of rice and jowar) is rather low. The major factor that has been adversely affected agricultural production in the State is the low and irregular rainfall which creates instability in agricultural production. In this situation irrigation becomes a crucial factor against irregular rainfall. However, even if the full irrigation potential is utilised in the State, the reality is that a large portion of cultivated area is going to remain under dry condition exposed to the varies of natural rainfall. Unless something is done on the front of the dry farming technology, the agriculture will continue to suffer from the problem of instability. It is this aspect of instability that we are going to examine in greater detail in the next three Chapters.

CHAPTER III

LEVELS OF VARIABILITY IN AREA, OUTPUT AND YIELD

In this chapter our main purpose is to examine and analyse the pattern of variability in the cropped area, output and yield at the State and at the level of the region, and in the process note inter-regional variation, if any. The variability has been studied in both absolute and relative terms. For the former, a measure standard deviation has been made use of, while for the latter, the co-efficient of variation has proved quite handy. An analysis of the levels of variability in output, area and yield for the State, and the regions, both in absolute and relative terms is made for period I (1959-60 to 1965-66), and for period II (1966-67 to 1976-77). In addition to the aggregate level data, we have also extended our analysis to the crop level data.

3.1 Levels of variability in cropped area, output and yield : At Aggregate Level

To begin with, we discuss the level of variability in area, yield and output for the State and the regions. Table 3.1 shows the value of mean, standard deviation and co-efficient of variations for three variables for period I (1959-60 to 1965-66) and period II (1966-67 to 1976-77). This scheme of periodization is followed for a specific purpose. Period I is the period before the influx of the new agricultural technology, that is before the new inputs came into use in agriculture of Karnataka. During this period agriculture was maily governed by the use of traditional inputs. Period II is the time when the cultivable area (NSA) in the State

TABLE 3.1

STANDARD DEVIATION, MEAN VALUE AND CO-EFFICIENT OF VARIATION OF AREA, OUTPUT AND PRODUCTIVITY OF CROP AGGREGATE

	Area('000 hec)			Output('000 Rs)			Yield (Rs./hec)		
	1959-60 1965-66	1966-67 1976-77	Percentage Change	1959-60 1965-66	1966-67 1976-77	Percentage Change	1959-60 1965-66	1966-67 1976-77	Percentage Change
				Mean Value					
State	8274	7247	-12.41	21838	82585	278.17	386	1493	286.78
Region I(L)	3085	2881	-6.61	16984	22332	31.49	93	339	264.51
Region II(L/M)	4510	4201	-6.85	11746	37700	220.96	201	773	284.57
Region III(M)	336	390	16.07	1568	10624	577.55	61	181	196.72
Region IV(H)	341	461	35.19	1537	11925	675.86	78	198	153.00
				Standard Deviation					
State	458	145	-68.34	726	1095	50.82	132	289	118.93
Region I	338	221	-34.61	791	1530	93.42	51	150	194.11
Region II	312	250	-19.87	797	964	20.95	95	173	82.10
Region III	22	20	-9.09	210	404	92.38	16	28	75.00
Region IV	39	68	74.36	198	258	30.30	31	54	74.19
				Co-efficient of Variation					
State	4.98	2.00	-59.38	4.27	1.32	-69.08	34.35	19.35	-43.66
Region I	10.96	7.67	-30.01	11.32	6.85	-39.48	55.46	44.24	20.23
Region II	6.92	5.96	-13.87	6.78	2.55	-62.38	27.68	22.48	-18.78
Region III	6.56	5.29	-19.36	13.39	3.80	-71.62	26.23	15.46	-41.06
Region IV	11.43	14.75	29.04	12.88	2.16	-83.22	39.74	27.29	-31.33

has not increased much, as a result, under the population pressure and rising demand for food, the farmer had to resort mostly to yield increasing measures such as increasing the intensity of cropping and making more use of new inputs on the existing land. In this period therefore, the cropping intensity has enhanced considerably as well as the use of chemical fertilizers and area under HYV. Consequently, the yield has become the main source of growth in agricultural output rather than area.

With this feature in the background let us first analyse the levels of variability in cropped area at State and at the level of regions. However, before we proceed further, it would be better to have a clear idea about the distinct features of each of the regions. Region I covers a large area in north maidan and has the lowest rainfall. Region II spreads over the south, west and also covers some pockets in northern part of the State. In this region rainfall varies between low to moderate range. In Regions I and II, therefore, we presumed that instability output, yield and area should be more pronounced compared with the other regions. Region III lies towards the west part and has a moderate level of rainfall. Lastly, Region IV falls in coastal area of the State and has a highest level of rainfall compared to other regions.

Period I - (1959-60 - 1965-66)

To begin with the State, the level of variability measured by co-efficient of variations indicate the value of 4.98 during period I. Among the regions, however, the pattern of variability varies considerably. Interestingly enough Region IV shows the highest level of variation in cropped area (11.43) in period I. Next comes

the Region II with a value of C.V. at 10.96. In fact, in both these regions the value of C.V. is nearly the same. As compared with Regions I and IV, level of variability is much lower in Regions II and III which is stood at 6.92 and 6.56 (CV) respectively. It may be noted that these regions have rainfall which varies from low-medium to medium level.

Coming to yield rate, what is striking is that the regional pattern of level of variability shows a remarkable similarity with the pattern of variability in the cropped area. It is clear from the table that the variability is the highest for Region I, which is closely followed by Region IV, while the variability level is nearly the same in Regions II and III. For instance, the C.V. is 55.46 in Region I closely followed by Region IV at 39.74. In Regions II and III the C.V. remain at a relatively level low of 27.68 and 26.23 respectively. It may be noted that in general level of variability in yield rate, both at State and regional level is higher compared with area.

Period II - (1966-67 - 1976-77)

Let us discuss the level of variability in area, output and yield in period II and note the changes over period I, if any. It is interesting to note that variability level in area both at State and regional level has been low in period II compared with period I (the only exception being region IV which suffered from higher level of variability in period II). This has been possible due to general decline in the values of C.Vs. For instance, the C.V. in Region I stood at 7.67, in Region II at 5.96 and in Region III at 5.29 indicating a change of -30.01%, -13.87% and -19.35% decline over period I for the three regions respectively. Region IV is the

only one which suffered from high level of variability in area, but also its level has gone up by as much as 29.04% over period I.

As regards output, the regional pattern has more or less remained the same, that is regions I and IV again showing the higher level of variability in yield as they did in period I. The level of variability was lower in Regions II and III compared with region I and IV. As far as changes are concerned, there has been a general decline in the yield variability in period II, this applies to the State and all the regions under study. However, the decline was more pronounced in Religions III and IV, it being 41.06% and 31.33% respectively. The percentage decline was 20.23 and 18.78 in regions I and II respectively. At the State level the decline was to the extent of 43.66%.

Finally, coming to the output, figures for the period II shows a remarkably low level of variability in the State level data, the C.V. was just 1.32%. Among the regions, however, the level of output variability was comparatively higher in region I which happens to be a low rainfall region. The level of variability was more or less the same in rest of the regions. The C.V. were 6.85, 2.55, 3.80 and 2.10 for regions I, II, III and IV respectively. With respect to the change, we observed with some satisfaction that there has been a general decline in the level of variability in all regions and for the State the percentages decrease, however, was higher for region IV, and region II compared with region I.

In the conclusion, our analysis of variability in aggregate area output and yield brings out few relevant results at the level of the State and the region. Firstly, the level of variability in output was higher in regions I and IV (which are lowest and high

rainfall regions respectively) compared with regions II and III (it was also somewhat higher in region III). And more or less the same regional pattern was observed with respect to variability in area and yield rates namely the level being higher in regions I and IV compared with regions II and III. Secondly, there has been a general decline in the level of variability in area, output and yield between periods I and II both at the level of the State and the regions (the only exception being an increase in the variability level of area in region IV).

3.2 **Levels of variability at crop level :**

It would be interesting to note the level and change in variability in the case of important crops in the State. We have taken three important crops for final analysis. Each of these crops is grown in a specific agro-economic codition. For instance, rice is a wet crop grown in wet condition, while jowar is restricted to the dry areas and therefore exposed to the uncertain rainfall. Cotton, which is a cash crop and is grown in varying situation all over the State.

Rice - We first start with rice, as it is the staple crop for most of the people in the State. It is a tropical crop and requires a high temperature, heavy rainfall and light loamy and alluvial soil. Rice is produced in all those areas where the rainfall is heavy or alternatively irrigation facilities are available. Since the natural rainfall is less reliable, in regions I and II a significant proportion of area under rice is grown under irrigated condition. While in regions III and IV (i.e. coastal areas) the rainfall is high and assured so cultivation of rice is mostly done on the basis of natural rainfall.

TABLE 3.2

STANDARD DEVIATION, MEAN VALUE, CO-EFFICIENT OF VARIATION OF AREA OUTPUT AND YIELD OF RICE

	Area			Output			Yield		
	P.I	P.II	%	P.I	P.II	%	P.I	P.II	%
				Mean Value					
State	1101	1166	5.90	5567	20854	274.60	190	781	311.05
I	79	111	1.77	192	537	179.68	29	98	65.51
II	496	516	4.03	2496	1691	-32.55	49	33	-32.65
III	186	223	19.89	1248	8308	565.70	67	372	455.00
IV	336	314	-6.54	1531	10318	573.93	45	328	628.89
				Standard Deviation					
State	60	69	13.04	661	1275	92.88	68	62	- 8.82
I	21	14	-33.00	36	107	197.22	12	27	125.00
II	69	139	101	2321	411	-82.29	34	12	96.07
III	20	13	-35	1798	2879	60.12	13	8	-38.46
IV	7	6	-4	1678	1738	3.57	16	18	12.50
				Co-efficient of Variation					
State	5.46	5,91	8,24	11,87	6,11	-48,52	35,78	7,93	-86,79
I	26.50	13.01	-50.90	18.93	19.72	5.29	41.37	56.25	35.96
II	13.91	26.93	93.60	92.97	24.32	-73.84	69.38	36.36	-47.59
III	10.85	6.25	-42.39	143,99	34,65	-75.93	19.40	2.15	-92.79
IV	2.16	2.30	6.48	109.59	16.84	-84.63	35.55	5.48	-95.11

Period I

The inter-regional pattern of levels of variability for rice can be studied from table 3.2. The C.V. for area under rice is found to be 5.46. However, there are marked inter-regional variations in the value of C.V. The variability in cropped areas is the lowest in region IV (2.16). It may be noted that this region is one of the highest rice growing areas in the State and also provides the ideal conditions for rice cultivation. As against this, Regions I and II, specially the former emerged as a high variability area in the State with a value of C.V. at 26.50 and 13.91 respectively. Region III shows a moderate oevel of variability with C.V. at 10.85. Thus in general the level of variability in cropped area is relatively higher in low and low-medium rainfall regions compared with high and medium rainfall regions of the State.

Coming to yield, it is observed that both at the State and at the level of region, the value of C.V. are uniformally higher than those for area, thereby indicating higher level of variability in yield rate. At the overall level (i.e. State) C.V. is 35.78. At regional level, the C.V. is higher for Regions I and II, it being particularly higher for the latter (69.38). This region suffers from high level of yield uncertainty. Comparatively speaking, the yield variability is lower in Regions III and IV, it is the lowest under the former. So with the exception of somewhat more C.V. in Region IV, the regional pattern of variability is nearly the same as is observed in the case of area.

The pattern in the case of output is somewhat different. At overall level the C.V. is 11.87. Four regions show a varied

pattern. The C.V. is high in Regions III and IV particularly high in latter. These are regions where the rainfall is moderate to high. While in other two regions the C.V. is lower, it is being particularly lower in Region I, the area with a lowest rainfall. This fact will have to be kept in mind while discussing the co-relates of output variability. At this stage, however, it may be noted that Regions III and IV are the main rice growing regions, while rice is a subsidiary crop in Regions I and II.

Period II

During this period there has been a significant improvement in the production of rice in the State. Hence it would be interesting to see the pattern and change in variability in output area and yield. To start with area it was observed that the overall level of the co-efficient of variation is 5.91 indicating a very small change over period I. So more or less the level of variability had remained constant at the level of the State. As expected Regions I and II have shown high variability in this period also, the C.V. being 13.01 and 26.93 respectively. The high level of variability in area is probably due to a very low level of rainfall and inadequate facilities of irrigation in the region. . Like the earlier peiod the variability level in area under rice is lowest in regions IV and II, it being the lowest in the latter. The regional pattern in area variability has more or less remained the same. However, the pattern of change varies significantly from region to region. What is striking is that two regions, namely, regions II and IV have witnessed an increase in the level of variability, the increase being significantly higher in region II (93.60) compared with region IV (6.48). As against this, regions I and III have shown a considerable decline in the variability of area under rice.

As far as yield variability in rice is concerned, the regional pattern in period II has remained the same. The level of variability was strikingly higher in regions I and II compared with regions III and IV. In fact, the gap in C.V. in regions I and II (which are low and low-medium regions) and regions III and IV (which are mediu and high rainfall regions) which was already there in period I had further widened in period II. For instance, the C.V. was 52.25 and 36.36 in regions I and II respectively while the same was just 2.15 and 5.48 for regions III and IV. Further, what is interesting is that there was a general decline in the level of yield variability in regions III and IV and also in Region II, the percentage decline was particularly higher in regions III and IV. While the C.V. for yield has increased in region I, which indeed happens to be a low (and uncertain) rainfall region. So during period II, region I not only has suffered from high level of variability, what is more worse is that it has shown an increasing trend over a period of time.

In the case of output variability, the regional pattern is a mixed one. Regions I and IV show a relatively lower level of variability in rice output as compared with regions II and III. As regards the change, however, there has been a general decline in the level of output variability in three region (including overall level), the only exception being region I (the low rainfall region) which has faced a mild increase in variability in rice's output. So the results indicate the bad distracting situation of region I which is a low rainfall region. It may be noted that the mild increase in output variability of rice in region I during period II is entirely due to rise in the variability level of yield, as the variability level in cropped area under rice has shown decline.

TABLE 3.3

JOWAR

	Area			Output			Yield		
	P.I	P.II	%	P.I	P.II	%	P.I	P.II	%
				Mean Value					
State	2715	2282	-15.94	3095	5672	83.26	92	180	95.65
I	1351	1130	-16.35	1601	2495	55.84	27	36	33.33
II	1323	1099	-16.93	1432	2549	78.00	53.	85	60.37
III	396	509	28.53	420	660	57.14	19	28	47.36
IV	1	4	300	101	196	94.06	4	21	425.00
				Standard Deviation					
State	374	197	-47.32	967	2632	172.18	41	67	63.41
I	124	149	20.16	152	310	103.94	16	20	25.00
II	274	121	-55.83	119	216	81.51	46	65	41.30
III	138	48	-65.21	256	391	52.73	9	14	55.55
IV	1	1	-	52	63	21.15	2	9	350.00
				Co-efficient of variation					
State	13.78	8.64	-37.30	31.24	46.40	48.52	44.56	39.22	-11.98
I	9.19	13.18	43.41	9.49	12.42	30.87	59.29	55.55	- 6.30
II	20.69	11.04	-46.64	8.31	8.47	1.92	86.79	76.47	-11.89
III	34.99	9.58	-72.62	60.95	59.24	- 2.80	47.36	50.50	5.57
IV	100.00	100.00	-	51.48	32.14	-37.56	50.00	42.85	-14.3

In contrast to the situation in region I, rest of the regions have experienced a general decline in output variability and this has been mainly due to fall in yield variability in period II.

Jowar - Jowar is a major crop of the Karnataka State. It is mostly grown in a dry condition. As a result (as we noted before) the area under this crop is gradually declining over a period of time. Table 3.3 describes the picture of Jowar in the State and brings out few interesting results.

Period I

The level of variability at overall levels, measure in terms of C.V. was found to be 13.78. At the level of the regions however the pattern varies. Region I, a major Jowar growing area, has a relatively low level of variability with C.V. at 9.19. But in Region II, an another Jowar growing area, has a relatively higher variation in cropped area under Jowar (20.69). This could probably due to the fact that this region possesses a lower level of irrigation than Region I. In regions III and IV the C.V. indicates a high variability in area under Jowar primarily due to the fact that Jowar is not a major crop in these areas. In fact,Region IV has negligible area under Jowar (about 1000 hectares).

Coming to yield, the variability level was found to be relatively high at the overall level of 44.56. However, the level was considerably higher in regions I and II (the region with low and low-medium rainfall) as compared to regions III and IV. The C.V. was 59.29 and 86.29 in regions I and II respectively. These figures were definitely lower with region III (47.36) and region IV

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(50.00). So, in general, yield variability was higher in low and low-medium rainfall areas as compared with medium and high rainfall areas.

As regards the output, we noticed a pattern which is different from the one we observed for yield. The C.V. was 31.24 at the overall level. At the regional level unlike yield, the variability in output is lowest in regions I and II (it may be noted that C.V. was higher for yield in regions I and II), it being 9.39 and 8.31 respectively. These figures were definitely lower compared with 60.95 and 51.48 in regions III and IV. So at least in the case of Jowar, the first two regions were some better off. It may, however, be noted that low output variability (in period I) in these regions was mainly due to lower variability in area as the C.V. was higher for these two regions (Regions I and II) than for regions III and IV.

Period II

During this period there was general decline in the level of variability in area at overall level and for the regions, the only exception being regions II and IV. While in region IV it remained constant, in region II it has experienced significant increase in C.V. from 9.19 to 13.18 showing an increase of 43.41 per cent. So the situation in region IV was pretty bad in period II as compared to period I.

Yield variability under Jowar in period II has remained at a higher level (39.22), this has happened inspite of a mild decrease in the value of C.V. by 11.98%. At the region level also the level of yield variability was generally higher in all regions, it being

particularly more for regions I, II and III compared with region IV. In region IV the lower value of C.V. was achieved due to a relatively greater decline in variability in period II (14.3) where in other region the percentage decline was rather low, it being 6.30, 11.89 and 5.57 in regions I, II and III respectively. We must note that both regions I and II, which are low, and low-moderate rainfall regions, had a higher level of variability in area as well as yield compared with the regions III and IV which enjoyed moderate to high rainfall. This was really a most depressing fact for regions I and II.

Output variability has increased for the State as a whole from 31.24 in period I to 46.40, period I showing an overall increase of 48.52%, which is very high. Obviously, as seen from the table, this was mainly due to the increase in the variability level in Region I to the extent of 30.37% and 1.92% in region II. It may however be noted that the level of C.V. for these two regions (i.e. regions I and II) was lower compared with regions III and IV. The only difference was that while in regions III and IV there was a declining trend in level of variability, the trend was in positive direction in regions I and II.

Cotton - Cotton is grown all over the State.[1] It is a product of the black cotton soil and hence is most prevalent in the nothern districts of the State. It is a dry crop but can also be grown under irrigated condition. Among the non-food crops, cotton still occupies the maximum area, which is about 9 % of the total cultivated area in the State. In fact, Karnataka occupies the second place in the country in terms of area under cotton. Yield rates are, however, low and the quality of the cotton produced is also relatively inferior.

R.P. Misra, ibid.

TABLE 3.4

STANDARD DEVIATION, MEAN VALUE, COEFFICIENT OF VARIATION OF AREA OUTPUT AND YIELD OF COTTON

	Area ('000 hec)			Output			Yield		
	P.I	P.II	%	P.I	P.II	%	P.I	P.II	%
Mean Value									
State	969	1041	7.43	1601	2508	56.65	26.	41	57.69
I	575	599	4.17	3528	5889	66.92	27	39	44.44
II	386	432	11.91	3027	4017	32.70	57	87	52.63
III	6	8	25.00	100	121	21.00	30	25	-16.66
IV	1	1	-	1	6	-	1	17	-
Standard Deviation									
State	89	78	-12.35	562	912	62.27	9	17	88.88
I	89	52	-41.57	1127	2259	92.25	4	15	2.75
II	16	31	93.75	1082	1145	5.82	17	36	111.76
III	1	2	100.00	41	75	82.92	13	11	- 15.38
IV	1	1	-	1	5	-	1	10	-
Coefficient of Variation									
State	9.24	7.56	-18.18	30.10	39.28	30.49	34.61	41.46	19.86
I	15.57	8.69	-44.18	21.93	38.36	74.92	15.46	39.00	152.26
II	4.14	7.20	73.91	35.75	28.51	-20.25	29.82	41.70	39.83
III	23.30	26.61	14.20	34.15	61.98	81.49	43.05	45.82	6.43
IV	100	100	-	100	83.09	-16.91	100	57.54	-42.60

As irrigation facilities in the State expand the yield rate of cotton is likely to go up.

It may be noted that cotton occupied a sizeable area in regions I and II but very small in regions III and IV. Hence for the purpose of analysis and right statistical inferences,we would confine the discussion to first two regions only (i.e. regions I and II).

Taking area first, in period I, the C.V. for area under cotton stood at 9.24 at the overall level. However, the level of variability in cropped area was higher in region I (15.57) than in region II (4.14). During period II, the level of C.V. was almost the same in two regions. This uniformity in the variability of two regions was achieved by rapid decline of C.V. in region I but by a significant increase in region II. It appears that as far as the level of variability was concerned, both the regions faced similar situation during period II.

As regards yield, during period I the level of yield variability was higher in region II as compared with region I, the figure of C.V. being 15.46 and 29.82 for respectivity, the gap was almost more than double. As in the case of area, the gap in the level of yield variability which was there in period I was minimised in period II as both the regions show nearly the same level of variability, the C.V. being 3900 and 41.70 in regions I and II respectively. However, what was more disappointing is the increase in the level of variability in period II. In fact, the rise in the value of C.V. was as high as 152.26 for region I, it being lower for region II (39.83).

Coming to output, at overall level the C.V. for period I was 30.10 and this has increased to 39.28% during period II indicating about 30.50% rise over the earlier period. Among the region the region I has shown a lower level of variability (i.e. 21.93) as compared with region II (i.e. 35.75). However, the pictures was just the opposite in period II. Now region I revealing a high variability in output of cotton as compared to region II. In fact, region I faced a considerable increase in the value of C.V. in period II, almost 75%, while region II shows a deline to the extent of 20.25% over period I.

The above analysis has revealed some interesting conclusions with regard to the variability in area output and yield at the level of the State and the regions :

i) Firstly, the level of variability in output measured through C.V. was higher in region I (which is low rainfall region) and region IV (which is high rainfall region as compared with regions II and III). And more or less the same pattern was observed with respect to the variability in area and yield rate i.e. the level of variability being higher in regions I and IV compared with regions II and III. In general, both at the State and regional level the level of yield variability was higher than that those in area. Further, there has been a general decline in the level of variability in area, output and yield between periods I and II for the State as well as for the region (the only exception being an increase in the variability of area in region IV).

ii) At the crop level it is seen that in general variability in the case of rice, area and yield variability was higher compared with regions III and IV. In the case of output, however, regions

I and IV shows higher reliability compared with regions I and IV. As regards the changes, there has been general decline in the level of output variability in all regions (except region I which is low rainfall region) and this has been mainly due to decline in yield variability. In the case of Jowar, the overall level of variability was higher in all the regions. However, the C.V. was particularly high in regions I and II as compared with regions III and IV. What is bad is that there has been increase in C.V. of output in region I and to some extent in Region II also. The other two region (i.e. regions III and IV) experience a decline in the C.V. As regards cotton, the C.V. of output was higher in region I than region II and further the variability in output of cotton has increased in region I.

CHAPTER IV

TREND DEVIATIONS IN AREA, OUTPUT AND YIELD

In the preceding Chapter, we have studied the variability in area, output and yield during two periods by taking the value of C.V for period as a whole. In this analysis, however, we could not examine year to year deviation in these variables which is a predominent feature of instability. One way to study such phenomena is to look in the year to year, or what are called annual fluctuation in gross cropped area, productivity and total output. Sizeable year to year fluctuations in these variables occurred in varying degrees in the State. But one of the limitations of annual fluctuation values is that a general trend in the movement of the variable cannot be obtained merely by looking at annual figures. A popular method to overcome this is to develop a trend by taking the three-year moving average of each series. Further, to ascertain the degree of deviation that would have operated from the trend itself, the magnitude of short term fluctuations is worked out firstly as an absolute deviation between the annual value and its trend value. These short term deviations provide a fairly clear idea of how the State agriculture would have departed from the underlying trend, roughly approximated by the three year moving average. This is another way of looking at the operation of the instability element. The underlying assumption is that the short term deviations would be almost nil if the temporal changes in area,productivity and output are free of instability and the movement of these variables proceed uninterrupted along the trend curve only howsoever roughly by the three year moving average. Short term deviations worked out by us are believed to subsume in themselves the combined effect of seasonal,cyclical and all resident variations. In view of this, in this section we examine

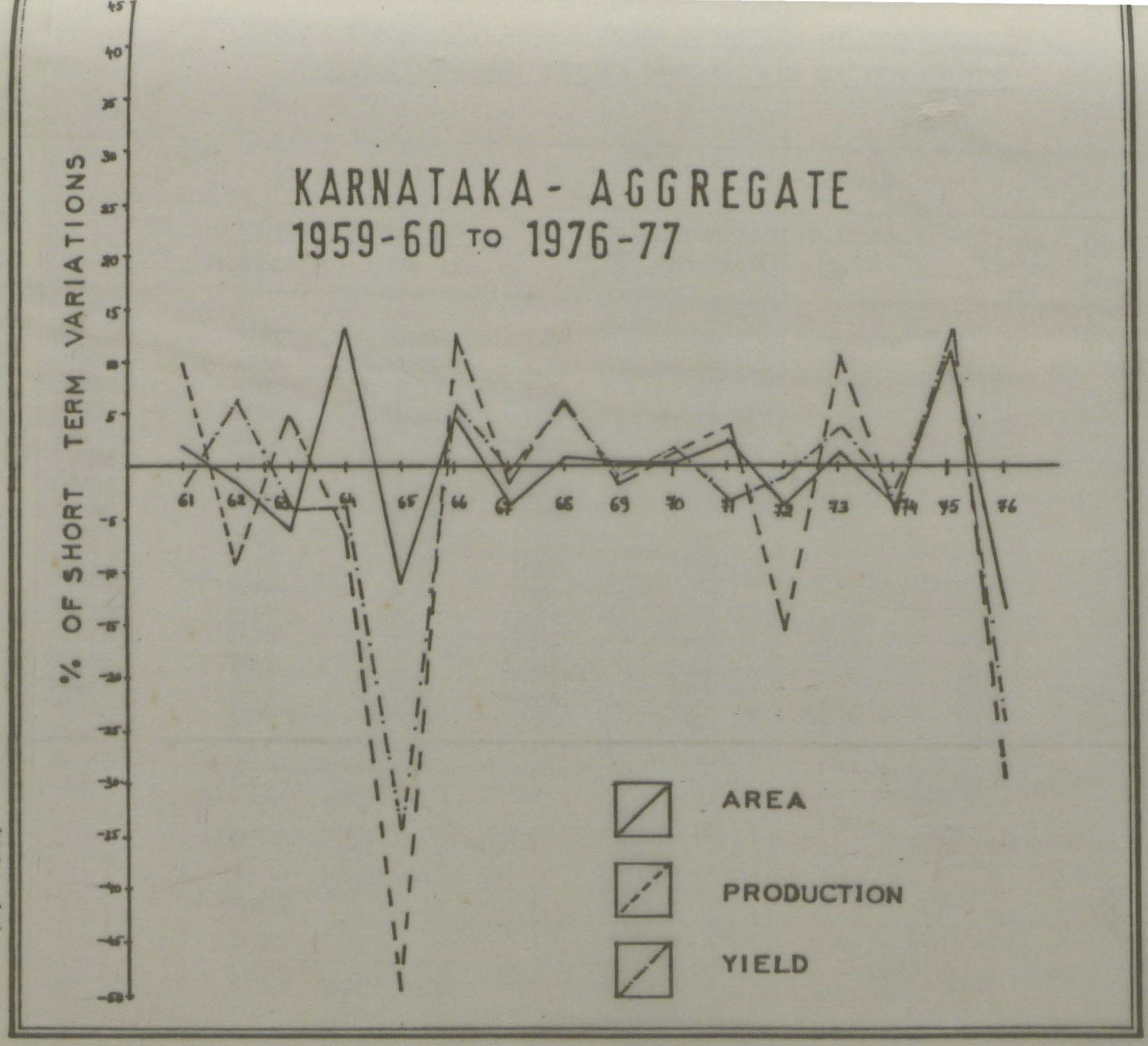

KARNATAKA - AGGREGATE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
AREA
PRODUCTION
YIELD

FIG -4.1

TABLE 4.1

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : (AGGREGATE OF TEN CROPS)

Years	(00 hectares)			(Rs. crore)			(Rs./hec.)		
	Trend Value (1)	Deviation from trend		Trend Value (1)	Deviation from trend		Trend Value (1)	Deviation from trend	
		Absolute (2)	% (3)		Absolute (2)	% (3)		Absolute (2)	% (3)
1960-61	80429	1182	1.45	1.70	.18	9.84	352	6	- 1.94
1961-62	80601	1414	- 1.79	1.75	.14	- 8.73	336	19	5.52
1962-63	85864	4860	- 6.00	1.68	.08	4.57	321	14	- 4.61
1963-64	85103	12298	12.63	1.77	.10	- 6.09	313	12	- 4.42
1964-65	85644	8739	-11.36	2.80	.92	- 49.12	446	114	-34.59
1965-66	78696	3928	4.75	4.26	.61	12.54	671	36	5.12
1966-67	79477	2916	- 3.81	6.15	.12	- 2.04	979	4	- 0.50
1967-68	78505	741	0.94	7.04	.50	6.65	1185	70	5.60
1968-69	79860	151	0.19	7.72	.15	- 2.10	1337	10	-0.78
1969-70	80673	47	- 0.06	7.93	.12	1.54	1402	26	1.85
1970-71	79855	1828	2.24	7.91	.26	3.26	1489	39	- 2.69
1971-72	79716	2460	-3.19	8.65	1.15	- 15.34	1615	25	- 1.60
1972-73	79079	1110	1.38	9.15	1.12	10.90	1730	75	4.18
1973-74	83000	3168	- 3.97	10.13	.45	- 4.65	1841	46	- 2.59
1974-75	79472	9426	10.66	9.13	1.31	12.60	1701	221	11.52
1975-76	79093	9468	- 13.60	9.35	2.09	- 28.81	1721	334	-24.12

the trend deviations (a) in area, yield and output for aggregate and crop level and (b) also the trend deviation in some of the inputs which alternately affect the variability pattern under output, yield and area.

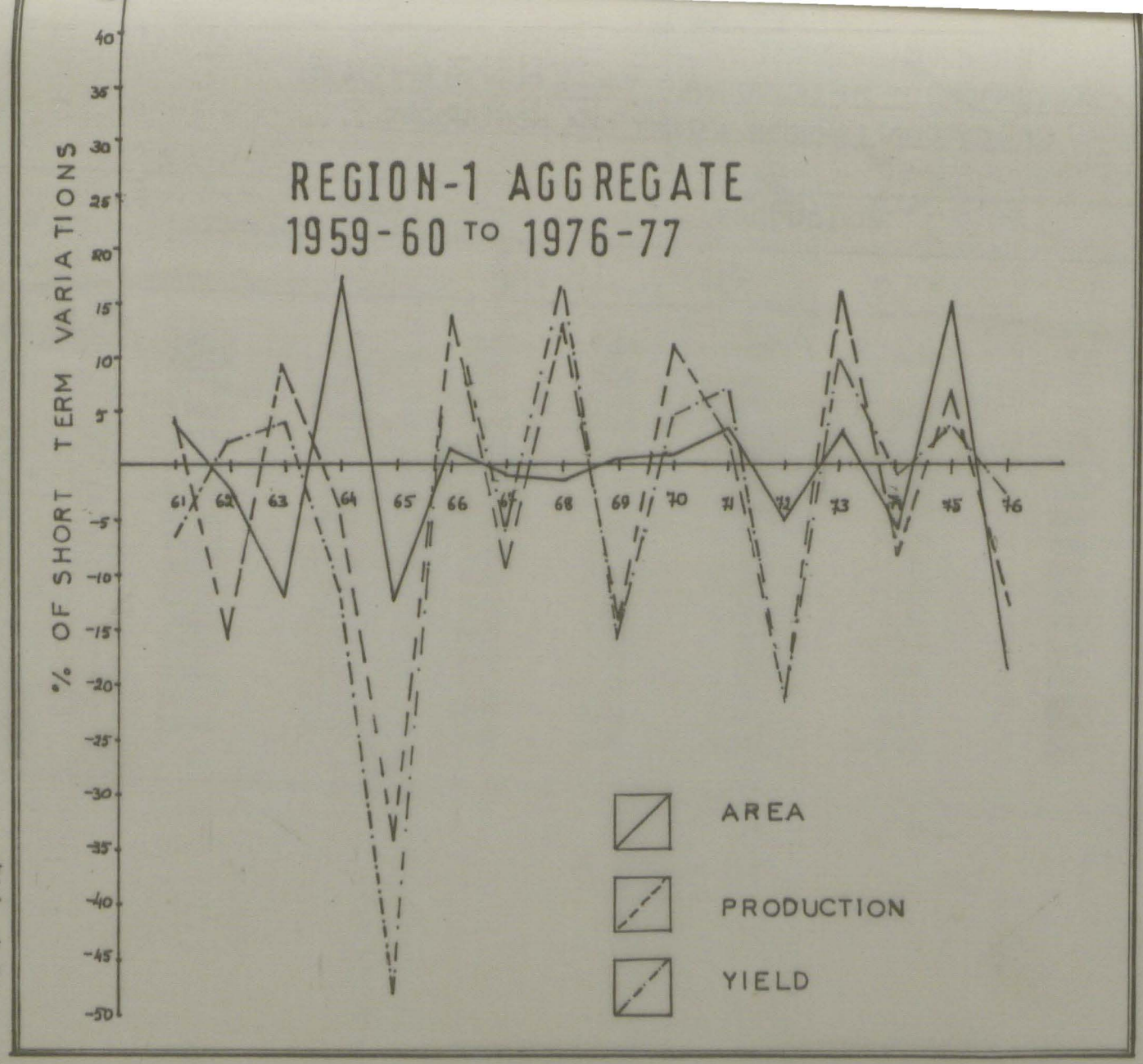
4.1 Trend deviation in area, yield and output

Table 4.1 shows the deviation(absolute and percentage) in area, output and yield for State and region, and the same are also depicted on the graph.(4.1)

Figure 4.1(and table 4.1)in which the deviation in the State level are shown, indicate that wide fluctuations have occurred in aggregate area till 1966 but after this period the deviation trend seems to have normalised.As is clear from the same graph(4.1)the same was followed both by production & yield. However, one notices some differences before mid 60s and after.Before mid 60s at least in some years the deviation output heavily coincided with yield(see year 1964-66). But after mid 60s trend deviation, in output are more closer to that in area,this is particularly so during 1971-76.For instance, production has decreased specifically in 1972 due to area decline, although yield has also shown a mild downward trend. In general trend shows a smoother curve after mid 1960 as compared with period before mid 1960s. This relates the area output and yield.

Region I on the other hand as seen from fig.4.2 indicates a rather instable trend in cropped area. However, wide fluctuations are noticed in output.This instability in output however has not been so much due to area fluctuations as by yield. In fact, wide fluctuation in yield rates remarkably coincides with those of output. So Region-I is really suffers more from yield variability and less from area. In region II, another drier region like region I, the output fluctuation seems to depend a lot on yield variability. In a way the yield curve determines the output curve.

Region III which has a moderate level of rainfall shows a moderate fluctuation in area, output and yield. In fact the deviation area is seen to


REGION-1 AGGREGATE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
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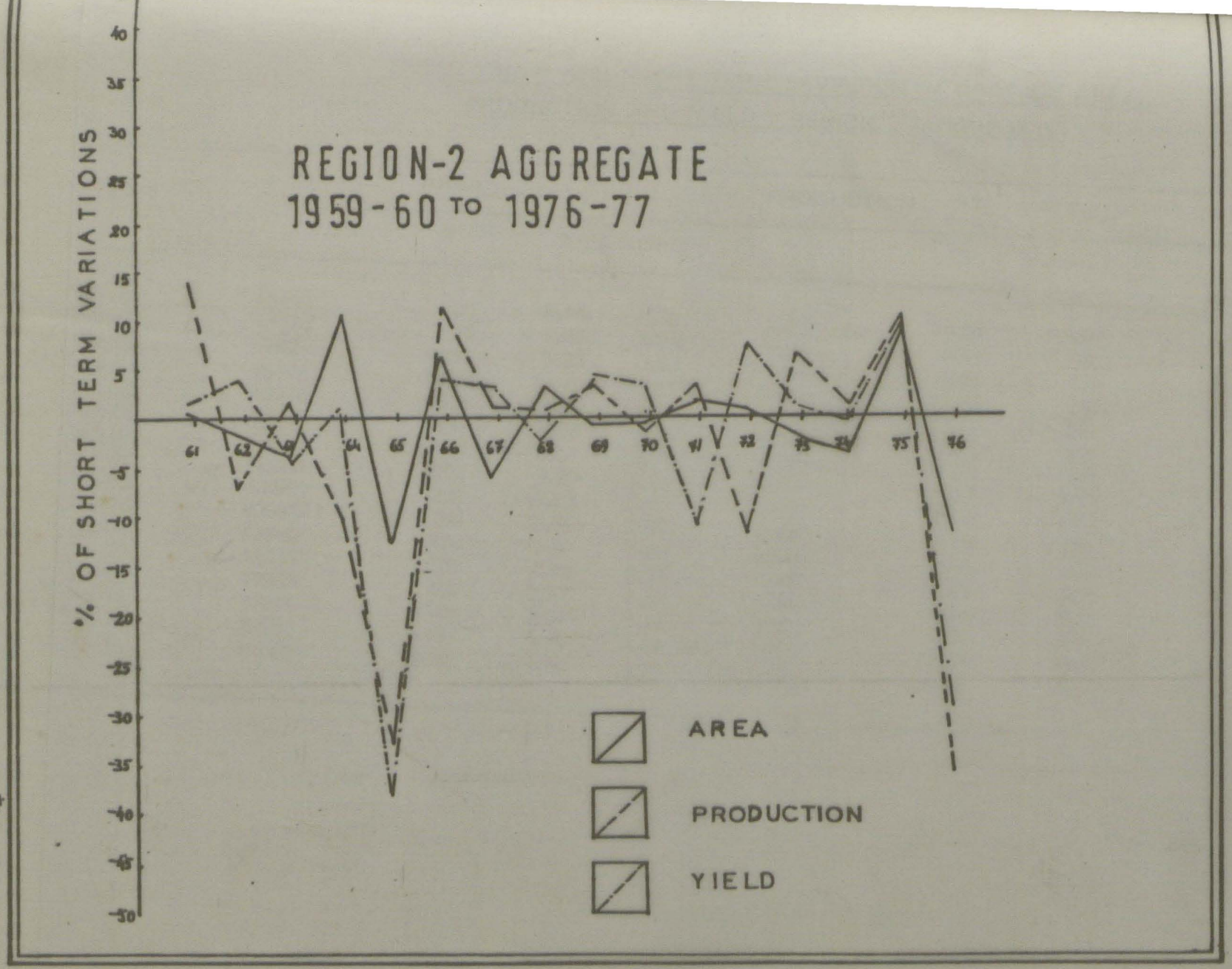
AREA
PRODUCTION
YIELD

FIG-4.2

TABLE 4.2

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : REGION I (AGGREGATE)

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	30375	945	3.02	0.53	0.02	3.98	71	4.63	- 6.97
1961-62	29659	715	- 2.47	0.56	0.07	-15.53	70	1.38	1.93
1962-63	32134	3420	-11.91	0.57	0.05	9.21	70	2.30	3.17
1963-64	31980	6763	17.46	0.63	0.02	- 3.72	74	7.58	- 11.35
1964-65	32044	3559	-12.49	0.87	0.22	-34.42	123	39.56	-47.33
1965-66	28528	374	1.30	1.18	0.18	13.35	190	28.90	13.19
1966-67	28394	197	- 0.70	1.69	0.15	- 9.88	283	15.26	- 5.70
1967-68	28409	325	- 1.16	1.88	0.28	13.09	302	60.48	16.68
1968-69	28911	370	0.13	2.22	0.28	-14.77	321	45.39	-16.46
1969-70	29542	1593	0.54	2.28	0.29	11.29	309	15.14	4.66
1970-71	29076	900	3.00	2.28	0.05	2.21	306	22.15	6.73
1971-72	2899	1446	- 5.25	2.36	0.42	-21.82	324	57.83	-21.69
1972-73	28565	900	3.06	2.38	0.43	15.56	342	34.66	9.18
1973-74	30533	1854	- 6.47	2.57	0.18	- 7.79	390	5.93	- 1.54
1974-75	28743	4712	14.09	2.33	0.17	6.84	397	12.26	2.99
1975-76	28560	4465	-18.53	2.38	0.26	-12.72	407	10.21	- 2.57


REGION-2 AGGREGATE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
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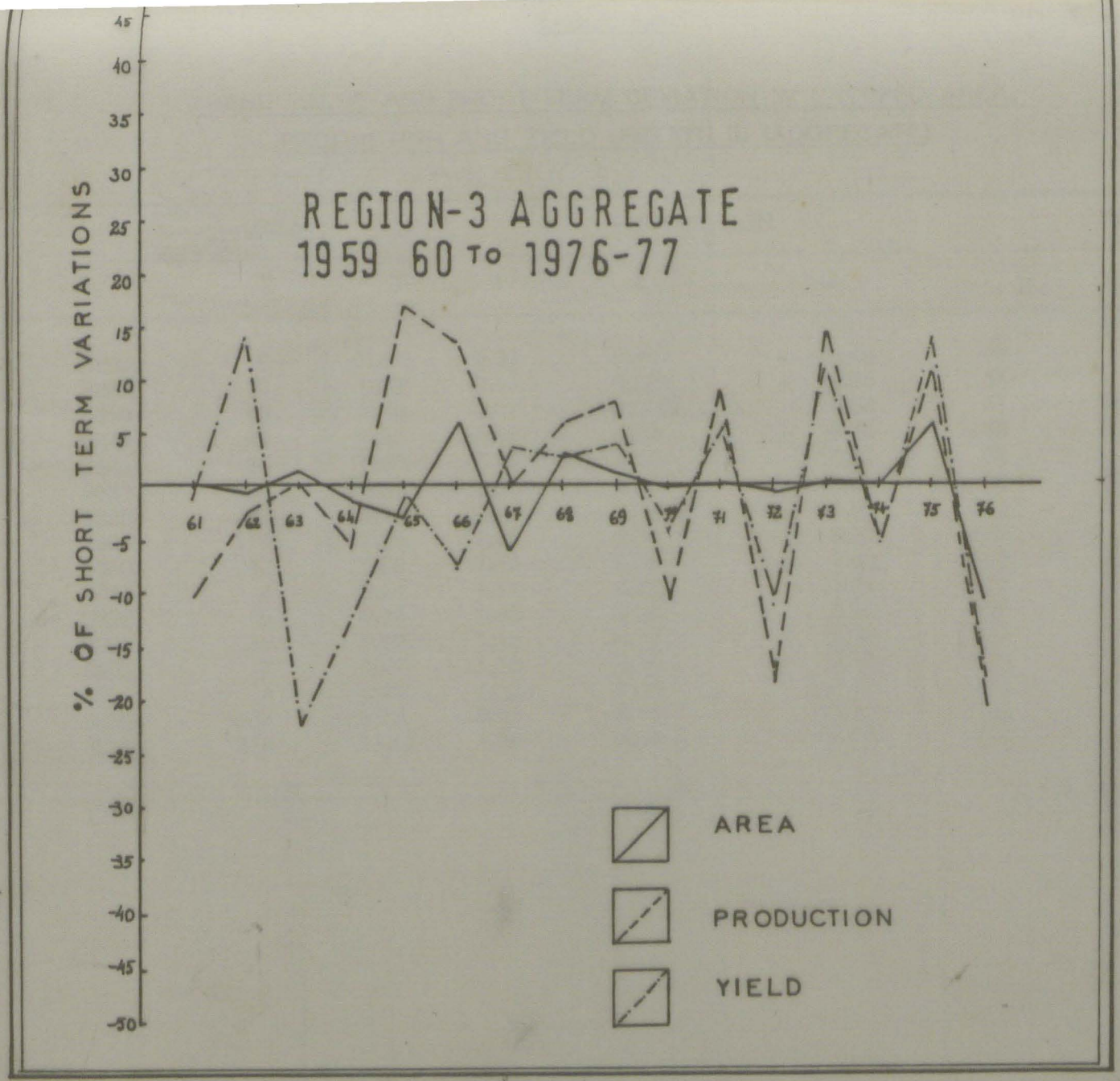
AREA
PRODUCTION
YIELD

#19-4.3

TABLE 4.3

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : REGION II (AGGREGATE)

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	43492	200	0.46	0.99	0.16	14.34	191	4	2.07
1961-62	44274	669	- 1.54	1.02	0.06	- 6.31	187	9	4.61
1962-63	47007	1481	- 3.25	0.93	0.01	1.87	179	8	- 4.68
1963-64	46322	5568	10.73	0.97	0.08	- 10.07	167	2	1.34
1964-65	46576	5025	-12.10	1.42	0.34	- 32.12	221	60	-37.33
1965-66	43055	3231	6.98	2.06	0.26	11.21	321	13	3.98
1966-67	43836	2507	- 6.07	2.75	0.02	1.01	454	12	2.60
1967-68	42886	1006	2.29	3.14	0.01	0.37	576	12	- 2.26
1968-69	43667	230	- 0.53	3.40	0.10	2.90	669	28	4.02
1969-70	43841	169	- 0.39	3.58	0.04	- 1.35	726	21	2.92
1970-71	43538	876	1.97	3.60	0.10	2.94	814	81	-11.09
1971-72	42332	196	0.46	3.99	0.42	- 11.83	889	72	7.55
1972-73	40962	908	- 2.27	4.36	0.32	6.87	965	6	0.71
1973-74	41609	1305	- 3.34	4.76	0.08	1.69	964	1	- 0.18
1974-75	40288	4181	9.40	4.24	0.50	10.60	863	94	9.91
1975-76	41060	4068	-11.27	4.29	1.15	- 36.61	863	195	-29.20


REGION-3 AGGREGATE
1959 60 TO 1976-77
% OF SHORT TERM VARIATIONS
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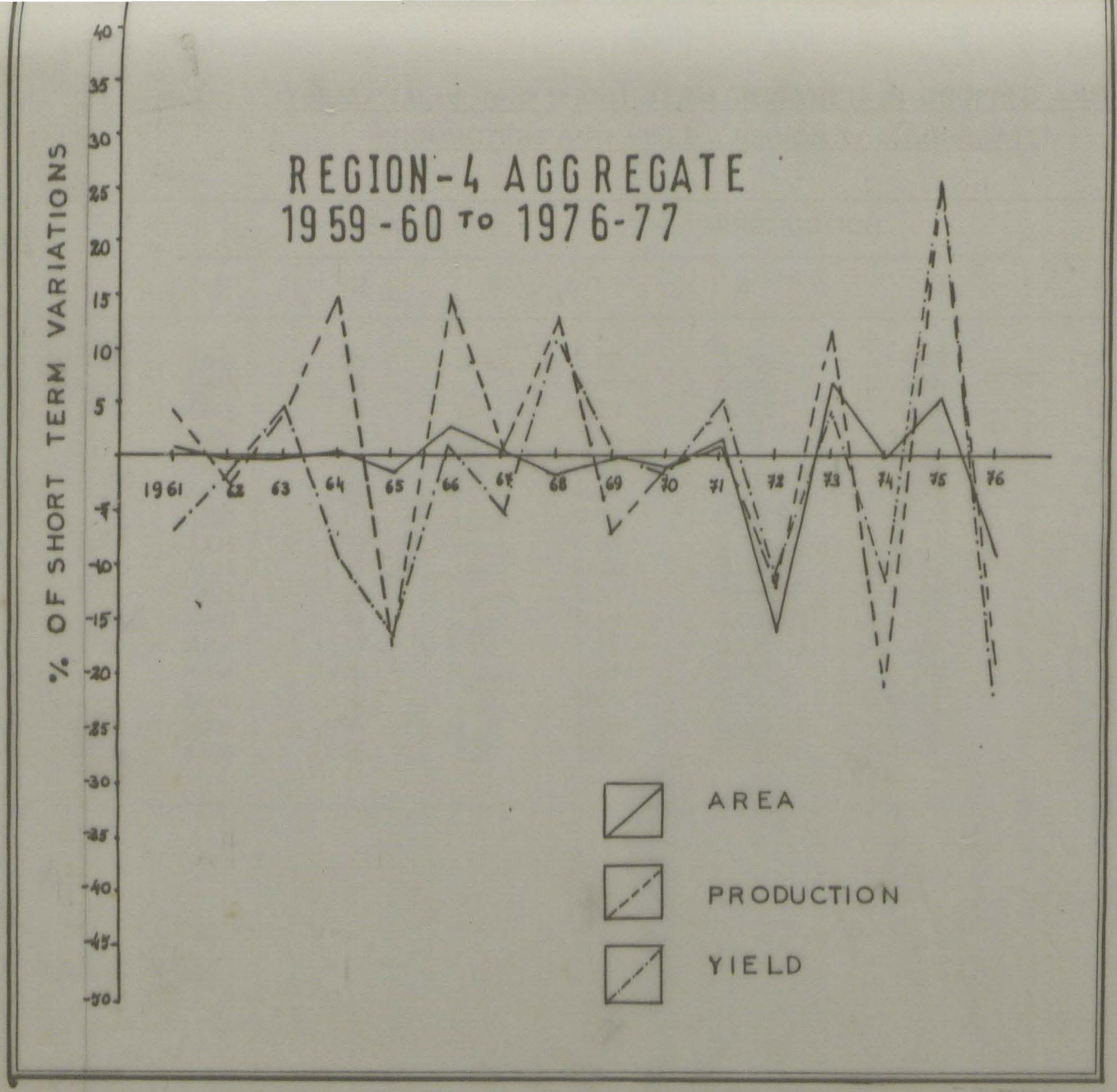
AREA
PRODUCTION
YIELD

FIG-4.4.

TABLE 4.4

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : REGION III (AGGREGATE)

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	3193	6	0.21	0.07	0.007	- 10.46	65	2	- 1.16
1961-62	3268	23	- 0.73	0.07	0.001	- 2.55	58	9	14.11
1962-63	3310	49	1.48	0.07	0.0002	0.38	51	9	- 22.49
1963-64	3376	49	- 1.48	0.08	0.04	- 5.76	50	5	- 12.61
1964-65	3541	99	- 2.90	0.26	0.16	16.87	65	1	- 0.81
1965-66	3631	224	5.82	0.53	0.08	13.39	93	6	- 7.74
1966-67	3825	228	- 6.35	0.88	0.0005	0.06	123	4	3.41
1967-68	3904	119	2.96	1.08	0.06	5.72	152	3	2.25
1968-69	4050	42	1.05	1.12	0.09	7.60	167	6	3.67
1969-70	4038	4	- 0.11	1.11	0.10	- 10.71	179	6	- 4.04
1970-71	3982	5	0.14	1.03	0.09	8.60	182	9	5.05
1971-72	3961	35	- 0.92	1.13	0.17	- 18.76	203	20	- 11.27
1972-73	3967	2	0.07	1.13	0.18	14.20	210	25	10.70
1973-74	4010	4	- 0.12	1.18	0.06	- 5.37	223	11	- 5.47
1974-75	3832	224	5.53	0.98	0.11	10.42	193	30	13.51
1975-76	3813	378	- 11.02	1.04	0.30	- 21.04	199	55	- 18.18


REGION-4 AGGREGATE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
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AREA
PRODUCTION
YIELD

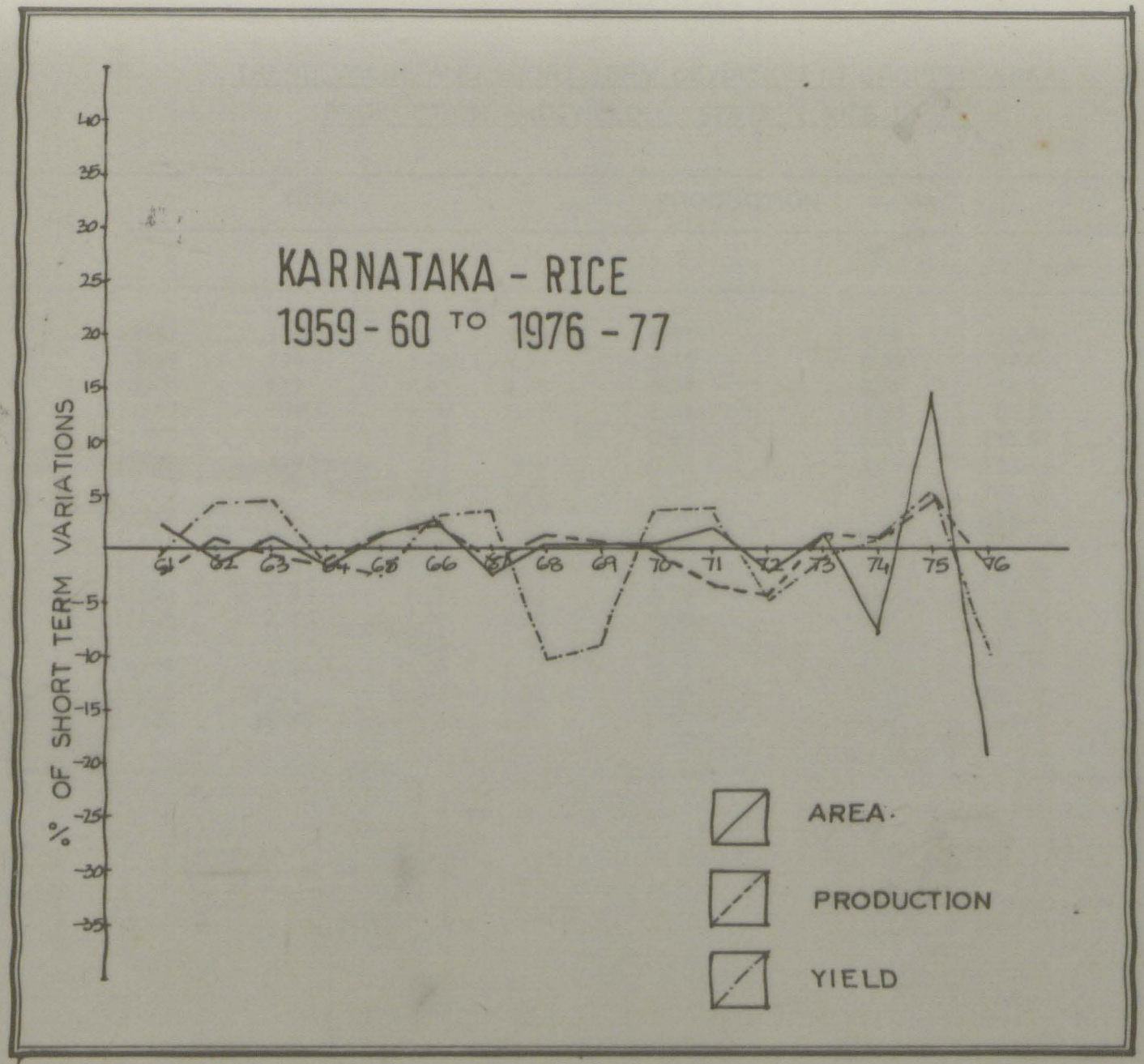
Fig-4.5.

TABLE 4.5

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : REGION IV (AGGREGATE)

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	3368	30	0.90	0.08	0.004	4.32	25	5	- 16.73
1961-62	3398	5	- 0.16	0.09	0.002	- 2.86	20	1	- 1.67
1962-63	3411	8	- 0.24	0.09	0.003	3.80	19	1	4.84
1963-64	3423	15	0.45	0.08	0.01	14.97	20	2	- 9.16
1964-65	3481	54	- 1.58	0.23	0.18	-17.40	36	14	- 16.28
1965-66	3481	97	2.73	0.47	0.08	15.11	66	1	1.02
1966-67	3420	16	0.48	0.82	0.0005	0.07	117	6	- 5.46
1967-68	3304	59	- 1.83	0.93	0.14	13.14	154	19	10.94
1968-69	3231	3	- 0.01	0.97	0.06	- 7.31	178	1	0.37
1969-70	3251	32	- 1.02	0.94	0.009	- 1.06	185	3	- 1.94
1970-71	3257	46	1.40	0.99	0.008	0.88	185	10	5.33
1971-72	4424	1174	- 16.13	1.15	0.12	-12.08	198	19	- 10.99
1972-73	5604	1115	6.60	1.27	0.17	11.86	211	8	3.92
1973-74	6846	3	- 0.05	1.62	0.28	-21.37	262	27	- 11.55
1974-75	6607	368	5.28	1.56	0.52	25.19	247	84	25.33
1975-76	6558	555	- 9.25	1.63	0.36	-19.07	250	73	- 21.88

develop a path almost along the normal curve. The yield fluctuations are not also very high, closer to the normal. They show a regular pattern of dips and peaks. Output fluctuation depends almost entirely on the yield factor. Region IV is the high rainfall region and, most fertile area which shows a typical pattern as regards to the fluctuation in area, output and yield. The fluctuations in area are very low, in fact close to the normal till 1971, but 1971 onwards it has shown wide ups and downs causing some swing in output. So far as yield and output is concerned both have experienced regular ups and downs over the entire period and therefore fluctuation in output seems to coincide with those of yield. Thus the analysis of aggregate output, area and yield brings out a distinctive pattern of trend deviations in each of these regions. We observed a wide fluctuation in the trend value of output in regions I and II, the deviations were however more pronounced in region I (a low rainfall region) compared with region II(a low-moderate rainfall region). Further, the amplitude of deviation, or ups and downs was more pronounced in yield than in the case of area. Thus although yield and area both affected fluctuations in output, fluctuation in yield has a somewhat upper hand. In regions III and IV(moderate and moderate-high rainfall) regions the pattern was somewhat different than those observed in regions I and II. Regularly fluctuation output seem to have occurred in output during the entire period under study. What is striking is that with the exception of few year the deviation in area was quite low, as compared with the yield. In fact, in both these regions, in some year trend curves for area is quite close to normal curve. But yield rate shows regular ups and downs and caused most of the fluctuation in output and yield as source of instability, was a strong factor in regions II and IV.


KARNATAKA - RICE
1959 - 60 TO 1976 - 77
% OF SHORT TERM VARIATIONS
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AREA
PRODUCTION
YIELD

FIG 4.6

TABLE :4.6

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *STATE (RICE)*

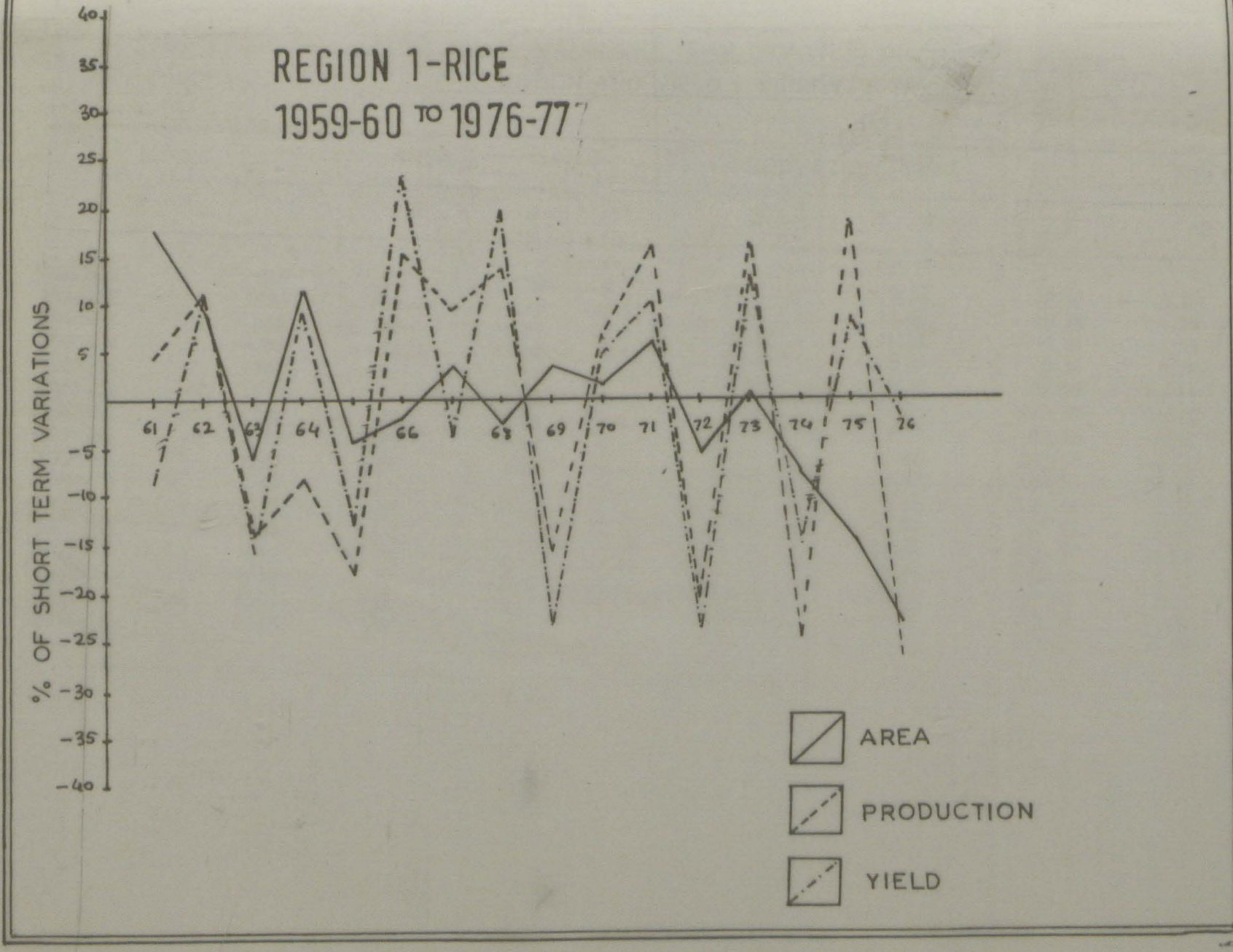
YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	10451	225	2.20	0.99	0.91	- 2.64	56.00	8.33	- 0.66
1961-62	10881	124	- 1.16	0.91	0.15	0.88	65.61	9.67	4.04
1962-63	10945	114	1.03	0.98	0.29	- 0.95	72.31	7.63	4.48
1963-64	11287	197	- 1.78	1.15	0.04	- 1.27	65.01	5.21	- 0.99
1964-65	11563	149	1.28	1.11	0.47	1.41	135.93	6.39	- 2.89
1965-66	11586	300	2.53	1.08	0.52	2.14	179.43	2.01	2.83
1966-67	11443	284	- 2.55	1.23	0.12	- 1.25	201.32	3.31	3.35
1967-68	11312	27	- 0.25	1.67	0.34	1.01	242.71	4.90	-10.76
1968-69	11492	2	0.02	1.87	0.03	0.50	236.00	6.00	- 9.45
1969-70	11663	34	0.30	2.04	0.34	- 0.46	251.36	2.06	3.52
1970-71	11562	234	1.99	1.83	0.70	- 2.47	269.09	7.37	3.42
1971-72	11464	271	- 2.43	1.88	0.60	- 4.31	306.00	6.52	- 5.11
1972-73	11243	161	1.41	2.09	1.26	1.35	317.67	6.59	- 1.00
1973-74	12779	1646	- 7.79	2.73	1.01	0.73	429.73	5.42	0.67
1974-75	12218	3581	14.67	2.82	0.91	4.67	491.91	5.67	5.51
1975-76	12182	2459	-19.30	3.23	0.97	- 2.08	553.67	6.93	- 9.59

4.2 Crop Level Analysis:

Let us now study the pattern of trend deviation at crop level:

Rice: At the State level rice has not experienced very wide fluctuations in area output and also in yield as can be seen from table 4.6 and figure 4.5 In fact, as we shall see later, rice has shown a remarkable stabilty as compared with the other crops such as jowar and cotton. Acreage-wise, although there has been a regular pattern of upswings and downswings, the deviation from the normal has not exceeded beyond 5% plus with us. With exception of year 1979, the output also follows the same pattern as is noticed in the case of area.

Yield trend has, however, shown a more severe fluctuating trend than area and output. Yield has shown a regular fluctuation during the entire period, the fluctuation being in period II particularly sharp between 1967 to 1970. The yield curve shows a dip during late sixties; in the early seventies it has picked up and shown a positive trend but has again faced a down trend after 1975. It may be noted that, precisely during this period the use of new inputs such as HYV & fertilizer was more common. The uncertainty in the use of the new input might have affected the yield rate more than during earlier period. Therefore, it would not be wrong to say that for a wet crop like rice, it has witnessed many changes which have been effective in changing the scenario of rice cultivation in the state from early sixties to late seventies. At State level the trend of fluctuations for area, output and yield seems to have maintained a dynamic balance between themselves, to let rice


REGION 1-RICE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
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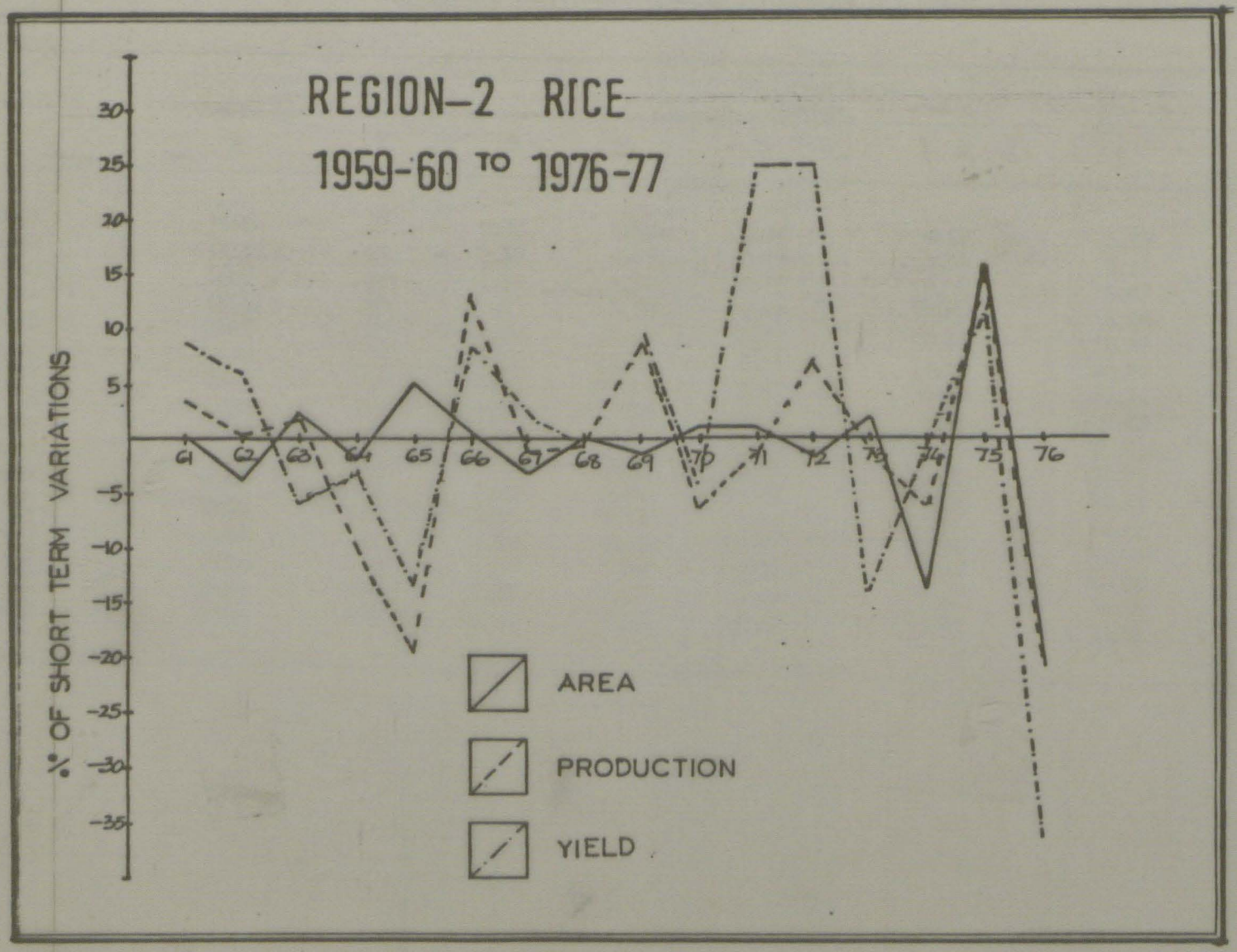
AREA
PRODUCTION
YIELD

Fig. 4.7

TABLE : 4.7

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION - I (RICE)*

YEAR	AREA			PRODUCTION *(lakhs)*			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	910	197	17.79	2,27	0.10	4.27	12.42	0.92	- 7.97
1961-62	1003	103	9.37	2.11	0.26	11.46	10.30	1.20	10.41
1962-63	844	48	-6.03	1.81	⅔0.22	-14.01	9.14	1.23	-15.51
1963-64	701	72	11.52	1.58	0.12	- 8.38	8.74	0.74	9.29
1964-65	708	30	-4.43	12.48	10.76	-18.25	55.46	45.14	-13.44
1965-66	833	14	-1.83	28.85	5.41	15.80	113.32	34.75	23.47
1966-67	970	33	3.33	50.57	1.91	9.17	182.42	7.85	-4.32
1967-68	1117	29	-2.68	56.37	10.50	13.80	192.11	46.51	19.49
1968-69	1221	38	3.09	61.89	10.20	-15.81	192.32	36.18	-23.17
1969-70	1298	17	1.33	62.81	4.33	6.46	174.15	8.05	4.42
1970-71	1241	77	5.88	58.75	10.86	15.61	165.59	18.53	10.06
1971-72	1154	65	-6.01	53.70	14.22	-21.02	161.97	31.51	-24.15
1972-73	1048	7	0.73	43.70	8.31	15.98	149.79	21.53	12.57
1973-74	1077	77	-7.75	49.66	10.04	-25.37	169.65	22.05	-14.94
1974-75	1007	168	-14.33	46.77	10.57	18.44	174.99	15.05	7.92
1975-76	1040	193	-22.82	54.51	11.11	-25.69	191.67	4.35	- 2.32


REGION–2 RICE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
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AREA
PRODUCTION
YIELD

Fig. 4.8

TABLE 4.8

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : REGION II (RICE)

YEAR	AREA			PRODUCTION (lakhs)			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	1699	9	0.56	4.52	0.34	- 8.19	5.28	0.40	- 8.13
1961-62	1753	44	- 2.59	4.43	0.25	- 6.09	5.11	0.23	- 4.64
1962-63	1807	34	1.85	4.79	0.15	3.07	5.47	0.09	1.56
1963-64	1905	33	- 1.81	5.79	0.54	-10.38	6.26	0.28	- 4.63
1964-65	2055	51	- 2.56	22.97	15.77	19.30	19.66	12.43	- 178 8
1965-66	2112	177	7.75	48.26	8.21	14.54	43.27	2.49	5.44
1966-67	2216	172	- 8.45	81.12	0.01	0.03	71.75	5.07	6.60
1967-68	2253	61	2.67	10.01	5.60	5.30	86.28	6.40	6.91
1968-69	2360	39	1.66	10.18	11.72	10.33	85.69	3.65	4.09
1969-70	2385	19	- 0.81	10.02	14.01	-16.26	83.10	8.06	- 10.75
1970-71	2295	93	3.92	9.02	10.62	10.53	79.77	5.16	6.07
1971-72	2254	123	- 5.81	9.56	11.94	-14.26	84.18	4.83	- 6.08
1972-73	2208	35	1.60	9.12	11.11	10.86	80.93	7.32	8.29
1973-74	2253	4	- 0.19	9.06	2.95	- 3.37	83.55	8.35	- 11.10
1974-75	2161	105	4.67	7.67	5.12	6.26	75.69	11.51	- 13.20
1975-76	2166	199	- 10.12	7.91	18.52	-30.54	73.65	8.97	- 13.87

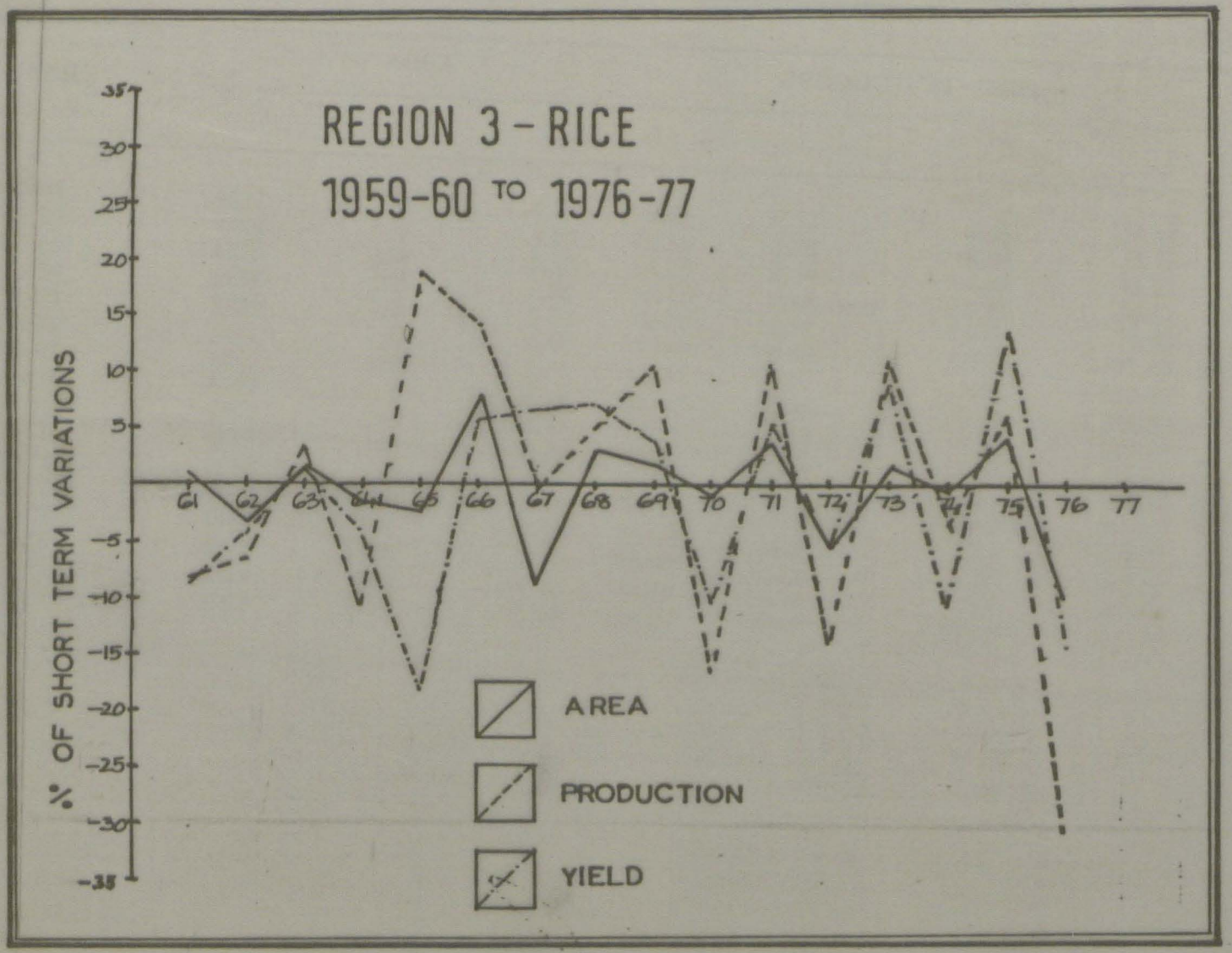
emerge as one of the important crops of the State. Having examined the pattern at State level, we now look in to the regional position so as to get a closer look at the spatial dimension.

Region I

In earlier analysis we noticed that region I which is a low rainfall area suffers from great instability in its agriculture. This fact gets a further support in cultivation of rice which is clear from figure 4.7 During entire period yield output and area has experienced continuous ups and downs in their values. The trend deviation, however, was more sharp, in the case of output yield in some year touching 25% limit on both positive and negative side. The deviation in the case of area was not that pronounced and never went beyond 5% limit, except after 1973, after which area has shown great negative swing to the extent of 25%. It is clear that the rice economy of region has been constantly suffering from the phenomena of instability in its area output and yield

Region II

Region II also suffers from the same degree of instability in cultivation of rice. Although this region has a slightly higher rainfall (low-medium) but it irrigates a smaller proportion of area under rice than in region I. So irrigation level is not adequate enough to provide protection against the failure of natural rainfall. The area under rice has shown a regular deviation from the normal. However, the amplitudes were not very pronounced till 1973. after which there was a sudden dip and an increase upto 1975. In general, deviation in area had maintained a low profile.


REGION 3 - RICE
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
35
30
25
20
15
10
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-5
-10
-15
-20
-25
-30
-35
61
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AREA
PRODUCTION
YIELD

FIG. 4.9

TABLE : 4.9

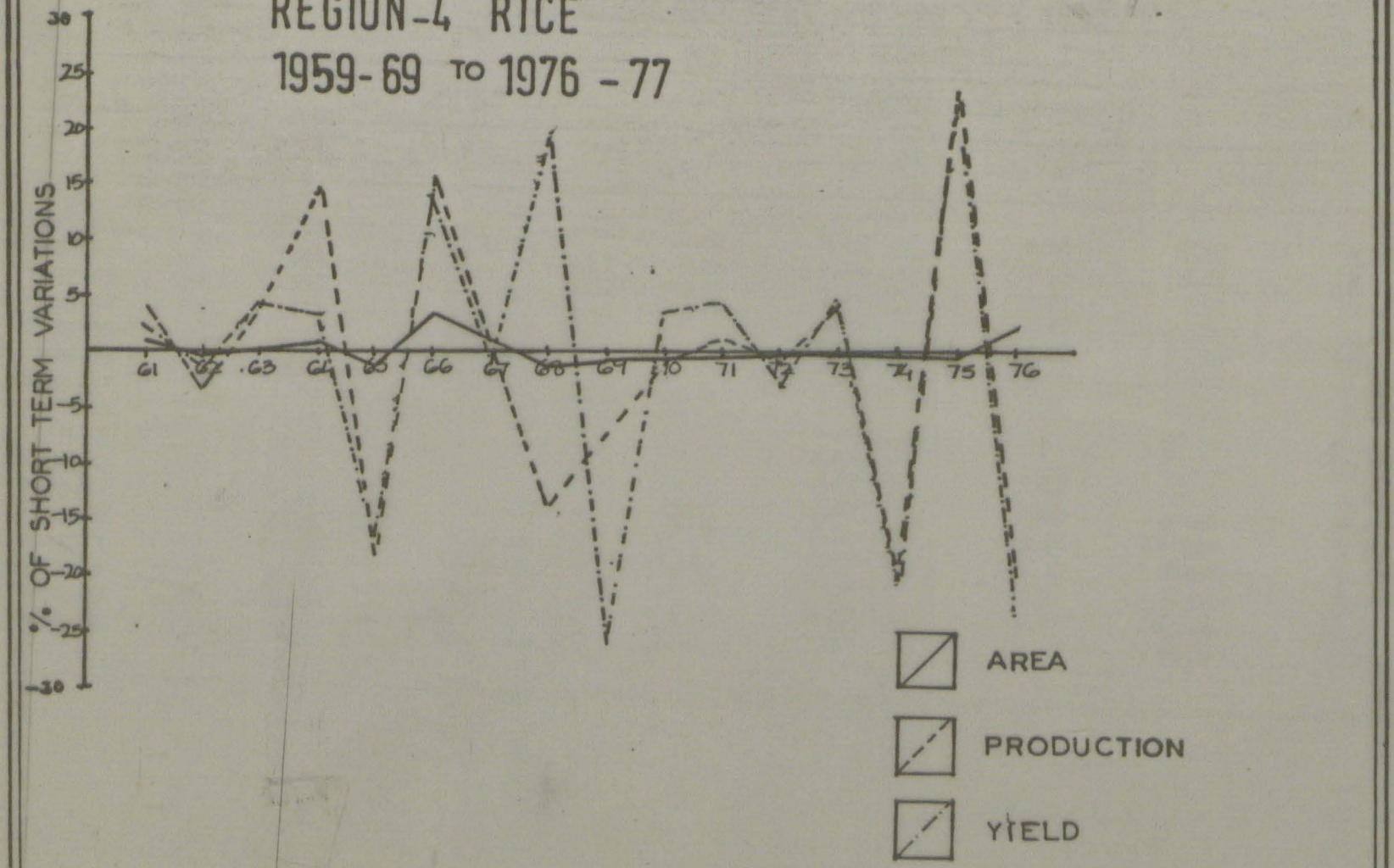
TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION-III (RICE)*

YEAR	AREA			PRODUCTION *(lakhs)*			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	4531	18	0.04	14.84	0.53	3.51	34.44	3.24	8.61
1961-62	4709	176	- 3.89	15.45	0.06	- 0.40	35.36	2.32	6.19
1962-63	4933	128	2.55	15.22	0.34	2.25	32.51	1.79	- 5.84
1963-64	5308	104	- 2.00	16.17	1.45	- 9.92	30.12	10.98	- 3.36
1964-65	5374	284	5.03	38.22	19.91	-19.72	71.49	40.99	-13.38
1965-66	5227	32	0.62	71.15	10.58	12.95	141.40	13.42	8.67
1966-67	4913	150	- 3.17	113.49	1.01	- 1.01	233.47	5.42	2.27
1967-68	4727	8	- 0.18	145.60	0.35	- 0.24	308.83	2.14	- 0.07
1968-69	4769	69	- 1.47	162.51	15.56	8.74	343.35	37.55	9.86
1969-70	4845	44	0.90	174.77	10.56	- 6.44	356.11	13.64	- 3.98
1970-71	4888	58	1.19	186.62	4.57	- 2.51	431.35	86.39	25.04
1971-72	4907	79	- 1.65	198.45	15.17	7.10	454.17	152.46	25.03
1972-73	4846	101	2.06	201.49	1.81	- 0.91	469.57	58.65	-14.27
1973-74	6323	1560	-13.77	203.30	12.11	- 6.34	391.89	0.74	- 0.19
1974-75	5957	3302	15.66	165.06	53.98	15.65	330.88	42.71	11.43
1975-76	5968	2119	-19.05	158.07	73.12	-20.07	310.79	82.89	-36.37

Yield on the other hand has developed a distinct pattern in this area. In fact it has shown a very erratic pattern through out the period. There has been a steep decline in yield upto 1965, which picks up by 1966. The period between 1970 to 1973 has shown a very peculiar type of increase which shows a positive deviation to the extent of 25%. The yield rate has been suffering from negative and positive ups and downs during the entire period under study. During none of the years it has experienced stability. Output values have also followed the same trend as that of the yield indicating strong association between the deviation in output and yield in region II(see table(4.8).

Region III The pattern of rice cultivation becomes more interesting as we move away from the instable dry areas to moderate areas like region III. This region is one of the most important rice growing regions of the State. It receives good rainfall and has a moderate to high level of irrigation. The fluctuations in area has been quite regular during the entire period. The negative or positive deviation have never crossed 5% limit on both side. The only exception being year 1966-67 and the last year 1976. Barring these two years, there has been regular but moderate deviation in area under rice.

The trend deviation in yield and for that matter in output were more pronounced & strong as compared with deviation in area. The deviation have been quite regular and some moving away to the extent of 20% on both side. The fluctuation in output again were strongly associated with the fluctuation in yield and less with cropped area under rice. What is interesting is that while there were positive deviations during some year, there were equal number of negative deviation. This could be avoided by developing irrigation at moderate level.


REGION-4 RICE
1959-69 TO 1976-77
% OF SHORT TERM VARIATIONS
30
25
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-5
-10
-15
-20
-25
-30
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AREA
PRODUCTION
YIELD

F14 4.10

TABLE . 4.10

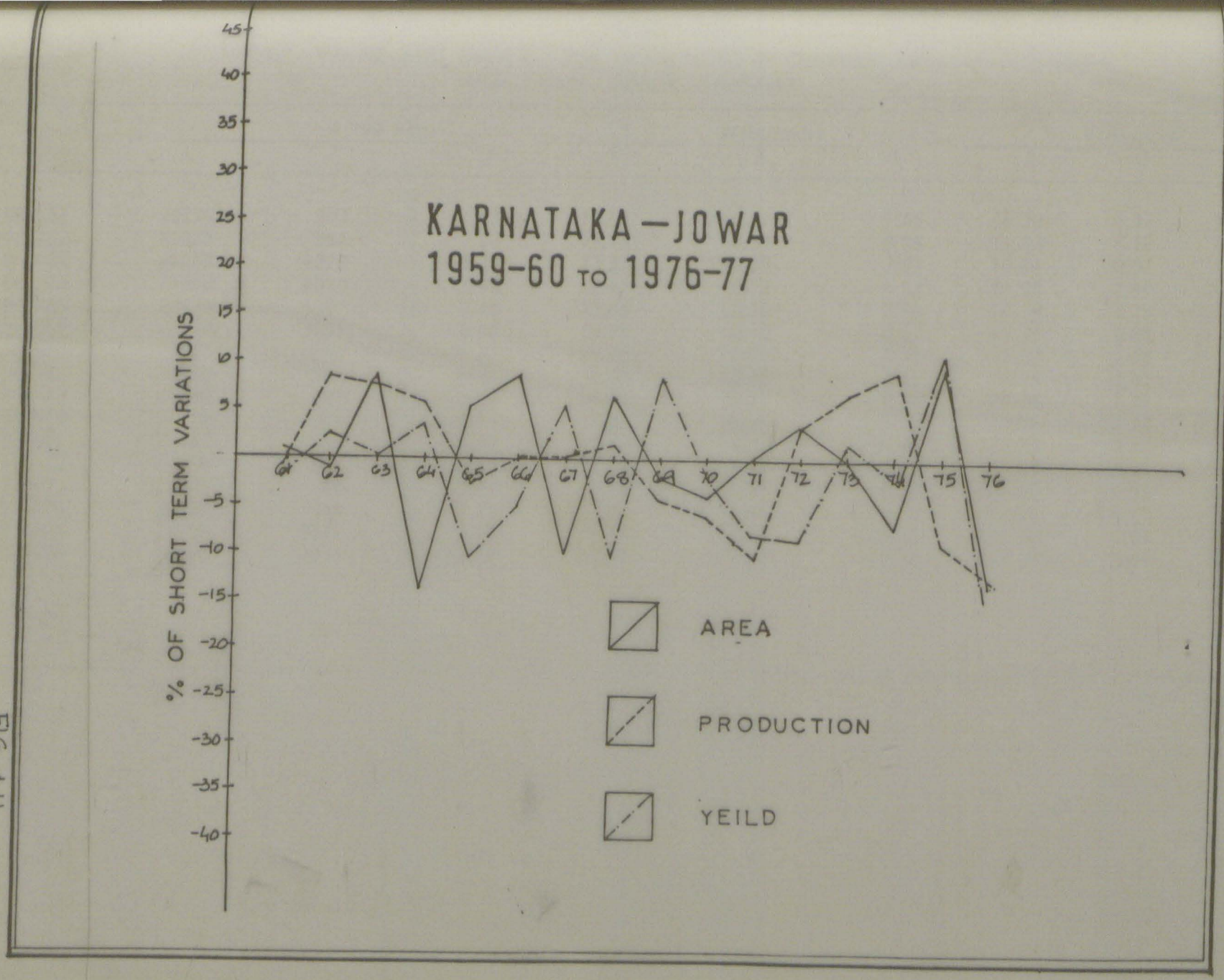
TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION IV (RICE)*

YEAR	AREA			PRODUCTION *(lakhs)*			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	3310	271	0.81	8.80	0.40	4.44	9.42	0.24	2.45
1961-62	3344	7	- 0.23	9.48	0.26	- 2.89	9.81	0.15	- 1.59
1962-63	3361	1	0.03	9.62	0.39	3.91	9.64	0.48	4. 78
1963-64	3372	13	0.39	8.18	1.45	15.05	8.86	0.27	2.96
1964-65	3424	53	- 1.59	23.60	18.68	-18.43	23.99	16.66	-17.29
1965-66	3412	105	3.00	47.69	8.55	15.21	47.87	7.64	13.76
1966-67	3342	5	0.15	81.91	0.56	0.05	81.45	0.68	-00.85
1967-68	3214	51	- 1.64	93.38	14.20	-13.20	87.16	20.92	19.36
1968-69	3140	7	- 0.24	97.29	6.65	- 7.34	91.33	18.70	-25.75
1969-70	3133	7	- 0.25	94.67	0.99	- 1.07	89.75	3.54	3.79
1970-71	3137	4	- 0.15	98.83	0.86	0.87	98.90	4.43	4.29
1971-72	3147	2	- 0.09	103.58	0.45	- 0.44	102.82	2.74	- 2.73
1972-73	3139	15	0.49	103.45	4.47	4.15	99.85	5.19	4.94
1973-74	3124	4	- 0.14	119.19	19.88	-20.03	114.50	20.08	-21.27
1974-75	3092	4	- 0.16	115.79	34.52	22.97	110.26	33.79	23.45
1975-76	3007	51	1.69	17.16	19.40	-19.85	115.27	22.94	-24.85

Region IV

Figure 4.10 indicated a very interesting pattern of variability for rice in region IV. It reveals that except for some positive increase in the area under rice in 1966, during the period the area has not shown any deviation. In fact the line of trend deviation was very close to the normal line. So during the period, area seems to have remained almost constant with a minimum deviation. Opposite is the situation with regard to trend deviation in output and yield. The deviation in output and yield has been most erratic. Except some minimum deviation during 1970-75, during rest of the year both yield and output has experienced sudden ups and downs in its level. In fact negative deviation in this variable went up to 20 to 30% in some year. The reason for such a situation is not difficult to explain. Region IV has higher rainfall but some it is concentrated in limited time period of the monsoon. Any uncertainty in the time or level of rainfall is not safeguarded by artificial supply of water as the irrigation level is low in this region. Further, whatever limited irrigation facilities is available is concentrated more on sugarcane crops, which increasingly acquire importance in this region. Region IV has a higher variability factor than region III. It solely depends on rainfall, which has very high irrigation pattern in this area has not been developed widely, which is probably the reason for so severe a fluctuation for yield. As mentioned before, rice is a crop being replaced fastly by sugarcane in terms of area.

In conclusion one could therefore say that region I and region II are areas in which cultivation of rice suffers from the phenomena of variability. Region III is perhaps the only region in which instability is of reasonable level. So this region seems to be more suitable for rice cultivation, more so because rice is showing a negative trend for production in Region II.


KARNATAKA – JOWAR
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
45
40
35
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-20
-25
-30
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AREA
PRODUCTION
YEILD

FIG-4.11

TABLE 4.11

TREND VALUE AND SHORT TERM DEVIATIONS IN CROPPED AREA, PRODUCTION AND YIELD : STATE (JOWAR)

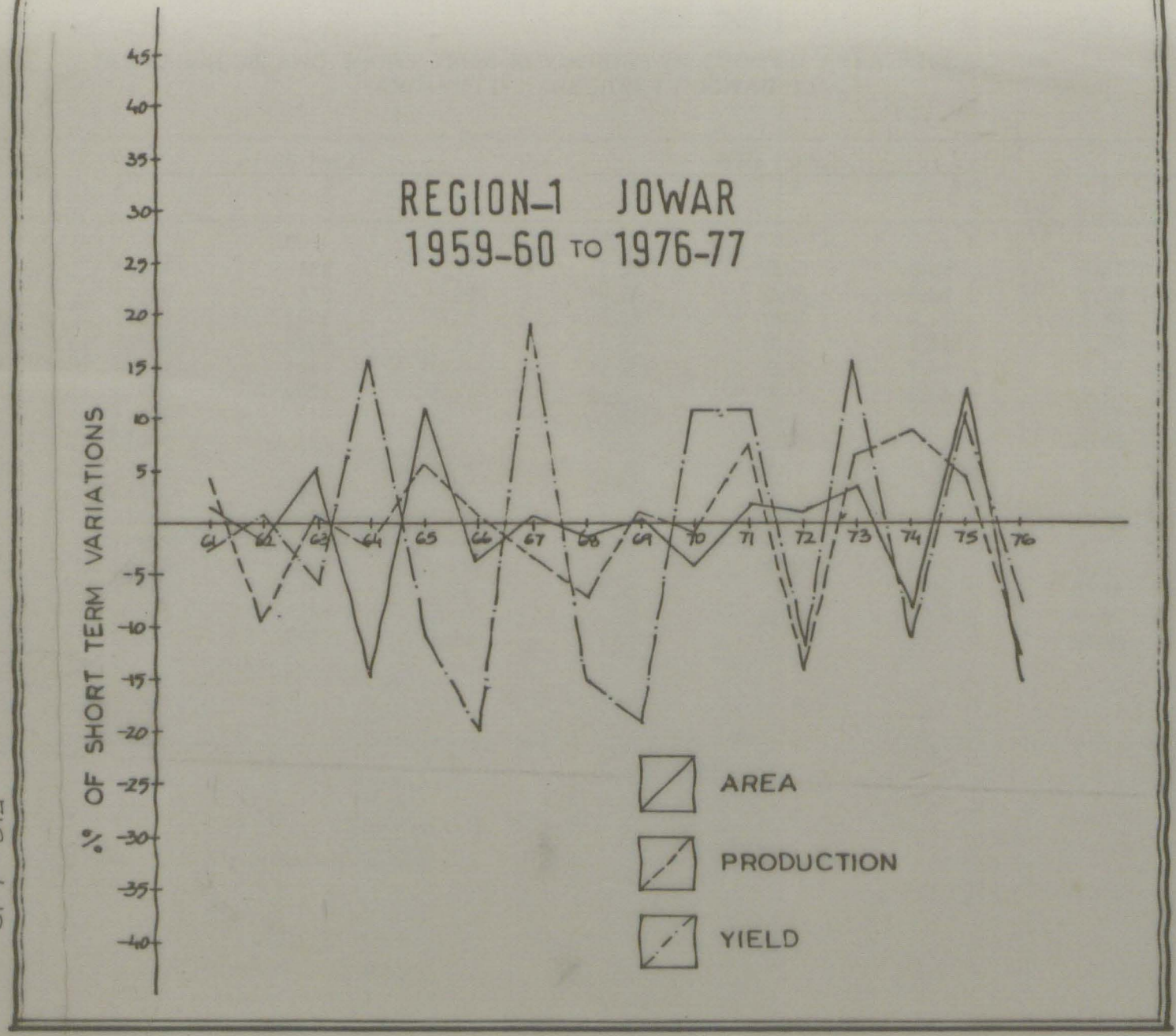
Years	A('00 hec)			P(Rs/lakh)			Y(Rs/hec)		
	1	2	3	1	2	3	1	2	3
1960-61	29270	303	1.03	13.08	0.31	- 1.06	9.30	6.02	- 0.23
1961-62	29858	361	- 1.23	13.15	0.39	8.06	11.53	0.12	2.44
1962-63	26280	4223	8.85	13.31	0.29	7.87	10.84	0.02	- 0.31
1963-64	24860	6019	-13.95	13.41	0.12	5.52	11.38	1.40	3.55
1964-65	23934	1301	5.16	13.66	0.16	- 2.50	10.78	2.25	11.11
1965-66	25319	2406	8.68	13.73	0.17	- 0.67	10.31	0.88	- 5.76
1966-67	25381	2385	-10.37	14.74	0.07	0.36	12.67	1.86	5.15
1967-68	23768	1654	6.51	14.64	0.03	1.85	18.25	3.41	-10.41
1968-69	23350	465	- 2.03	14.89	0.13	- 4.59	20.71	1.24	8.05
1969-70	22709	964	- 4.44	15.00	1.21	- 6.34	23.02	1.23	- 1.98
1970-71	23287	209	0.89	15.64	0.82	-10.12	25.30	0.49	- 8.00
1971-72	23759	861	3.50	15.89	0.86	3.64	32.25	0.54	8.77
1972-73	23078	80	0.35	16.13	1.31	6.80	60.92	9.50	1.47
1973-74	21323	1564	- 7.29	16.61	1.01	9.17	112.84	6.57	- 1.70
1974-75	21323	3124	9.78	16.38	2.51	- 8.56	128.36	5.93	10.59
1975-76	20881	2814	-12.58	16.62	2.52	-12.88	118.78	3.01	-14.63

This does not mean that rice is loosing its importance in the state as a major crop. If rice is loosing its hold on area in region IV, it is gaining in area under its cultivation in region II and region I(to some extent) where the irrigation level is high.

Jowar

Jowar occupies a maximum proportion of cultivated area in the State (about 25%) and therefore it is the main crop of the State. It is essentially a crop for the dry areas, where the level of instability is high. Instability can be controlled basically by dependable rainfall or assured irrigation. But in area where jowar is grown,neither of these two exists. So this crop continues to suffer from the phenomena of instability. Jowar being a main crop in the State, it would therefore be interesting to study the instability situation in the case of this crop. Table 4.11 and fig. 4.11 show short-term deviations in area, output and yield for jowar at the State level. The fluctuation in area turned out to be quite prominent during 1959-60 to 1965-66. However 1965-66 onwards the result showed a somewhat subdued pattern in terms of area fluctuation. A very interesting factor to be noticed is that during the drought period, of 1970-73,there were minimum fluctuations in area under jowar at the over all level. This brings out the drought resistance quality of this particular crop. Yield variability for jowar has maintained a rather normal behaviour with a subdued deviation trend.Yield level at the overall level as such is not exceptionally high (table 4.11 though it has picked up towards the tail end of the period. It may be noted that unlike area, the fluctuation in the yield rate were quite high during drought years of 1970-73.

In fact the situation output front should bring out a clear picture of the status of this crop in the State. Table 4.11 does


REGION-1 JOWAR
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
45
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AREA
PRODUCTION
YIELD

FIG-4.12

TABLE 4.12

TREND VALUE AND SHORT TERM DEVIATIONS IN CROPPED AREA PRODUCTION AND YIELD : REGION I (JOWAR)

Years	A('00 hec)			P(Rs lakhs)			Y(Rs/hec)		
	1	2	3	1	2	3	1	2	3
1960-61	13971	188	1.33	11.06	0.50	4.38	5.21	0.12	- 2.36
1961-62	14330	279	- 1.99	10.79	0.86	- 8.68	4.50	0.02	0.52
1962-63	13273	1506	5.20	10.85	0.01	0.15	5.28	1.40	- 6.08
1963-64	13418	2429	-14.11	11.97	0.21	- 1.82	5.19	2.25	15.29
1964-65	12644	1841	10.71	12.56	0.72	5.44	5.12	0.88	-10.83
1965-66	12948	4891	- 3.93	12.53	0.11	0.91	5.55	1.86	-20.41
1966-67	11838	615	0.52	12.04	0.38	- 3.27	5.31	3.41	19.14
1967-68	11308	152	- 1.37	12.65	0.83	- 7.08	4.75	1.24	-15.33
1968-69	10843	26	0.24	14.36	0.13	0.90	3.25	1.23	-19.89
1969-70	10968	463	- 4.41	16.95	0.18	- 1.08	3.73	0.49	11.52
1970-71	11310	219	1.90	15.37	4.21	12.50	4.42	0.54	10.95
1971-72	11785	111	0.94	14.34	4.56	-14.69	12.57	9.50	-12.64
1972-73	11488	440	3.69	12.72	0.92	6.79	16.91	10.78	15.59
1973-74	12350	1710	- 8.08	13.43	1.31	8.90	23.55	4.57	-11.72
1974-75	11105	3377	13.32	11.36	0.54	4.54	28.05	5.93	10.99
1975-76	10767	2574	-15.43	9.63	2.19	-12.57	30.79	3.61	- 7.05

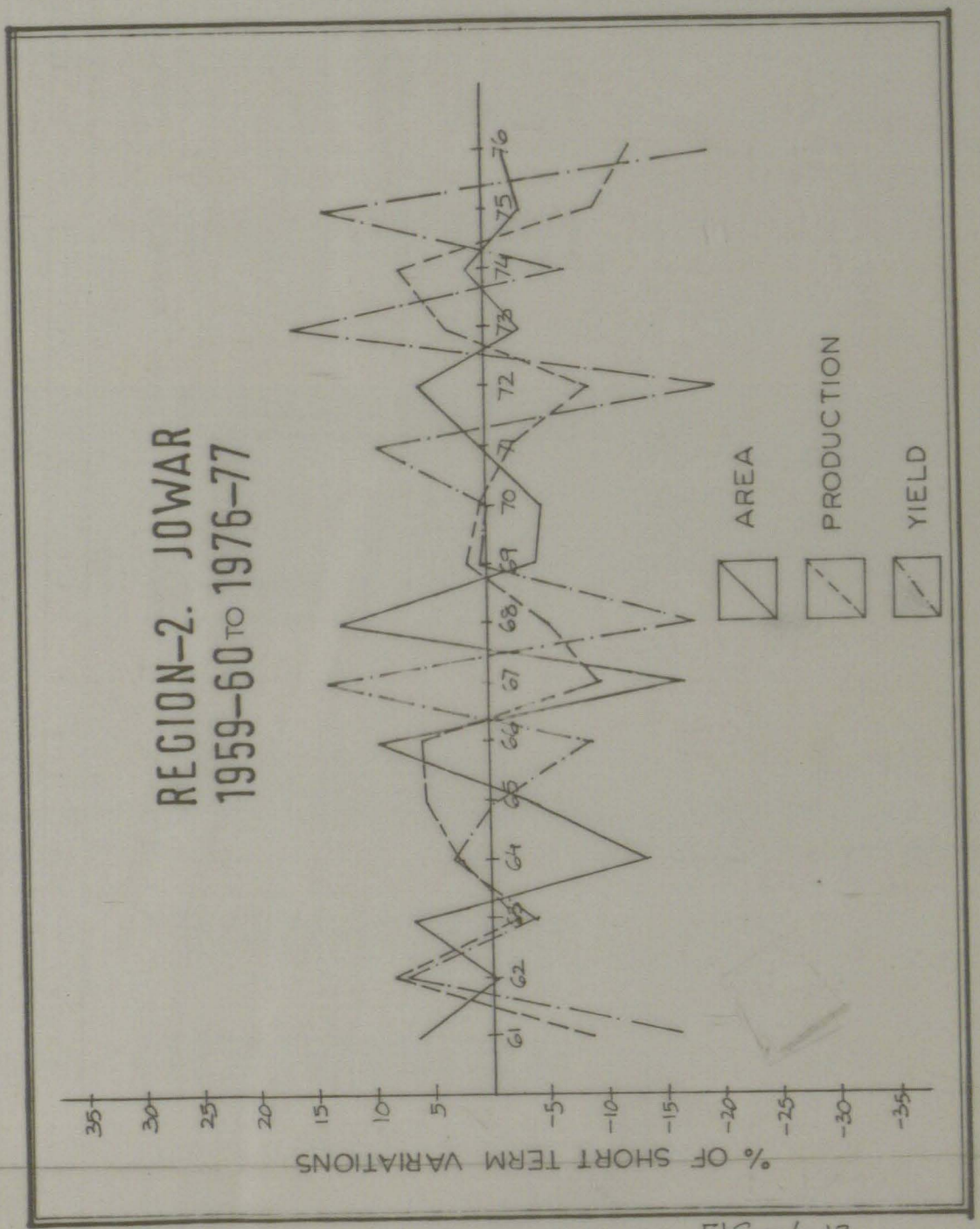
not present a rosy picture for jowar in terms of its variability status. Output has shown a fair amount of variation in its level and this has occurred both due to area and yield, more so due to area than yield.

Region I

Since the rainfall and irrigation is low in this particular region, it has become an ideal area for cultivation of low value crops such as jowar. Table 4.12 indicates that fluctuation in area has shown a definite and regular pattern of fluctuations till 1965-66(fig. 4.12. Thereafter, however, it has shown a trend close to the normal upti 1974 after which it suddenly shoots up over the time. Area under jowar has experienced decline but this was accompanied with low level of fluctutions in areas. Per hectare yield in the case of jowar is very low but besides yeld being low, it has also shown relatively frequent fluctuations which are quite high. These fluctuations were uniformaly noticed during the entire period under study. What is worse is that most of these deviations were negative in nature thereby indicating a decline in yeld rate of jowar. The output variability in area seems to coincide with that of area in Region under jowar. The overall output has seen a decline in period I ending in 1966-67 to a period thereafter with a peak during 1969-71. Because of the low yield and high instability in jowar, we notice a continuous decline in area jowar in this region. The farmers in this region have tried diversified cropping pattern in favour of rice and groundnut, especially under the canal lined land.

Region II

Like the earlier region (Region I), this region has also experienced deterioration in the area under jowar. Fluctuating trend


REGION-2. JOWAR
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
35
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-20
-25
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-35
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AREA
PRODUCTION
YIELD

FIG.-4.13

TABLE 4.13

TREND VALUE AND SHORT TERM DEVIATIONS IN CROPPED AREA PRODUCTION AND YIELD: REGION II(JOWAR)

Years	Area('00 hec)			P (lakh)			Yield		
	1	2	3	1	2	3	1	2	3
1960-61	14835	98	0.66	9.81	1.55	- 8.79	10.77	1.47	-15.81
1961-62	15069	72	- 0.48	10.16	0.98	8.86	10.56	0.97	6.44
1962-63	12689	2587	6.49	11.34	0.26	- 2.44	11.25	0.41	- 3.78
1963-64	11128	3334	-12.78	11.47	0.33	2.80	11.00	0.38	3.34
1964-65	10972	659	- 3.39	10.92	0.62	5.41	10.82	0.04	- 0.40
1965-66	11916	2893	9.54	8.89	0.52	5.56	11.25	0.94	- 9.15
1966-67	13051	2424	-16.82	7.39	1.68	- 9.44	10.41	2.26	13.84
1967-68	11934	1781	12.99	7.42	0.36	- 5.21	10.54	2.29	-17.80
1968-69	11966	505	- 4.41	9.31	0.18	1.90	10.66	1.05	0.47
1969-70	11229	508	- 4.74	11.44	0.08	0.34	13.01	1.78	0.08
1970-71	11454	51	0.45	11.76	1.65	- 2.37	13.52	9.91	9.61
1971-72	11440	696	5.74	30.54	2.88	- 9.00	48.16	11.08	-20.12
1972-73	11037	360	- 3.37	51.91	1.84	3.39	85.84	9.25	16.58
1973-74	10139	159	1.55	71.67	3.82	7.50	137.61	15.99	- 7.21
1974-75	9731	289	- 3.06	76.52	4.75	- 9.68	137.56	19.99	13.90
1975-76	9617	163	- 1.73	97.67	5.01	-12.66	151.25	24.47	-19.52

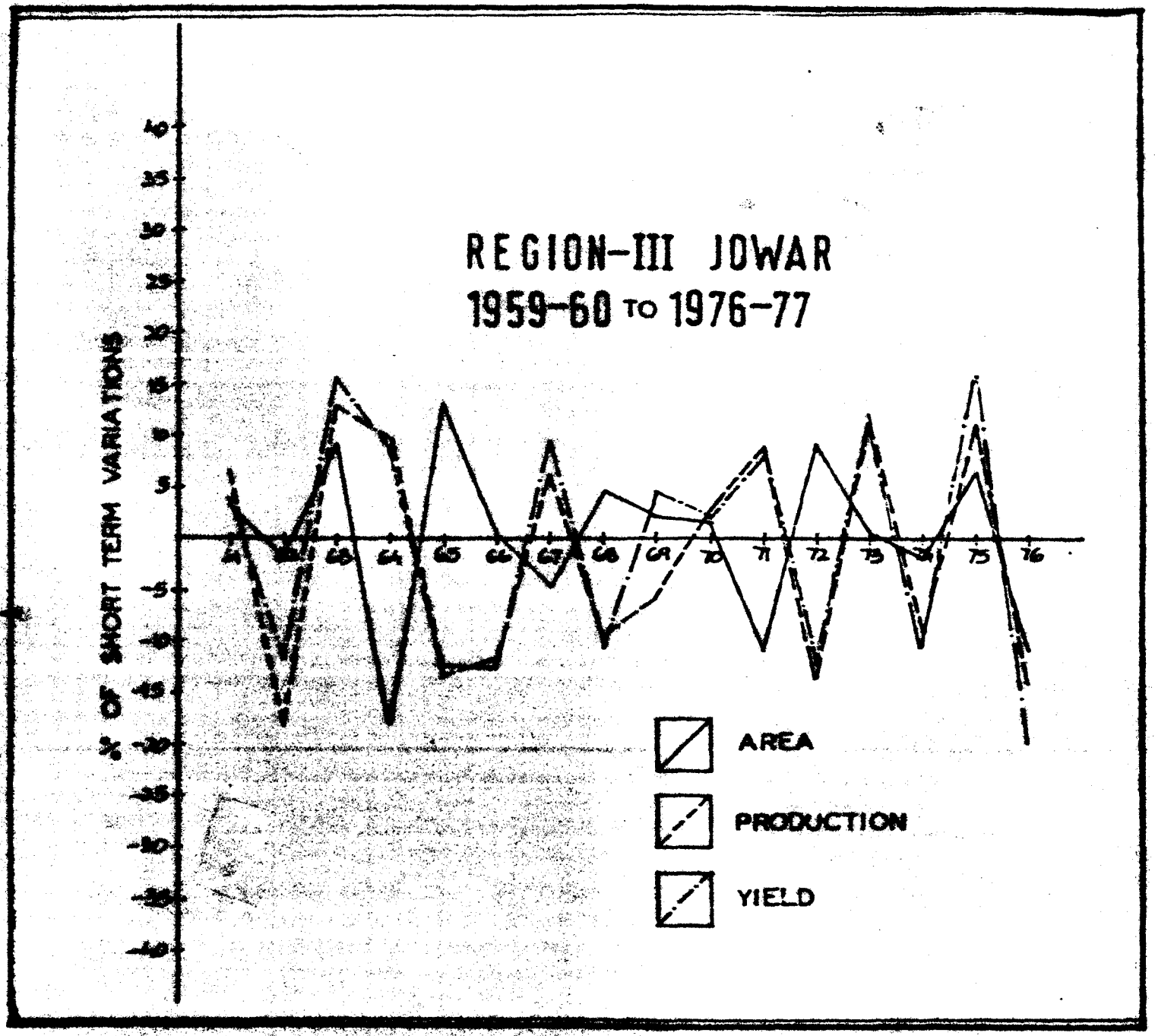

REGION-III JOWAR
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
AREA
PRODUCTION
YIELD

TABLE : 4.14

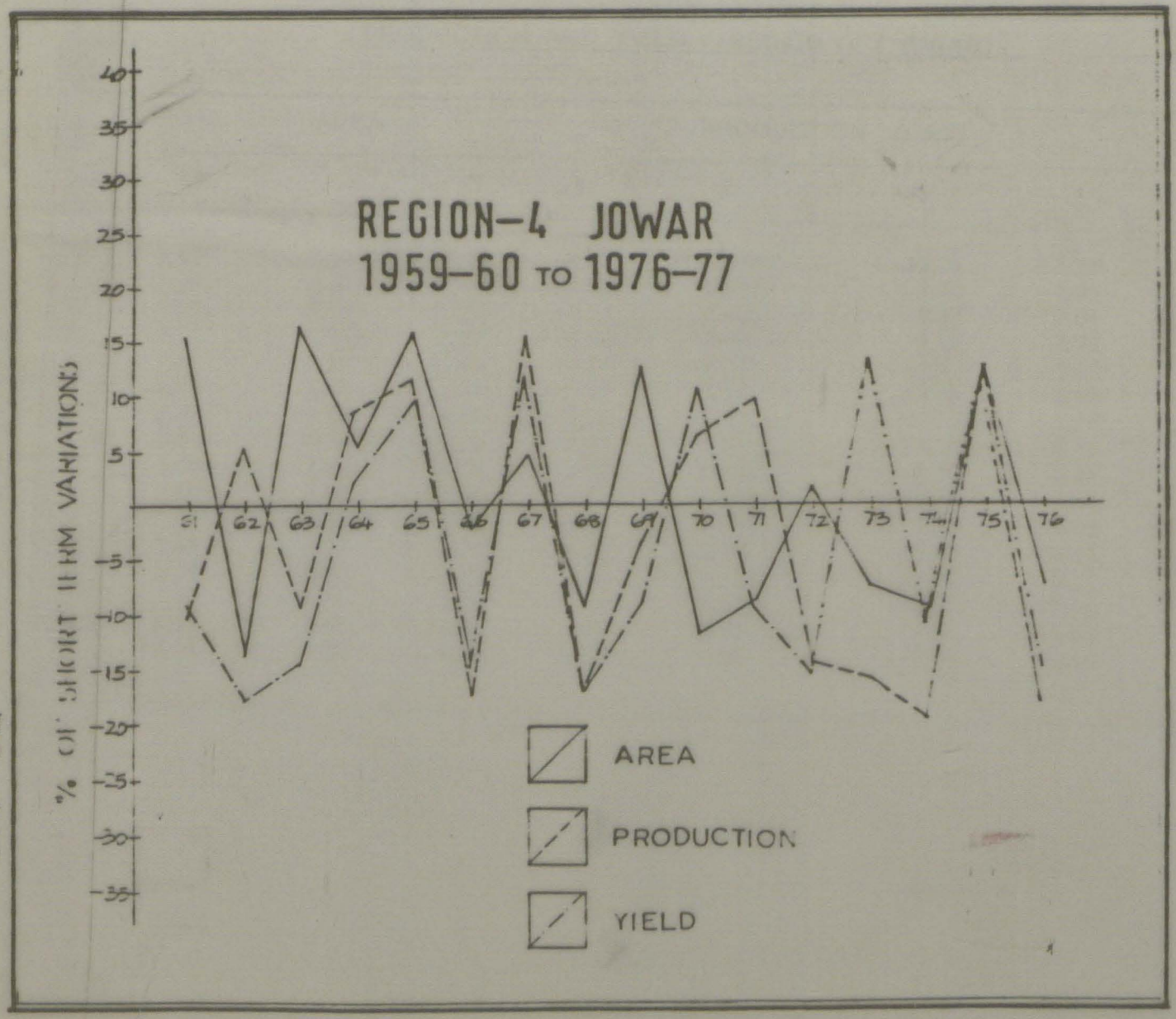
TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION III (JOWAR)*

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	461	15	3.24	0.62	0.12	6.72	1.90	0.37	6.30
1961-62	456	9	- 2.15	0.63	0.31	-18.47	1.87	0.94	-11.08
1962-63	317	128	8.85	0.64	0.19	13.09	1.87	0.54	15.54
1963-64	312	254	-18.08	0.71	0.07	9.70	2.02	0.24	8.47
1964-65	315	118	13.34	0.57	0.08	-13.56	1.62	0.22	-12.95
1965-66	451	2	0.56	0.50	0.05	-11.81	1.40	0.19	-12.70
1966-67	488	22	- 4.83	0.53	0.03	6.02	1.44	0.15	9.43
1967-68	520	25	4.68	0.63	0.05	- 9.66	1.71	0.19	-10.50
1968-69	536	12	2.20	0.80	0.04	- 5.72	2.11	0.09	4.62
1969-70	507	8	1.57	1.05	0.03	2.68	2.74	0.06	2.02
1970-71	519	60	-10.31	1.14	0.16	8.78	2.90	0.51	8.96
1971-72	529	53	9.21	3.65	2.62	-13.63	9.51	7.02	-13.79
1972-73	547	1	0.07	6.62	2.00	11.19	16.90	5.72	12.30
1973-74	523	12	- 2.43	11.76	1.54	- 9.16	28.81	3.23	-10.63
1974-75	444	33	6.50	11.45	4.99	12.39	27.46	10.77	15.18
1975-76	486	74	-12.13	13.43	5.74	-14.75	31.51	12.95	-19.79

has decreased over period of time. As regards yield,it has shown an increase in its level. However increase in the yield rate was accompanied wth high fluctuation yield level. This has happened probably due to the highly erratic behaviour of availability of water for this crop. Due to the increase in the yield level the output has, therefore, shown an increasing trend presumably due to expansion of area, HYV of jowar. An increase in the level of output (on account of rise in yield rate) was however not accompanied by wide fluctuation in output during the period under consideration., which was a happy situation from the part of economy of jowar crop. Since this region depends normally on jowar which has shown growth with stability , it is, therefore, desirable for this region to be developed into an advanced belt for dry crops, through the practice of various dry farming techniques.

Region III

Table 4.14 shows the picture, a situation with regard to jowar in region III. The area under jowar has shown a slight increase from over period of time with a further decrease in tail end of poeriod under study. The decrease in the area under jowar was accompanied with year to year fluctuations which were more poredominant before 1966-67 than after it. In fact it is only after 1966-67 that there seems to be a steady trend for area. Yield per hectar of jowar in Region III is the lowest in the State and what is worst is that the low level yield is accompanied with highest magnitude of fluctuation in its yield level. It may be noted that jowar is a minor crop in this region and it is neglected in terms of the use of new inputs like irrigation, etc. The fluctuation in output is more or less on the pattern of yield rate.


REGION–4 JOWAR
1959–60 TO 1976–77
% OF SHORT TERM VARIATIONS
40
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
61
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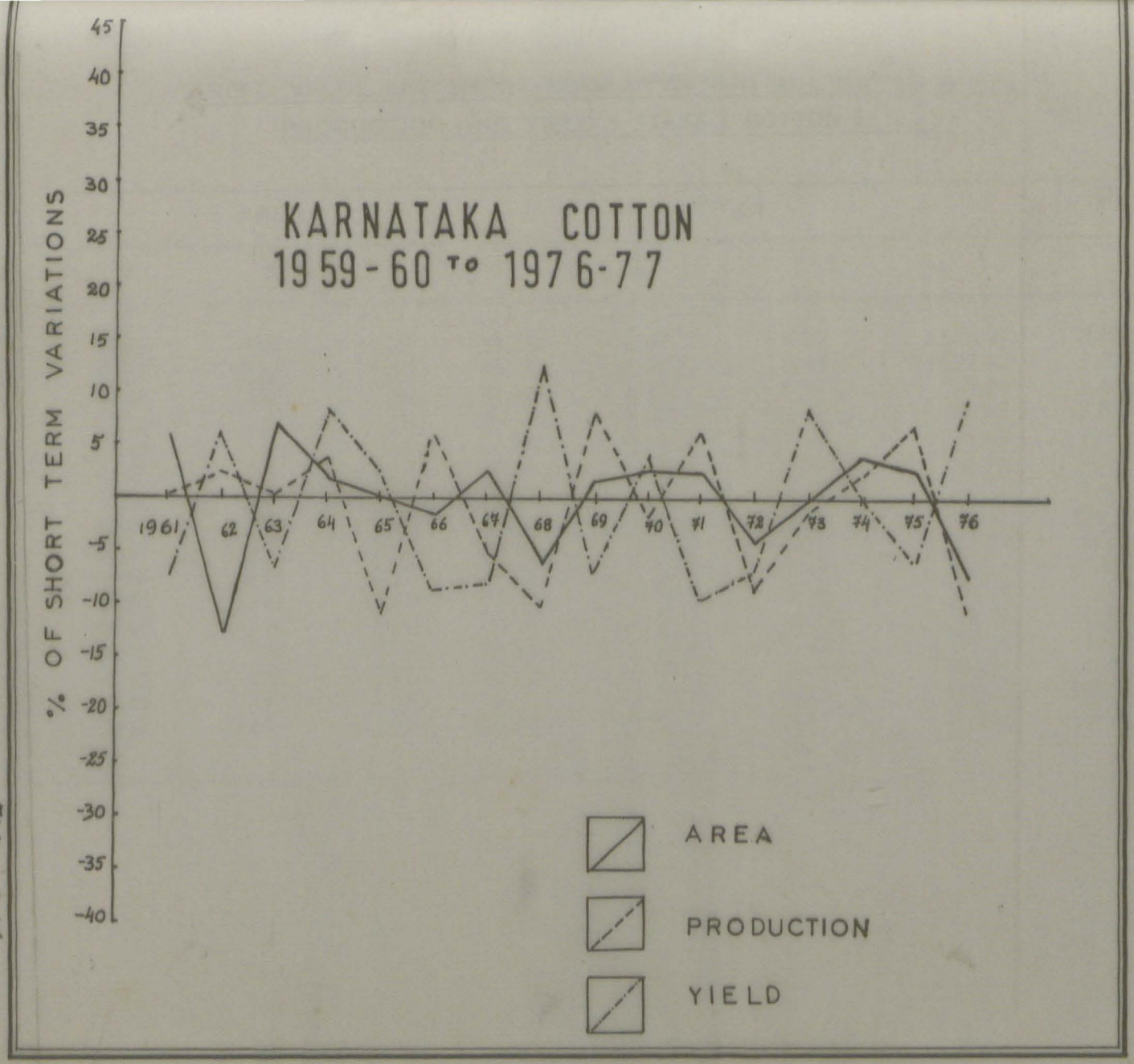
76
AREA
PRODUCTION
YIELD

FIG.–4.15

TABLE : 4.15

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION IV (JOWAR)*

YEAR	AREA			PRODUCTION *(Lacs)*			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	1.69	0.50	15.40	0.02	0.008	-10.05	2.40	0.22	- 9.94
1961-62	1.74	0.30	-13.88	0.02	0.001	5.74	1.85	0.28	-17.83
1962-63	1.00	0.50	16.54	0.03	0.006	- 9.97	2.06	0.26	-14.44
1963-64	1.15	0.15	5.61	0.03	0.003	8.95	2.75	0.06	2.25
1964-65	1.41	0.50	15.83	0.07	0.004	10.65	3.10	0.53	9.69
1965-66	2.39	0.05	- 2.14	0.07	0.03	-17.88	4.54	1.69	-15.30
1966-67	2.77	0.14	4.91	0.08	0.07	15.17	4.15	2.99	11.88
1967-68	3.91	0.84	- 9.36	0.05	0.04	-16.95	4.21	1.75	-16.14
1968-69	3.90	1.83	12.94	0.06	0.002	- 4.17	3.31	0.28	- 9.13
1969-70	3.80	0.89	-11.80	0.06	0.004	6.15	3.54	0.89	10.17
1970-71	3.11	0.35	- 8.80	0.06	0.070	9.78	3.69	0.54	- 9.14
1971-72	3.62	0.05	1.36	0.12	0.90	-13.73	14.53	11.04	-16.33
1972-73	4.76	0.33	- 7.60	2.14	1.21	16.24	25.13	11.82	13.99
1973-74	7.37	1.17	- 9.92	3.98	0.92	-19.94	43.44	8.49	-12.30
1974-75	8.88	2.60	12.66	3.77	1.74	11.64	41.83	16.60	14.41
1975-76	10.05	1.08	- 8.08	4.33	1.58	-17.99	45.60	13.49	-15.01


KARNATAKA COTTON
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
45
40
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
-40
1961
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63
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75
76
AREA
PRODUCTION
YIELD

Fig - 4.16

TABLE : 4.16

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : STATE (COTTON)

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	9293	995	6.06	75.33	0.92	0.23	23.31	0.45	- 7.19
1961-62	9115	1561	-12.67	74.94	1.87	2.44	22.87	1.32	5.84
1962-63	9273	682	6.86	72.28	0.32	0.31	24.84	6.43	6.58
1963-64	10019	191	1.86	65.12	2.39	3.55	40.51	2.01	8.10
1964-65	10064	25	0.26	61.49	6.14	-11.11	51.81	1.91	2.26
1965-66	9965	172	- 1.76	58.06	3.54	5.76	71.95	1.45	- 8.67
1966-67	9761	252	2.52	60.17	2.94	- 5.15	81.72	0.62	- 8.26
1967-68	10068	590	- 6.23	68.11	6.42	-10.41	77.33	0.63	12.10
1968-69	10536	176	1.65	78.54	6.37	8.05	83.96	0.97	- 6.94
1969-70	11126	291	2.56	90.27	1.75	- 1.98	92.03	1.01	3.54
1970-71	10990	257	2.29	89.14	7.75	6.00	93.45	1.35	- 9.68
1971-72	10755	450	- 4.37	89.19	7.19	- 8.77	84.31	2.91	- 7.07
1972-73	10725	12	- 0.11	89.99	1.30	- 1.47	91.93	3.02	8.33
1973-74	10739	417	3.75	100.98	2.92	1.70	122.91	1.56	0.02
1974-75	10089	258	2.50	102.78	7.31	6.59	135.63	0.93	- 6.23
1975-76	9834	1071	- 7.22	107.86	9.96	-10.83	158.93	2.56	9.01

In the conclusion it may be noticed that it can be said that jowar which is main crop grown in Regions I and II, is faced with a very high level of instability due to lower rainfall and inadequate facilities of irrigation on this region.

Cotton

Cotton is a dry crop which is mostly grown in region I and II of this State. Karnataka State, in fact, rates quite high in cotton production in the country. Black cotton soil is mostly prevalent in region I and I. As a matter of fact the production in area under jowar is being shifted to cotton which is a commercial crop. Cotton being an important crop in regions I and II, it would be interesting to study the trends and short term deviations in its area, yield and output.

At the overall level we noticed a wide fluctuation on short term deviations in area under cotton, the fluctuation being relatively higher before 1966-67 than those after 1966-67. The high yielding varieties for cotton have not been introduced in the state as yet. The short staple variety is still a favourite among the farmers. It was only towards the tail end of 70s that a small area was put to the use of HYV permanently on irrigated areas. Since this crop has yet (at least during the period under consideration) not come under the influence of new technology(such as use of HYV), the overall yield rate per hectare has been very low. But what is worse is that apart, from effect of low yield(compared with sugarcane or with cotton in other State or areas) it also suffers tremendously from the instability on yield rates. Throughout the period under study the yield level has experienced a regular (but a constant)ups and downs (both regular practice) the downward swings were pronounce during 1968 and 1972.

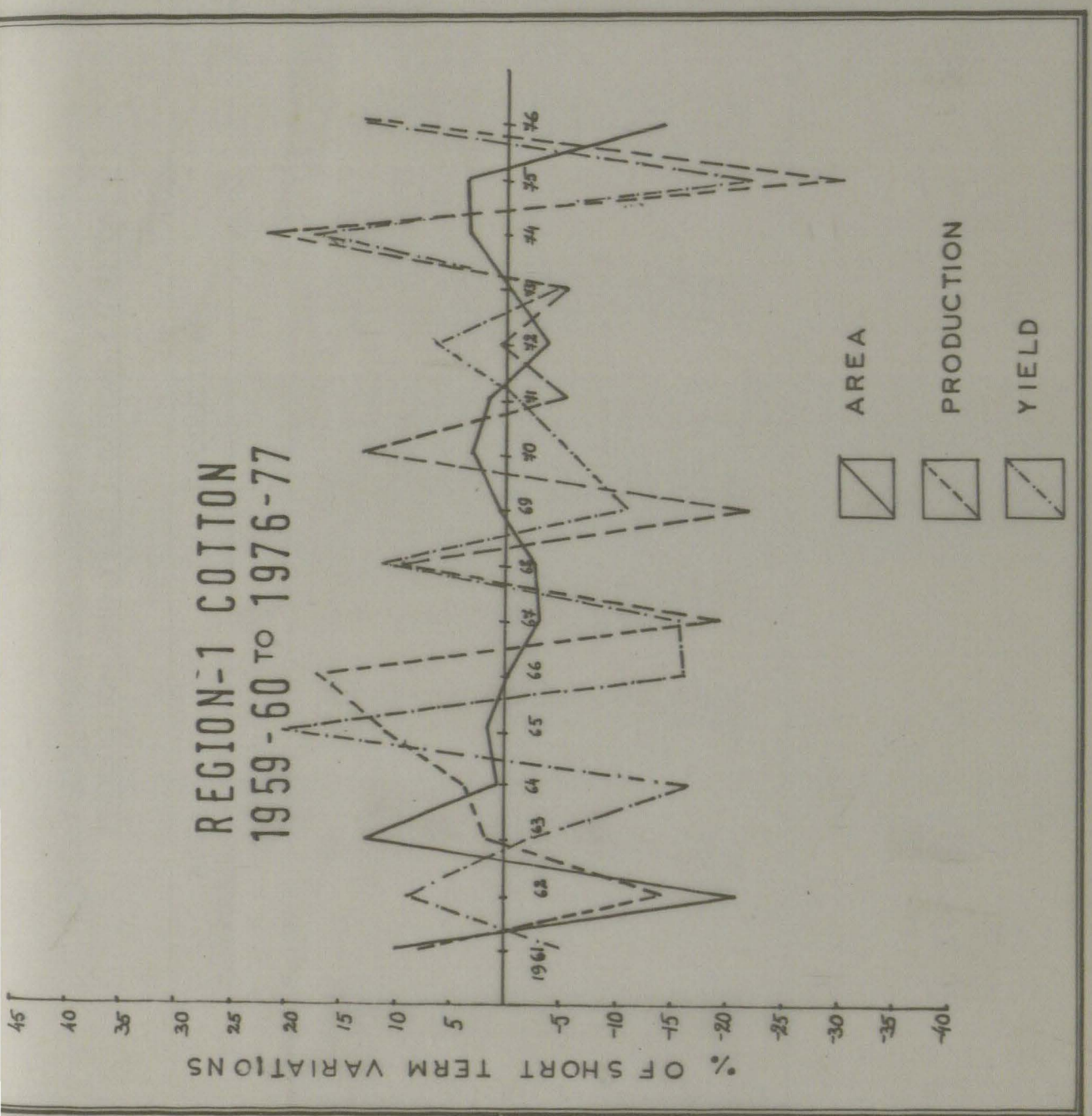
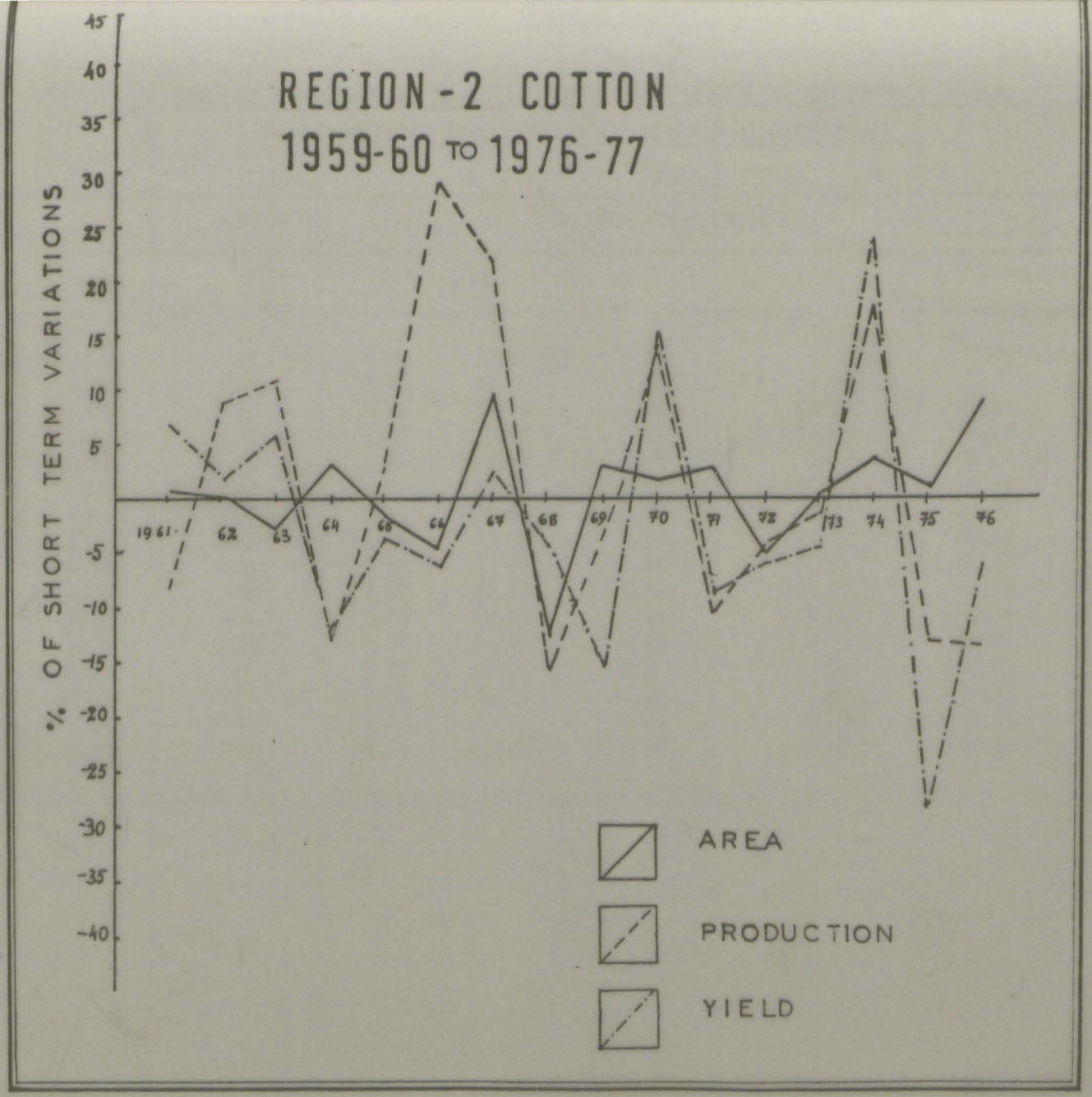

REGION-1 COTTON
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
AREA
PRODUCTION
YIELD

FIG - 4.17

TABLE : 4.17

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION- I (COTTON)*

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	5282	574	9.80	36.09	3.01	7.72	30.47	1.45	- 5.01
1961-62	5188	1580	-20.79	35.46	4.45	-14.38	29.67	3.09	9.39
1962-63	5314	786	12.89	35.64	0.62	1.72	27.71	0.46	- 1.68
1963-64	6188	46	0.74	38.15	1.50	3.79	27.01	3.89	-16.81
1964-65	6120	108	1.75	34.14	4.40	11.42	24.41	6.24	20.37
1965-66	5897	1	- 0.01	28.40	4.17	17.25	22.58	3.13	-16.11
1966-67	5736	170	- 3.05	26.75	4.32	-19.26	20.40	2.75	-15.56
1967-68	5872	127	- 2.21	30.40	3.20	9.53	21.34	2.75	11.40
1968-69	6266	40	0.64	42.94	7.75	-22.06	24.82	2.53	-11.34
1969-70	6527	219	3.25	51.86	8.16	-13.60	29.84	1.77	- 6.29
1970-71	6415	112	1.73	63.74	3.36	- 5.57	39.57	0.42	- 1.06
1971-72	6202	230	- 3.86	70.39	0.43	0.62	48.16	3.32	6.45
1972-73	6134	27	- 0.44	84.56	4.59	- 5.75	56.47	2.62	- 4.87
1973-74	6102	221	3.50	80.19	22.69	22.06	52.77	11.32	17.67
1974-75	5670	205	3.50	75.52	17.78	-30.81	53.29	12.93	-22.04
1975-76	5504	693	-14.40	60.07	5.86	8.90	47.71	7.72	13.93


REGION-2 COTTON
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
45
40
35
30
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-15
-20
-25
-30
-35
-40
1961
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76
AREA
PRODUCTION
YIELD

FIG - 4.18

TABLE : 4.18

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION-II (COTTON)*

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	3887	29	0.74	37.61	2.92	- 8.43	75.46	5.38	6.66
1961-62	3854	14	0.39	40.18	3.97	8.99	73.02	1.22	1.64
1962-63	3880	103	- 2.74	37.15	4.56	10.93	60.41	3.58	5.60
1963-64	3867	127	3.20	29.03	3.44	-13.47	48.38	5.39	-12.53
1964-65	3884	53	- 1.41	19.14	0.65	3.28	39.25	1.10	- 2.87
1965-66	4008	182	- 4.76	19.43	7.38	29.24	38.89	2.29	- 6.27
1966-67	3949	420	9.63	20.66	5.80	21.93	40.87	1.06	2.52
1967-68	4114	462	-12.68	27.26	3.79	-16.17	46.09	2.00	- 4.54
1968-69	4184	136	3.16	33.00	1.14	- 3.61	60.36	8.10	-15.50
1969-70	4505	76	1.67	37.52	6.15	14.10	71.70	13.03	15.38
1970-71	4470	141	3.07	40.93	3.89	-10.52	84.80	6.69	- 8.56
1971-72	4438	220	- 5.24	43.85	1.76	- 4.19	97.05	5.49	- 6.00
1972-73	4469	16	0.37	52.97	0.55	- 1.06	127.03	5.55	- 4.57
1973-74	4522	182	3.88	53.15	11.27	17.50	127.69	40.39	24.02
1974-75	4329	45	1.05	48.25	5.64	-13.25	120.34	26.80	-28.65
1975-76	4258	349	8.95	42.88	5.14	-13.65	105.59	6.16	- 6.20

The output curve follows the area curve more systematically than the yield curve. The fluctuatiaon in the output level both negative and positive signs are quite regular in the case of cotton, output at State level. The increase in the outpout of this crop has not been free from the ups and downs and thereby causing the concerns to the farmers.

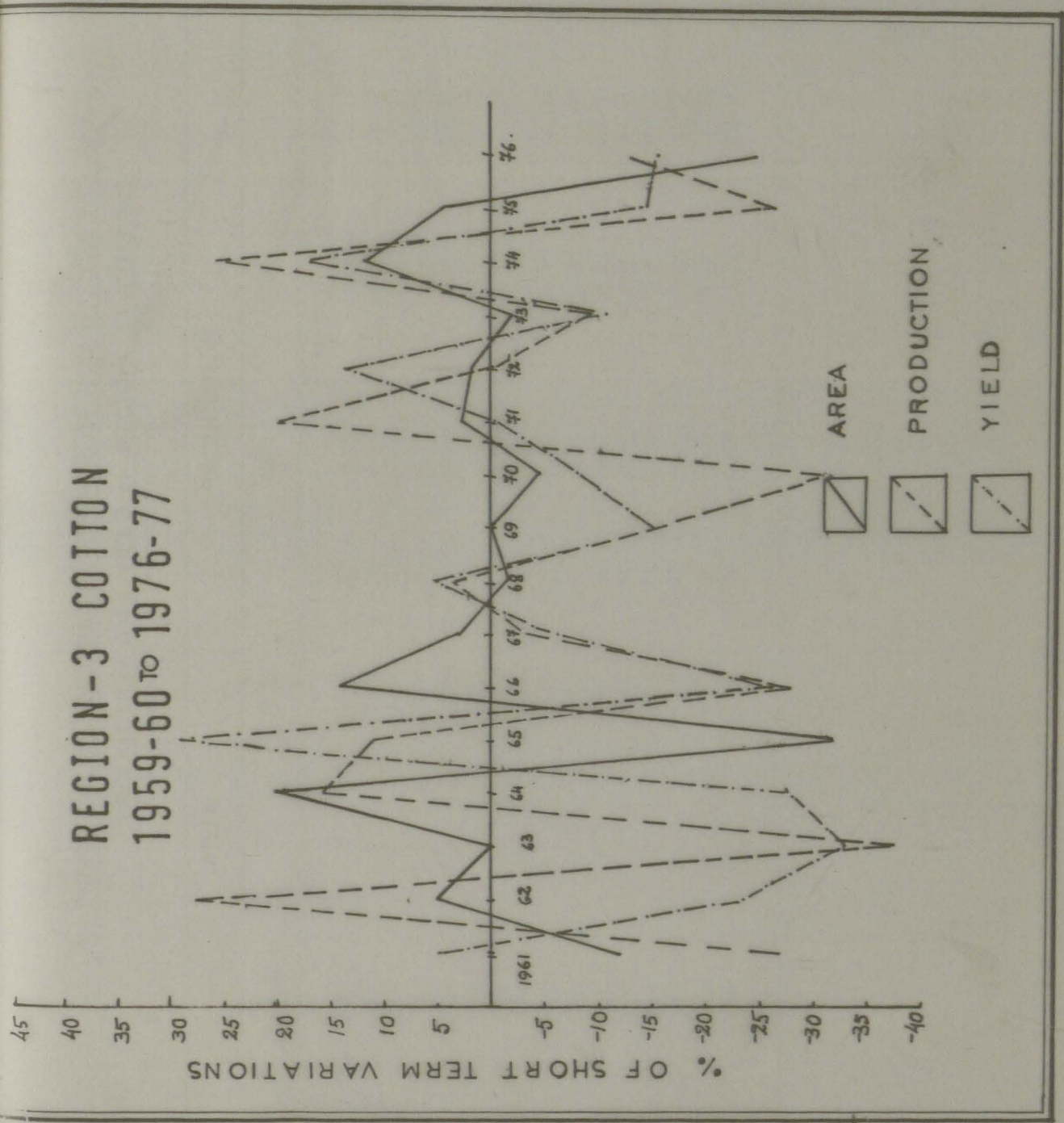
Region I

This region has the maximum area under cotton in the State as a result we can have better idea from the situation in this region, as is seen from table **4.17.** There has not been much change in area over the years, **except** a sudden decline in 1961-62 and again in 1975 it has been an almost smooth curve to be followed till the end of the period, so the fluctuation in the case of area in region I were minimum.

But the situation with regard to yield and output was entirely different from that of area. The yield **per** hectare as well as the total output under cotton has shown a sharp deviation during the entire period. In fact the deviation in output went quite in hand with those of yield rate (see table **4.9.)**. The swings, upwards or downwards were so pronounced that during 1974-75 it has gone down to a level of 30%, the level which no other crop has shown so far. Same was the situation even in early sixties. So the cotton in Region I represent a situation of a crop which constantly suffers from the creativity in yield and **output level.**

Region II

The situation with regards to fluctuatioan in area, yield and output was not much different than that of region I. Although the


REGION-3 COTTON
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
45
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35
30
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20
15
10
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-5
-10
-15
-20
-25
-30
-35
-40
1961
62
63
64
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67
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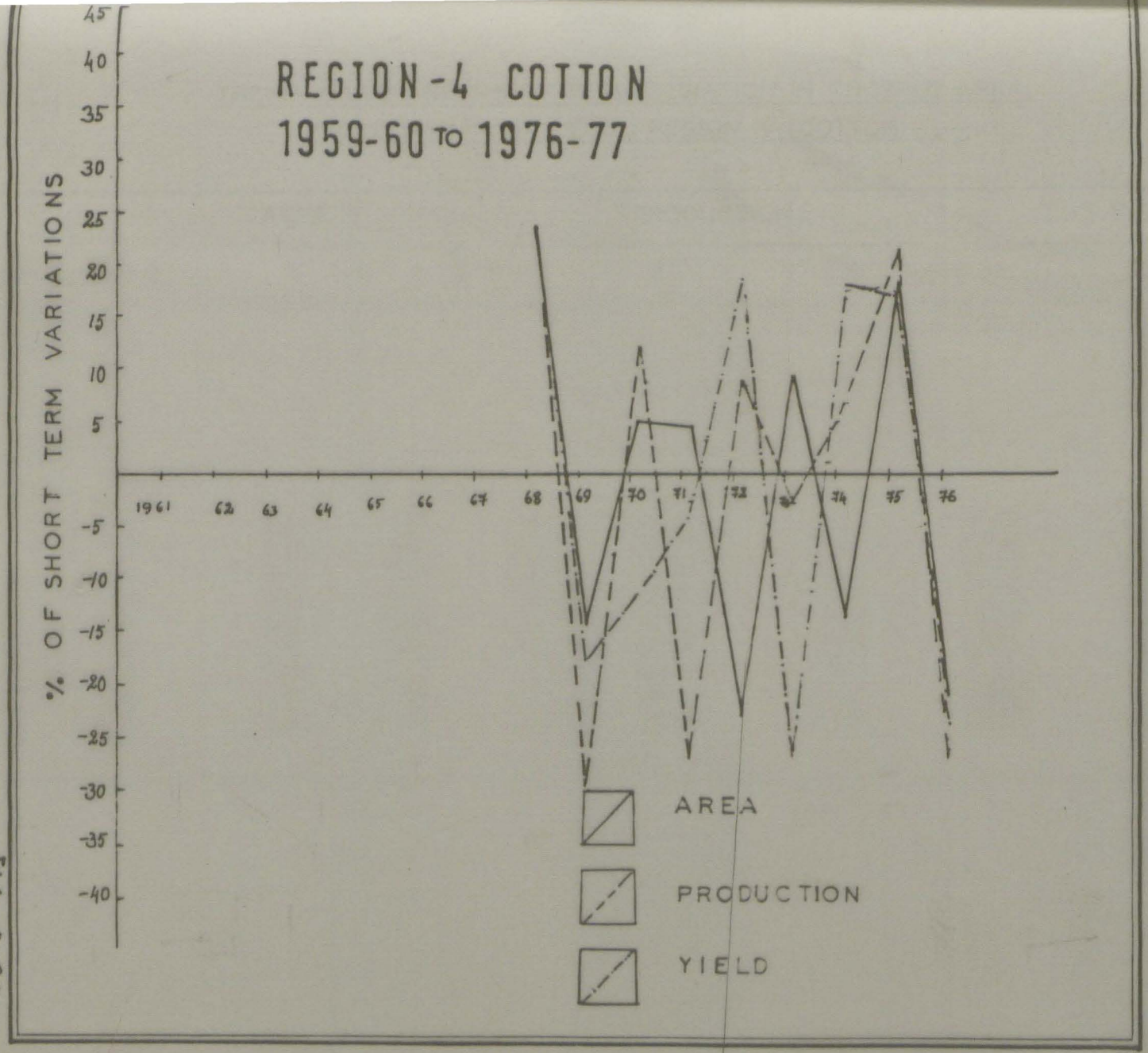
69
70
71
72
73
74
75
76
AREA
PRODUCTION
YIELD

FIG-4.19

TABLE :4.19

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : *REGION- III (COTTON)*

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61	69	7	-12.16	1.26	0.26	-26.80	40.19	2.16	5.11
1961-62	71	3	5.04	1.11	0.42	27.48	36.21	11.01	-23.32
1962-63	77	1	- 0.20	1.16	0.34	-37.69	29.31	10.25	-33.78
1963-64	63	17	21.39	0.94	0.17	15.94	27.68	6.03	-27.85
1964-65	60	28	-31.76	0.80	0.09	11.01	24.95	17.38	29.06
1965-66	59	9	14.36	0.56	0.18	-28.17	21.35	10.48	-26.38
1966-67	75	2	3.08	0.43	0.01	- 3.32	11.53	0.69	- 6.33
1967-68	79	1	- 1.54	0.48	0.01	3.87	12.17	0.70	5.41
1968-69	82	1	0.08	0.61	0.08	-15.13	14.80	1.99	-15.56
1969-70	91	4	- 4.92	1.11	0.31	-31.03	20.37	1.64	- 8.74
1970-71	101	3	2.91	1.60	0.42	20.82	29.87	0.31	- 1.06
1971-72	110	2	1.94	1.98	0.56	- 0.02	35.70	5.63	13.61
1972-73	116	2	- 2.10	2.13	0.18	- 9.50	40.25	4.03	-11.13
1973-74	107	14	11.97	1.82	0.64	25.96	35.72	7.48	17.31
1974-75	83	3	4.43	1.34	0.28	-26.52	31.96	4.21	-15.18
1975-76	66	26	-25.05	0.98	0.47	-13.28	28.92	3.98	-15.96


REGION-4 COTTON
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
45
40
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
-40
1961
62
63
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71
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75
76
AREA
PRODUCTION
YIELD

Fig-4.20

TABLE 4.20

TREND VALUE AND SHORT TERM DEVIATION IN CROPPED AREA, PRODUCTION AND YIELD : REGION IV (COTTON)

YEAR	AREA			PRODUCTION			YIELD		
	1	2	3	1	2	3	1	2	3
1960-61									
1961-62									
1962-63									
1963-64									
1964-65									
1965-66									
1966-67									
1967-68	1	0.67	3.33	0.008	0.004	23.82	4.27	2.19	23.85
1968-69	2	0.29	- 14.61	0.021	0.005	- 29.71	7.48	1.12	- 17.66
1969-70	2	0.15	5.14	0.024	0.003	12.61	10.71	1.08	- 11.25
1970-71	3	0.16	4.76	0.047	0.014	- 26.96	16.76	0.61	- 3.76
1971-72	4	0.77	- 23.29	0.074	0.007	8.88	19.99	4.50	18.36
1972-73	5	0.53	9.58	0.111	0.003	- 2.88	26.41	7.07	- 26.56
1973-74	7	0.86	- 13.77	0.135	0.009	6.43	28.95	6.45	18.21
1974-75	6	3.21	18.68	0.112	0.041	21.76	26.58	5.54	17.25
1975-76	5	2.19	- 21.30	0.079	0.041	- 27.60	22.31	10.09	- 28.54

area under cotton has shown mild increase but it was not free from the fluctuation. This area has experienced a regular ups and downs. The positive deviations were more close to the normal lines but the negative value was more at district from the normal value. More than the area, however, the yield rate as output level seem to have suffered from the regular and often erratic ups and down swings. For instance if the positive deviation in yield rate were at 25% in 1974, in the very next year it correspondingly came down to 30% in 1975, leading to similar type of fluctuation in the output level.

It appears that the cotton crops suffer more from the phenomens of instability both at State and regional level than the other crops of the State, namely rice and jowar.

4.3. Trend Deviation and the Inputs

Having studied the pattern of trend deviation in area, output and yield rate, it would be in the fitness of the things if we examine the fluctuation in some of the inputs in ultimate analysis. This would govern the pattern of fluctuation in area, output and the yield rate. The relevant variables which are studied, include annual rainfall, irrigation, sources of irrigation, fertilizer and areas under HYV at the State and at the level of regions.

Rainfall and Irrigation

Firstly we study the trend deviation in the annual rainfall, irrigation and also note whether the variations in one is dependent on the other in the State and for the region. Table 4.21 and figure 4.21 show a relative picture of the two parameters together. It indicates that the total rainfall experienced a sharp deviation till about 1964 after which

TABLE 4.21

TREND VALUE AND SHORT TERM DEVIATION IN

ANNUAL RAINFALL AND IRRIGATION LEVEL : STATE

YEARS	RAINFALL			IRRIGATION LEVEL		
	1	2	3	1	2	3
1960-61	666	111	- 20.03	490	37	0.64
1961-62	649	124	16.05	608	142	2.29
1962-63	609	10	1.77	613	52	- 0.86
1963-64	506	71	- 16.46	743	154	- 5.53
1964-65	559	95	3.57	1380	872	30.83
1965-66	721	57	7.34	8311	356	24.19
1966-67	894	28	3.05	10678	274	- 2.21
1967-68	954	27	2.76	13639	1176	0.86
1968-69	1017	569	- 5.93	14783	265	- 0.18
1969-70	997	111	- 9.00	18982	3146	- 12.87
1970-71	940	16	- 1.75	18448	7906	19.00
1971-72	885	96	- 8.27	17909	4754	- 31.14
1972-73	907	35	3.78	14117	1001	0.70
1973-74	1148	58	- 5.87	15421	4421	- 2.95
1974-75	1075	136	8.23	16371	6961	4.08
1975-76	1195	70	- 6.86	17038	293	0.17

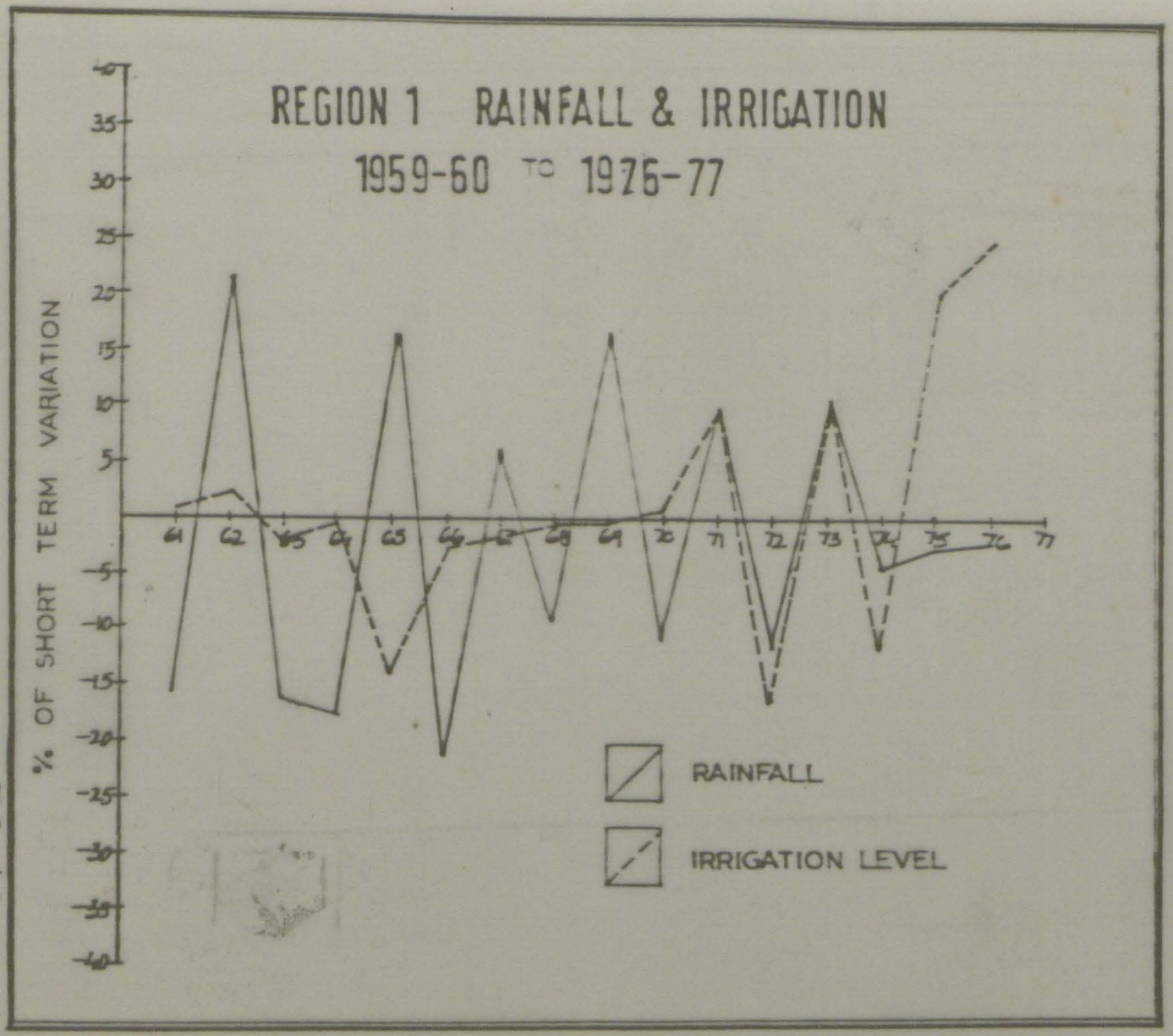
REGION 1 RAINFALL & IRRIGATION
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
40
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
-40
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
RAINFALL
IRRIGATION LEVEL

FIG-4.22

TABLE 4.22

TREND VALUE AND SHORT TERM DEVIATION IN ANNUAL RAINFALL AND IRRIGATION LEVEL -REGION-I

Year	RF			IL		
	1	2	3	1	2	3
1960-61	600	91	-15.01	75	2	0.01
1961-62	590	169	20.33	76	18	2.38
1962-63	571	72	16.61	97	16	- 2.13
1963-64	392	57	-17.01	109	104	1.10
1964-65	337	65	16.31	1114	1035	-13.02
1965-66	333	58	-21.21	2176	911	- 3.72
1966-67	301	19	5.95	3336	73	- 2.26
1967-68	339	29	- 9.60	3571	13	- 0.37
1968-69	326	60	15.68	3905	11	- 0.30
1969-70	332	49	-11.56	4212	15	1.19
1970-71	295	32	9.80	4005	476	10.64
1971-72	313	37	-12.35	3846	576	-17.62
1972-73	301	33	9.90	3741	145	10.20
1973-74	307	12	- 4.29	9530	5363	-12.70
1974-75	301	9	- 3.26	15147	5490	22.60
1975-76	327	10	- 3.21	15514	5122	24.82

the fluctuation more or less stabilized till 1969-70 but again to realise a strong positive swing of 9%. So at the state rainfall has faced regular fluctuation, although the amplitude was not so strong.

The irrigation level also shows sharp deviation from the normal trend. A formidable peak in 1964-66 nearly coincides with the variation in the rainfall. Again in 1970-71, table shows a rise in the deviation which corresponds to the level of rainfall. Another dip in 1971-72 goes hand in hand with the dip in the annual rainfall. Apparently the variation in the level of irrigation at the state level seems to be dependent on the behaviour of the rainfall.

The behaviour of rainfall and irrigation and their natural inter-dependence would be much more clear if we take a look at the region-al data. The trend deviation for regions I and II are shown in figures 4.22 and 4.23(and tables 4.22 & 4.23) respectively. These two regions get a low; and low-to moderate level of railfall respectively. And in both the regions, tank occupies a major portion. From the table it is clear that the annual rainfall in this region is not only low and low-to medium level but is also subjected to considerable amount of fluctuation. In some of the years, the percentages of deviation in this region went upto 20%. The rest of the values lie between 10 to 20% in both the region. So it is clear that regions I and II suffer from the phenomina of instability in the annual rainfall which in turn has a serious implication on the stability and otherwise in the output yield and area.

Coming to trend deviation in irrigation there seems to be a definite association between the deviation in annual rainfall and the

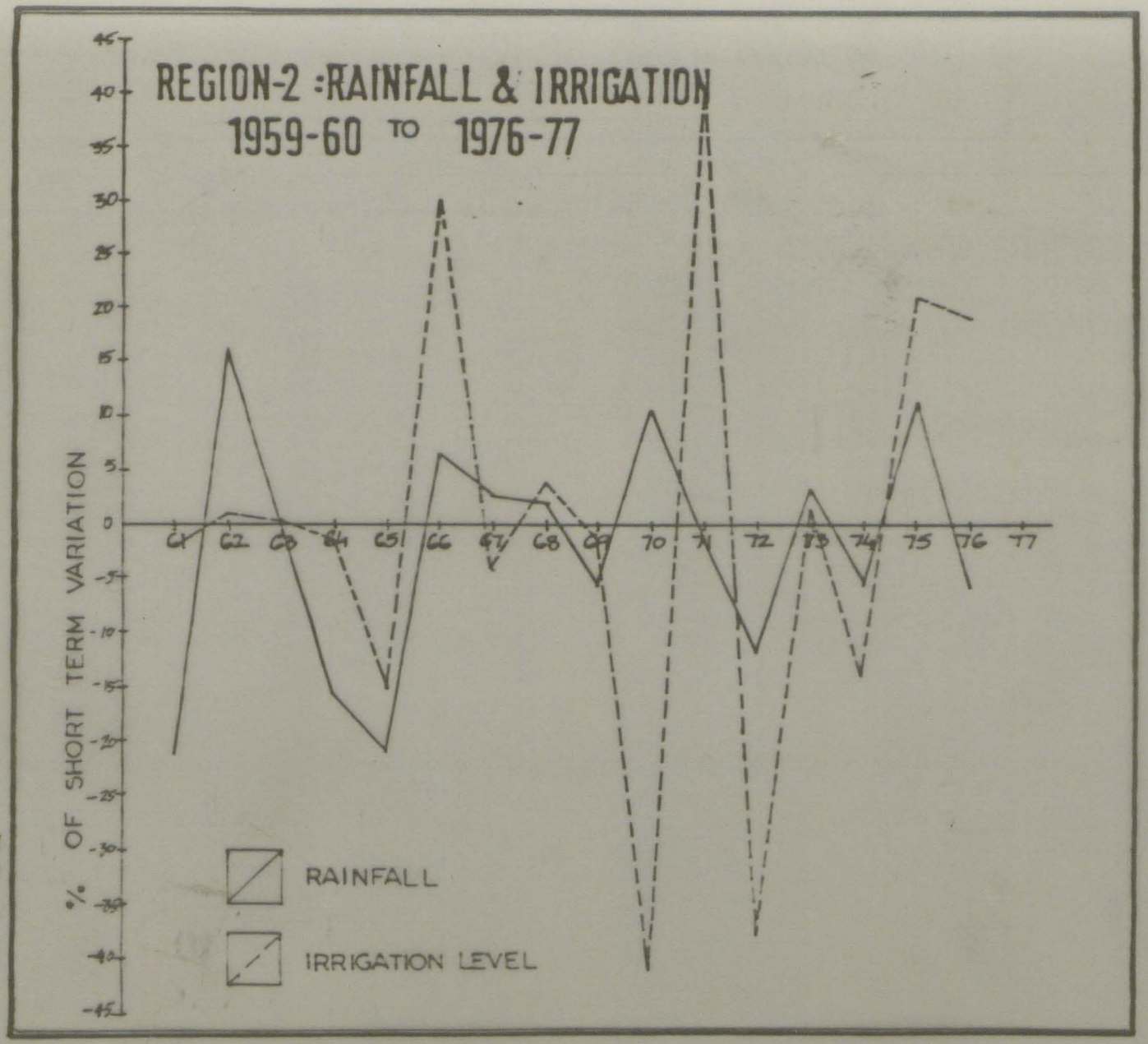
REGION-2 : RAINFALL & IRRIGATION
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
RAINFALL
IRRIGATION LEVEL

FIG-4.23

TABLE 4.23

TREND VALUE AND SHORT TERM DEVIATION IN ANNUAL RAINFALL AND IRRIGATION LEVEL - REGION II

Year	RF			IL		
	1	2	3	1	2	3
1960-61	666	111	-20.03	97	2	- 2.12
1961-62	649	124	16.04	101	1	0.96
1962-63	609	10	1.72	105	1	0.46
1963-64	606	71	-16.47	109	1	- 0.94
1964-65	661	95	-20.56	1915	1802	-15.91
1965-66	721	57	7.34	3862	1663	30.10
1966-67	894	28	3.04	6169	220	- 3.71
1967-68	954	27	2.76	6754	279	3.97
1968-69	1000	56	-5.93	7412	132	- 1.83
1969-70	997	111	10.02	11191	3265	-41.20
1970-71	940	16	- 1.75	10968	7399	40.23
1971-72	885	96	-12.26	10730	4118	-38.23
1972-73	907	35	3.77	7086	125	1.74
1973-74	1000	58	- 5.86	111485	4049	-14.45
1974-75	1000	136	11.23	15683	4123	20.82
1975-76	997	70	- 6.86	16064	3742	18.89

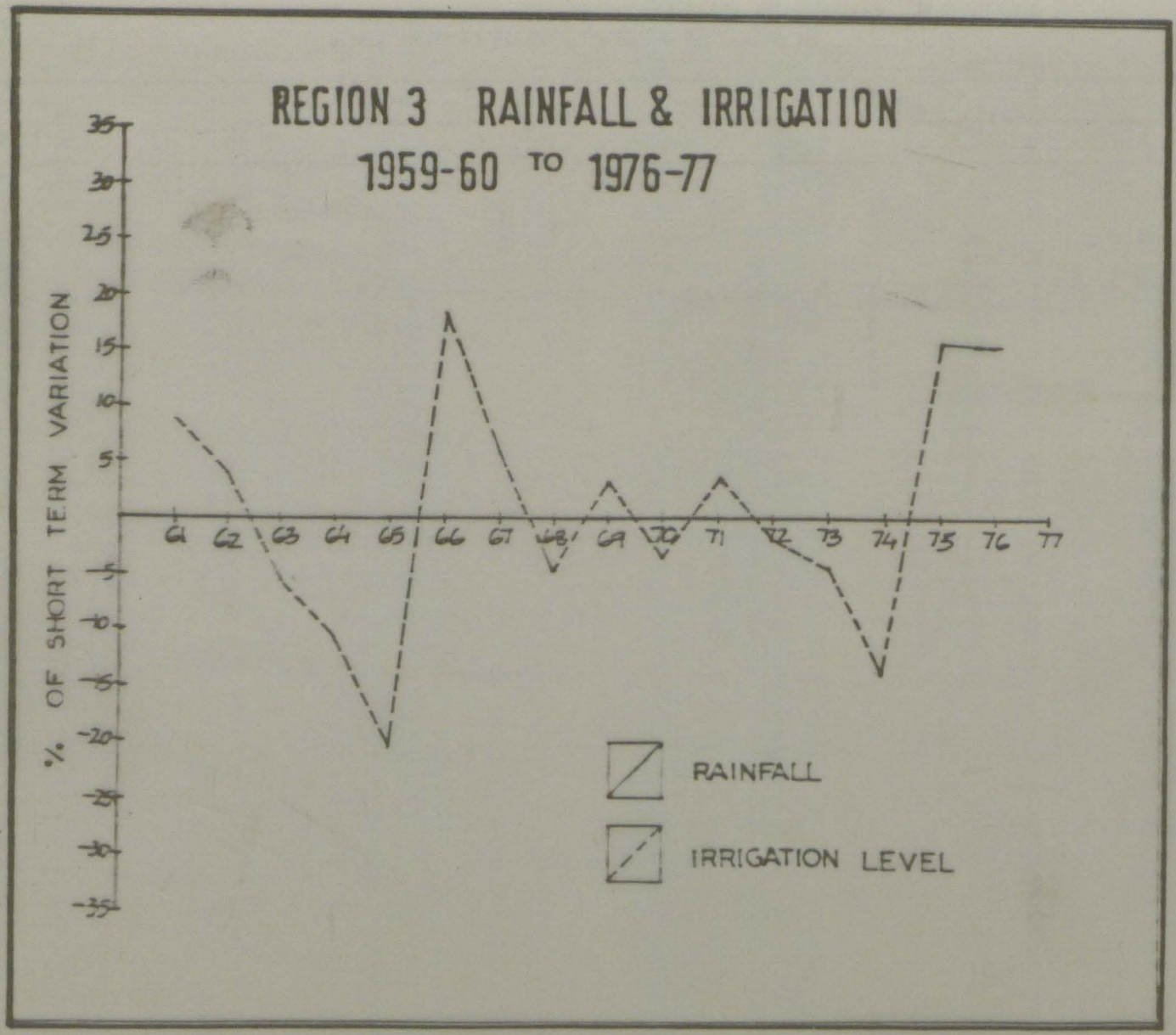
REGION 3 RAINFALL & IRRIGATION
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
RAINFALL
IRRIGATION LEVEL

FIG-4.24

TABLE 4.24

TREND VALUE AND SHORT TERM DEVIATIAN IN ANNUAL RAINFALL AND IRRIGATION LEVEL - REGION III

Years	RF			I.L		
	1	2	3	1	2	3
1960-61	-	-	-	33	3	8.60
1961-62	-	-	-	35	2	4.94
1962-63	-	-	-	33	2	-5.96
1963-64	-	-	-	131	9.9	-11.48
1964-65	-	-	-	696	665	-20.92
1965-66	-	-	-	1419	607	19.98
1966-67	-	-	-	2083	115	5.27
1967.68	-	-	-	2110	86	- 4.26
1968-69	-	-	-	2041	66	3.17
1969-70	-	-	-	2063	72	- 3.66
1970-71	-	-	-	2012	79	- 3.81
1971-72	-	-	-	2002	47	- 2.44
1972-73	-	-	-	3074	174	- 4.79
1973-74	-	-	-	6803	4793	-13.39
1974-75	-	-	-	11630	4810	15.26
1975-76	-	-	-	11580	4860	15.13

level of irrigation.

In both regions tank irrigation is the basic source of irrigation. The tank irrigation being rainfed it depends for water on the natural rainfall. Because of this typical association we notice a typical relation between rainfall and the irrigation. In both the regions, the irrigation has shown a very sharp ups and downs in its level. While in some year the positive and negative deviation was in the ranges of 20 to 40% in region I , the level of deviation remains at 20% in region II.So instability in the irrigation level seems to be the major characteristic of these two regions. Further, interestingly enough the deviation in irrigation seems to be negatively correlated with the level of annual rainfall. As and when there is a good rainfall the farmer does not use tank irrigation and it may be noted that tank irrigation is seasonal in nature and can be used only for one seasons. So in a year, when rainfall is high the use of irrigation (particularly from tank) appears to be low. In both the regions correlation coefficient between annual rainfall and irrigation is negative and returns high(at only- 5.9 and - 5.2 in regions I and II respectively).So in that irrigation and rainfall closely correlated with each other.

Region III with rainfall varying between 1000 - 2000 mm can be said to be more or less a wet area. This region falls in the northern coastal belt of the state. Irrigation sources mainly used here are both canals and tanks. Hence the fluctuation in irrigation level is not so much because fluctuation in rainfall can be compensated satisfactorily by canal and tank usage. Therefore, one does not see such wide fluctua--tions in the irrigation level here. Rainfall pattern is also more or less

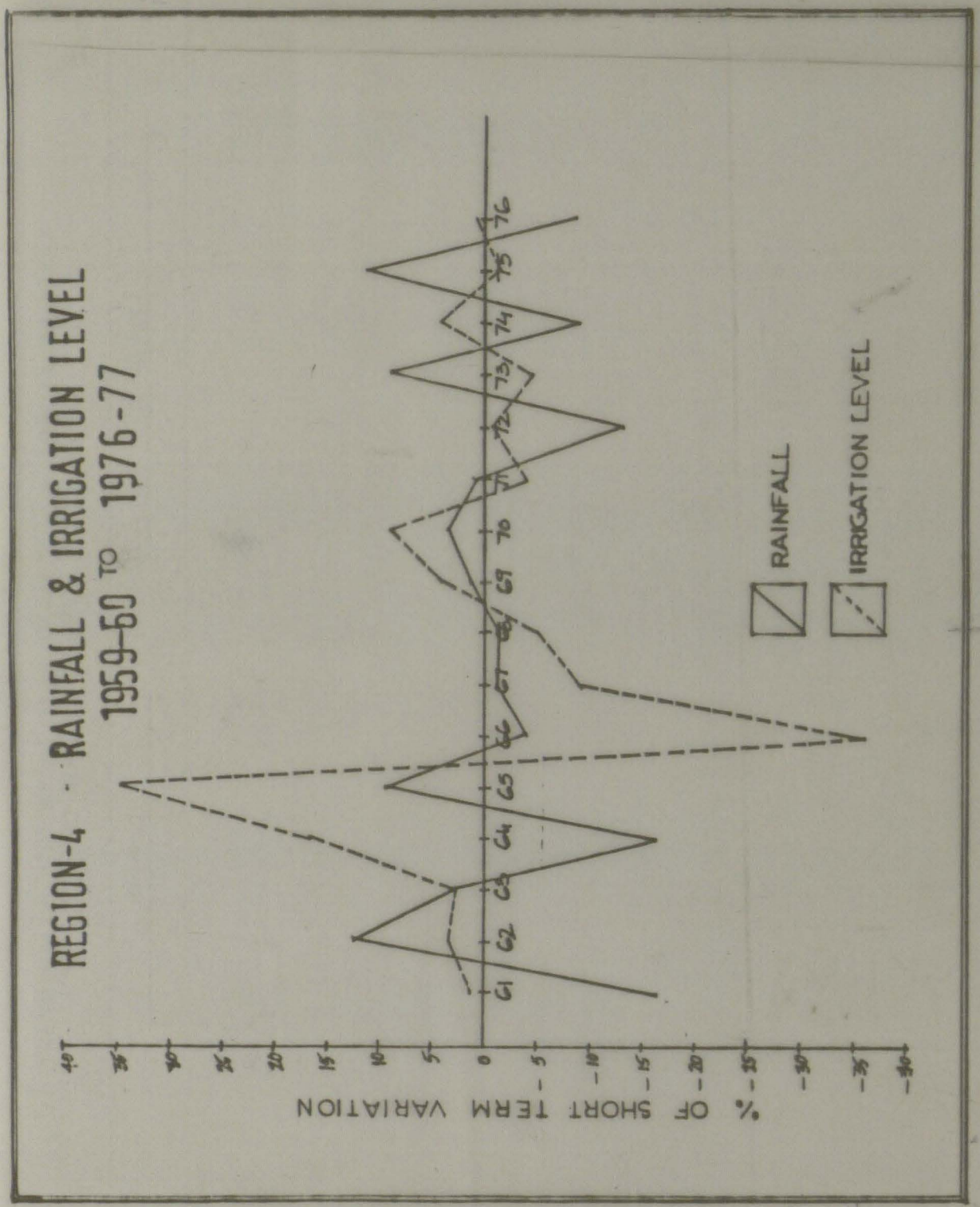
REGION-4 - RAINFALL & IRRIGATION LEVEL
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
RAINFALL
IRRIGATION LEVEL
G1
G2
G3
G4
G5
G6
G7
G8
G9
70
71
72
73
74
75
76

FIG.-4.25

TABLE 4.25

TREND VALUE AND SHORT TERM DEVIATION IN ANNUAL RAINFALL AND IRRIGATION LEVEL - REGION IV

Year	RF(mm)			IL('00 hec)		
	1	2	3	1	2	3
1960-61	2778	414	-17.54	31	3	1.14
1961-62	2741	410	13.03	33	11	3.19
1962-63	2641	66	2.46	62	8	2.64
1963-64	2413	349	-16.92	84	51	17.43
1964-65	2231	236	9.57	401	360	34.91
1965-66	2261	98	- 4,56	722	410	-36.24
1966-67	2178	24	- 1.16	1089	95	- 9.65
1967-68	2258	39	- 1.78	1202	62	- 5.46
1968-69	2357	45	1.89	1423	51	3.46
1969-70	2369	80	3.30	1514	141	8.53
1970-71	2220	34	1.54	1462	49	- 3.48
1971-72	2224	268	-13.70	1330	12	- 0.92
1972-73	2263	197	8.01	1314	54	- 4.36
1973-74	2586	212	- 8.93	1309	56	4.10
1974-75	2588	335	11.48	1324	20	- 1.58
1975-76	2676	210	- 8.52	1292	11	0.87

stable, except for the period around 1970-71, when the entire state was under severe drought conditions. Area being on the windward side is not so much affected by dried conditions as on the leeward side and central and eastern Karnataka.

An area which sees a lot of rainfall in the monsoon months, would have a slightly weaker irrigation base. Main reason being that the farmer would have access to natural rainfall and therefore pay little heed to artificial forms of irrigation. The irrigation practice in such areas would only act as a support for the farmer. With a normal rainfall greater than 2000 mm (upto 3000 mm), Region IV presents the situation that is mentioned earlier. Region IV gets sufficiently heavy rainfall from the south-west monsoon and therefore the predominant crops are rice and sugarcane. Rainfall deviation pattern is also not so severe as in other areas. As a result the deviation in irrigation is not so sharp as in the case of other region.

From the above discussion, it is clear that irrigation along with rainfall plays a major role in the stability of the agricultural economy of the regions. Each region differs from the other primarily with respect to the level of irrigation and rainfall. Therefore given the level and variability in rainfall the main emphasis has to be given in stabilizing irrigation level.

4.4 Trend Deviations and Sources of Irrigation

Since the different sources of irrigation differ in terms of efficiency(reflected in timelessness and adequacy of supply of water), we would expect differential behaviour in their temporal fluctuations. Further as the area under irrigation has been showing a rising trend over a period, one would expect upward rising or positive trend in the

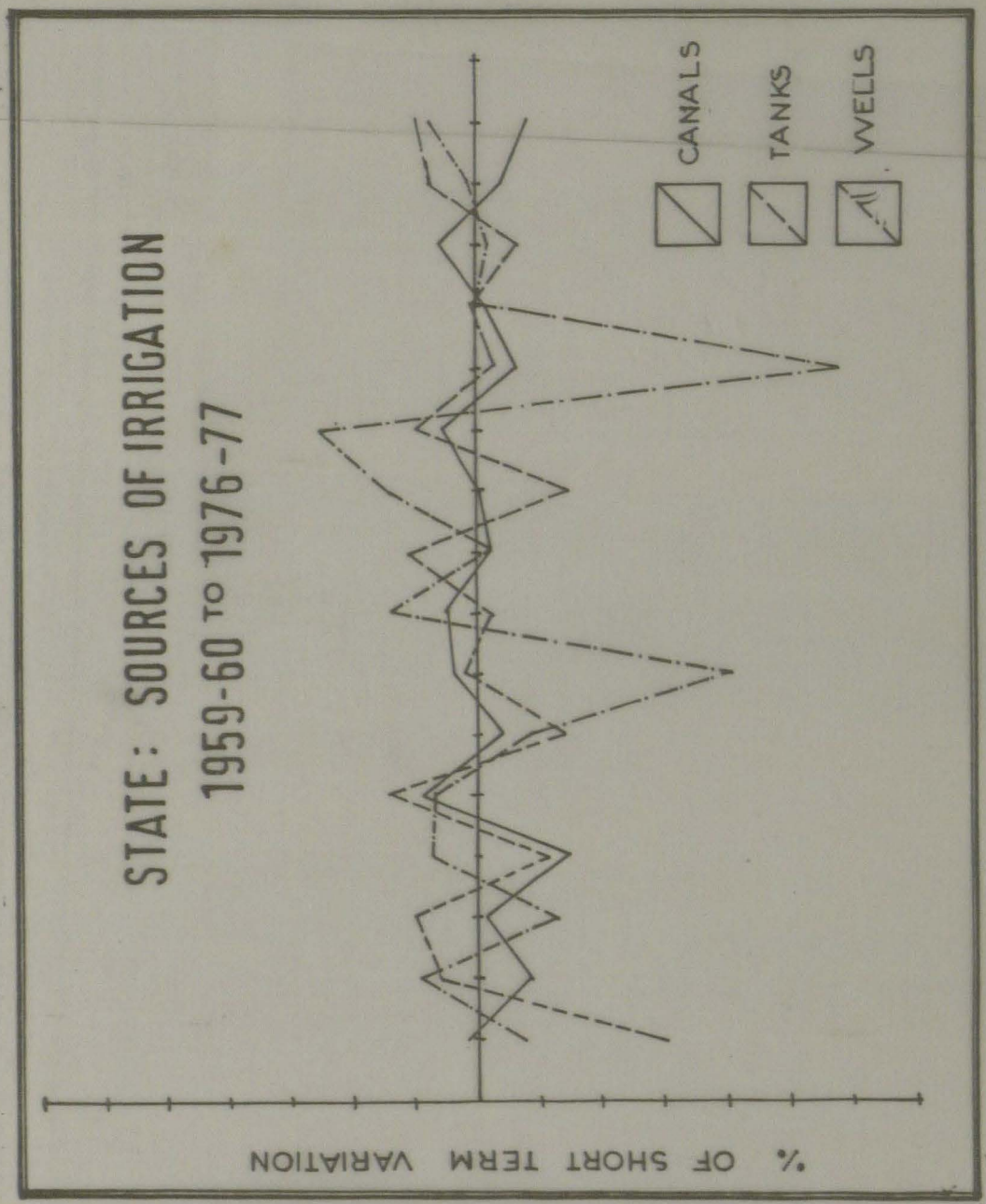
STATE: SOURCES OF IRRIGATION
1959-60 TO 1976-77
CANALS
TANKS
WELLS
% OF SHORT TERM VARIATION

FIG-4.26

TABLE 4.26

TREND VALUE AND SHORT TERM DEVIATION IN SOURCES OF IRRIGATION - CANALS, TANKS, WELLS : STATE

('00 hectares)

YEAR	CANALS			TANKS			WELLS		
	1	2	3	1	2	3	1	2	3
1960-61	2274	22	0.99	3250	433	- 15.39	1353	50	- 3.88
1961-62	2519	109	- 4.17	3304	102	- 3.00	1425	67	4.52
1962-63	2695	18	- 0.70	3499	189	5.13	1576	96	- 6.51
1963-64	2984	208	- 7.30	3600	197	- 5.79	1691	65	3.73
1964-65	3343	151	4.33	3437	272	7.33	1774	63	3.44
1965-66	3829	74	- 1.98	3434	234	- 7.33	1812	84	- 4.87
1966-67	4157	80	1.90	3365	27	0.80	2257	386	- 20.67
1967-68	4372	106	2.38	3542	37	- 1.06	2955	219	6.90
1968-69	4455	54	- 1.25	3527	201	5.40	3863	43	- 1.13
1969-70	4493	6	- 0.15	3606	257	- 7.69	4268	327	7.13
1970-71	4477	116	2.53	3570	171	4.57	3818	569	12.67
1971-72	4492	141	- 3.26	3672	51	- 1.43	3199	726	- 29.36
1972-73	4568	33	- 0.75	3657	1	- 0.05	2737	1	- 0.03
1973-74	4683	136	2.83	3818	122	- 3.31	3032	30	- 1.02
1974-75	4795	99	- 2.11	3967	135	3.31	3340	19	0.57
1975-76	5077	207	- 4.25	3910	192	4.69	3528	130	3.57

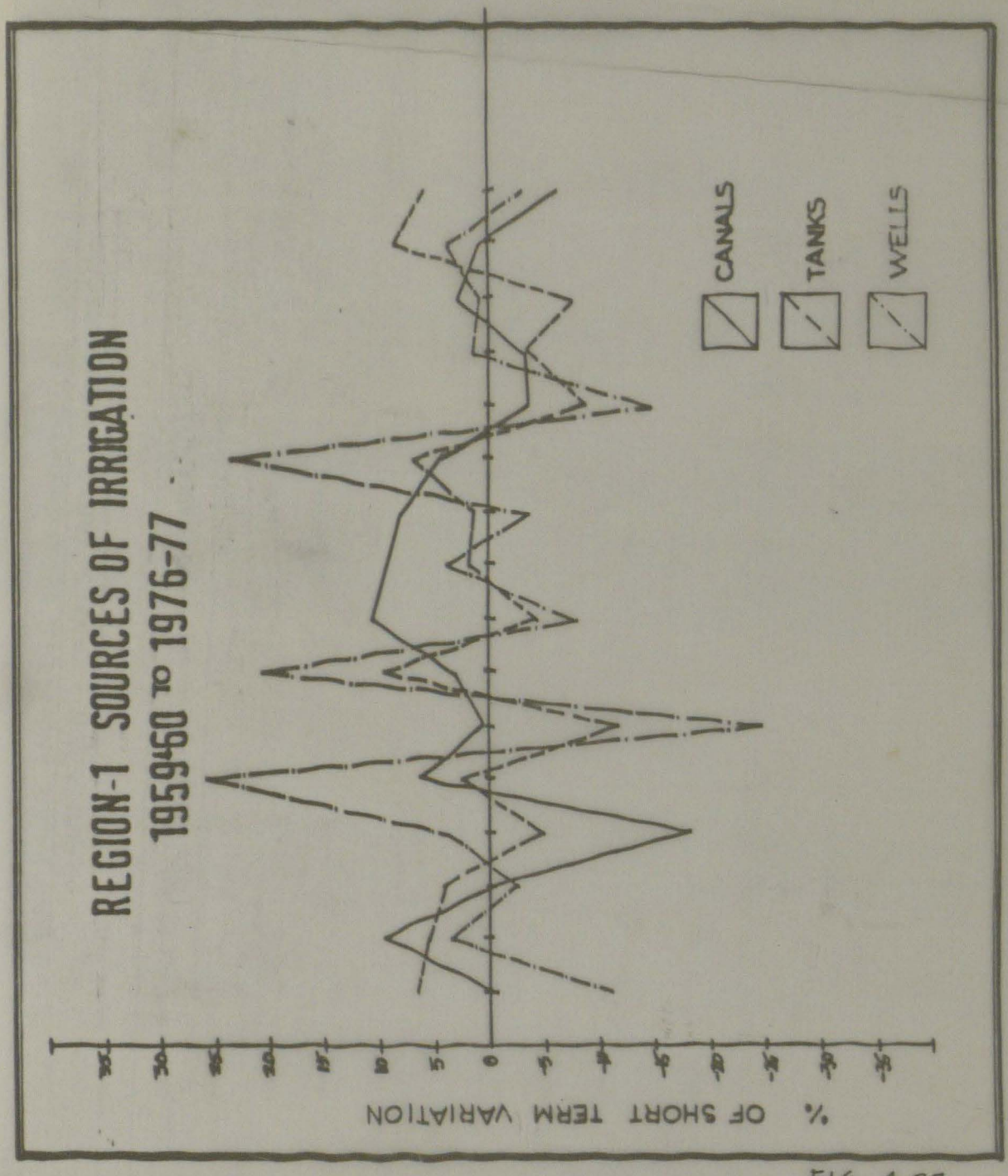
REGION-1 SOURCES OF IRRIGATION
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
CANALS
TANKS
WELLS

FIG 4.27

TABLE : 4.27

TREND VALUE AND SHORT TERM DEVIATION IN SOURCES OF IRRIGATION - CANALS, TANKS & WELLS: REGION-I

('00 hectares)

YEAR	CANALS			TANKS			WELLS		
	1	2	3	1	2	3	1	2	3
1960-61	551	1	- 0.05	294	18	6.86	433	44	-11.44
1961-62	740	80	9.85	315	19	5.92	432	16	3.70
1962-63	854	4	- 0.57	320	14	4.42	471	12	- 2.76
1963-64	1059	167	-18.83	305	14	- 4.81	436	20	4.00
1964-65	1347	90	6.33	280	8	2.96	364	128	26.03
1965-66	1708	2	0.16	295	33	-12.79	366	271	-25.20
1966-67	1914	62	3.15	301	32	9.82	4¾0	118	21.69
1967-68	1841	214	10.42	322	14	- 4.62	640	46	- 7.89
1968-69	1870	379	-25.47	319	6	1.86	784	32	3.96
1969-70	1903	163	7.90	327	3	- 1.21	975	33	- 3.57
1970-71	2060	90	4.23	311	22	6.84	889	278	23.88
1971-72	2041	77	- 3.92	298	22	- 8.23	810	252	-15.29
1972-73	2072	64	- 3.19	296	10	- 3.69	696	8	1.16
1973-74	2184	59	2.66	353	25	- 7.81	818	8	1.01
1974-75	2281	19	0.85	406	39	8.85	892	32	3.51
1975-76	2452	154	- 6.71	419	26	5.92	949	24	- 2.70

area irrigated by different sources of irrigation. The value of trend deviations for canal, tank and well irrigation are given in table 4.26 and figure 4.26.

At the overall level, we have some interesting result with regard to trend deviation in level of irrigation under canal , tank and well. From figure 4.26 it is clear that although tank and canal irrigation have shown a regular ups and downs the deviation from the normal curve has not been strong. On the whole deviation in the area irrigated by these two sources were minimum and fall within limit of 5 to 7% on both sides(see table 4.13). But what is interesting is that the well irrigation has shown a sharp fluctuation in its area through the period.

In 1961-66 the deviation was + 5% but in 1967 it showed a sudden decline upto - 20%; but between 1968 and 1971 it has experienced a limited increase but again to experience a worst fall in 1972-73 to the extent of -30%. The regular fluctuation in the area under well irrigation appears to be due to fluctuation in the annual rainfall. In fact the correlation coefficient between the deviation rainfall and well irrigation is positive and stood at .74 indicating the heavy dependence of well irrigation on the behaviour of rainfall. It is clear that this region in the state has predominance of well irrigation which will suffer from instability in overall irrigation.

A study of the variability in the area irrigated by various sources of irrigation at the regional level would therefore be interesting to explain the variation in output,area and the yield.Figure 4.27 shows the state of picture for region I(northern maidan). This is a plateau region where tank irrigation is the main sources, followed by well irrigation. Canals are only interpersed sporadically.

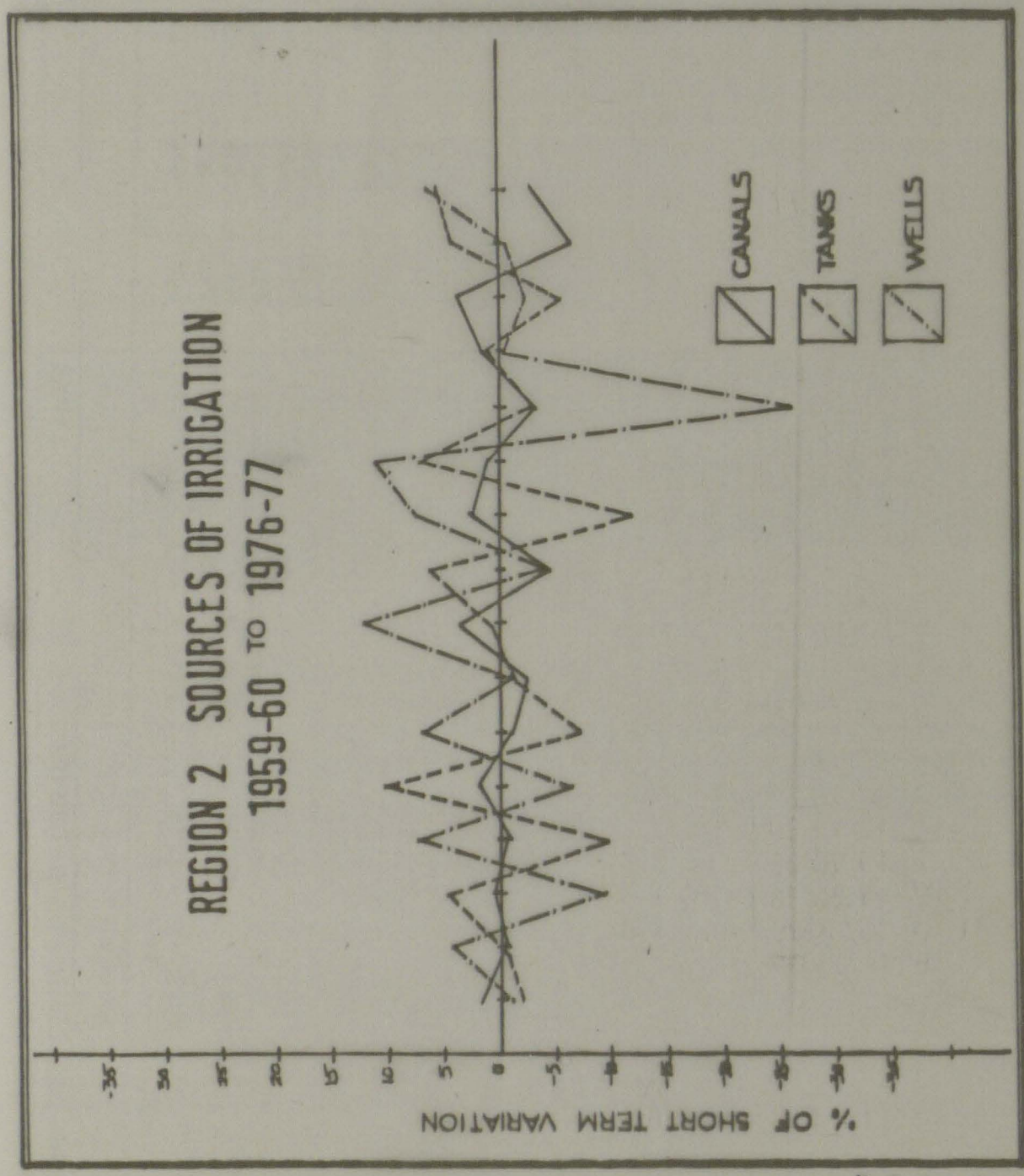
REGION 2 SOURCES OF IRRIGATION
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
CANALS
TANKS
WELLS

FIG 4.28

TABLE : 4.28

TREND VALUE AND SHORT TERM DEVIATION IN SOURCES OF IRRIGATION
CANALS, TANKS & WELLS: REGION II

('00 hectares)

Years	CANALS			TANKS			WELLS		
	1	2	3	1	2	3	1	2	3
1960-61	1366	25.22	1.81	2083	47.11	- 2.31	848	13	- 1.54
1961-62	1418	5.25	- 0.37	2123	1.50	- 0.07	902	37	4. 02
1962-63	1445	5.69	0.37	2103	108.50	4.91	992	87	- 9.62
1963-64	1484	11.46	- 0.78	2173	196.84	- 9.90	1047	83	7.38
1964-65	1499	28.89	1.89	2098	233.70	10.02	1179	72	- 6.55
1965-66	1515	17.70	- 1.18	2125	139.12	- 7.00	1211	88	6.82
1966-67	1546	27.04	- 1.78	2080	22.36	- 1.09	1599	371	-30.28
1967-68	1562	50.39	3.72	2179	16.87	0.77	1983	287	12. 64
1968-69	1618	73.25	- 4.74	2139	145.42	6.37	2555	103	- 4.22
1969-70	1647	39.78	2.36	2179	243.48	-12.57	2727	217	7.37
1970-71	1693	16.58	0.97	2149	169.31	7.30	2457	327	11.74
1971-72	1738	55.91	- 3.32	2265	72.19	- 3.29	2071	427	-26.01
1972-73	1792	31.12	1.71	2246	37.00	1.62	1789	3	- 0.22
1973-74	1797	73.64	3.94	2383	119.68	- 5.29	1967	27	- 1.43
1974-75	1813	116.80	- 6.68	2489	112.95	4.33	2197	20	- 0.96
1975-76	1927	53.74	- 2.87	2464	137.64	5.29	2318	158	6.39

Fluctuation in canal irrigation is rather interesting. Before 1965-66, it experienced wide fluctuation, experiencing a downward swing upto -17% in 1964-65. Three year later in 1968 it showed positive deviation to the extent of 10%. From 1966 to 1971, this source was optimally used, when inflow was more than the normal. After 1971 however it showed ups and downs at regular intervals till 1976. Well irrigation shows an almost constant pattern of distribution in terms of its deviations. But deviations were more sharp as compared with canal irrigation. Thus this region which is dry and more prone to drought relies on well irrigation and also suffers from the instability amounted with it. In such areas it is looked upon as an essential element of agricultural development for it gives an element of stability into agriculture. In recent years more emphasis has been laid on minor irrigation schemes particularly well irrigation.

As compared to well and canal, tank irrigation on the other hand shows a more balanced picture. Fluctuations in this source show a average trend deviation of + 7%. The distribution is more or less even with deviation at regular intervals. N.Maidan area has made maximum use of tank irrigation. this is a very important source particularly during drought year. In general it may be said that in region I, well irrigation is more instable as compared to the canal and wells.

Region II present a **(4.28)** slightly different picture. This region includes S.Maidan and parts of Malanad and N.Maidan.The canal irrigation dominates the scene, followed by tanks and wells. Average fluctuation for canals is about + 4% whereas tank irrigation shows a somewhat even trend with regular fluctuations of about + 9%. As compared with tank and canal , well irrigation is more variable source in the irrigation in region II.

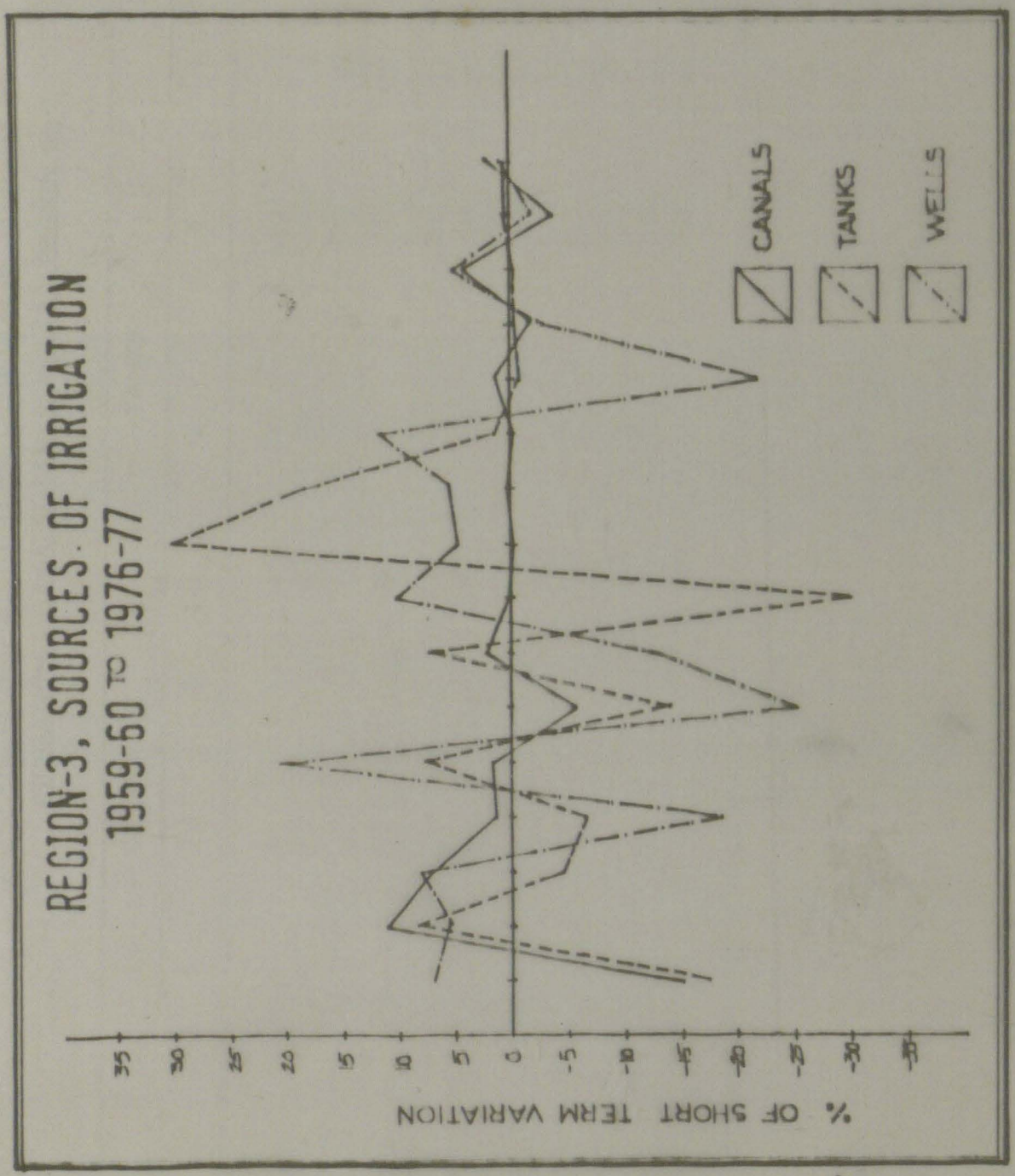
REGION-3, SOURCES OF IRRIGATION
1959-60 TO 1976-77
CANALS
TANKS
WELLS
% OF SHORT TERM VARIATION
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35

FIG- 4.29

TABLE 4.29

TREND VALUE AND SHORT TERM DEVIATION IN SOURCES OF IRRIGATION - CANALS, TANKS, WELLS : REGION III

('00 hectares)

YEAR	CANALS			TANKS			WELLS		
	1	2	3	1	2	3	1	2	3
1960-61	317	47	- 17.53	626	147	- 14.41	7	1	6.72
1961-62	323	30	8.52	628	80	11.30	8	1	5.41
1962-63	361	15	- 4.48	834	62	6.94	20	1	8.26
1963-64	410	25	- 6.74	886	13	1.47	48	8	- 18.91
1964-65	460	40	8.01	848	13	1.52	102	23	20.63
1965-66	562	65	- 13.17	829	44	- 5.70	111	60	- 25.29
1966-67	635	54	7.83	822	19	2.26	82	46	- 12.56
1967-68	503	21	- 30.11	841	1	0.07	43	3	10.15
1968-69	499	19	29.92	843	2	- 0.34	52	2	4.71
1969-70	485	93	18.52	845	2	0.28	60	3	5.31
1970-71	673	3	1.44	849	2	- 0.31	54	7	11.91
1971-72	669	3	- 0.47	845	10	1.19	46	8	- 22.10
1972-73	665	1	- 0.19	846	13	- 1.63	39	1	- 2.04
1973-74	668	2	- 0.29	814	35	4.23	40	2	5.30
1974-75	671	2	0.40	790	29	- 3.93	41	1	- 1.93
1975-76	673	1	0.20	746	14	1.87	40	1	0.89

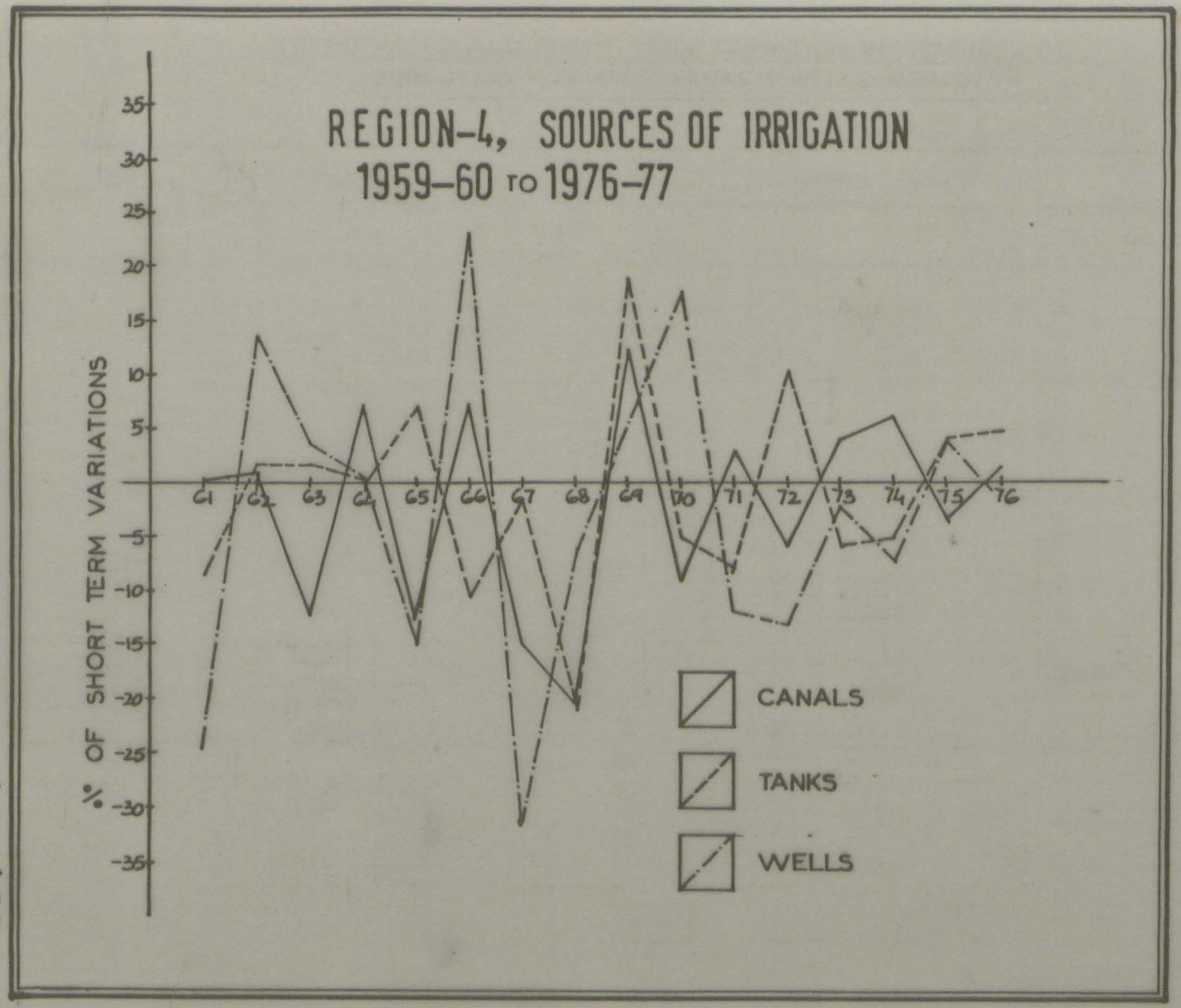
REGION-4, SOURCES OF IRRIGATION
1959-60 TO 1976-77
% OF SHORT TERM VARIATIONS
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
CANALS
TANKS
WELLS

FIG - 4.30

TABLE : 4.30

TREND VALUE AND SHORT TERM DEVIATION IN SOURCES OF IRRIGATION - CANALS, TANKS & WELLS: REGION IV

('00 hectares)

YEAR	CANALS			TANKS			WELLS		
	1	2	3	1	2	3	1	2	3
1960-61	38	1	0.35	246	20	- 8.89	64	19	-24.57
1961-62	36	3	9.34	237	3	1.62	82	13	13.65
1962-63	34	3	-12.29	214	3	1.55	104	3	3.12
1963-64	30	2	7.08	235	1	0.23	109	1	0.49
1964-65	35	8	-12.61	209	16	7.36	127	16	-15.02
1965-66	42	16	6.95	184	17	-10.36	122	37	23.65
1966-67	160	28	-14.78	161	2	- 1.42	175	59	-31.59
1967-68	465	384	-20.11	198	40	-20.64	287	19	- 6.49
1968-69	466	797	12.35	225	52	18.90	470	25	5.11
1969-70	457	403	- 9.24	253	12	- 5.17	505	140	17.78
1970-71	248	125	3.59	259	18	- 7.69	417	44	-11.82
1971-72	143	57	- 5.97	263	32	11.09	271	37	-13.10
1972-73	37	1	4.32	267	14	- 5.77	210	3	- 1.84
1973-74	38	4	6.31	267	12	- 5.08	205	13	- 7.12
1974-75	28	4	- 3.29	280	13	4.48	208	8	3.91
1975-76	24	1	1.77	279	14	4.86	220	3	- 1.43

It is interesting to note that the canal irrigation which is a major source of irrigation in region II shows a fair amount of stability in its use.

Region III

Region III falls in the high rainfall area, covering the districts of Chikmagalur and Shimoga which lie on the coastal side of the state. The pattern of deviation for this region is shown in fig. 4.29. It is interesting to note that the tank irrigation which is the main source in region III have shown a fair amount of stability in its area during the entire period. Barring the early years, deviation from the normal times has been minimum.

On the other hand area, well and canal irrigation has shown tremendous deviation during the entire period. The level of deviation was to the extent of - 30% and + 30% during 1968 and 1969 respectively for well irrigation. The deviation in canal was equally sharp. These two put together must be adding lot to the instability in agriculture of this region.

Region IV

Region IV, covering the districts of Coorg, N. Kanara and S. Kanara, has the highest amount of rainfall varying between 2000 mm to 3000 mm. In this region, canal and tank irrigation are the main sources of irrigation. Both sources indicate a relatively high fluctuation in area irrigated; the fluctuation being more pronounce in the case tank than the canal. The well irrigation which occupy a lower percentage of area indicate a very high level of fluctuation during the entire period. It is really amazing to note that in the high rainfall area such region IV should face high degree of instability in irrigation level.

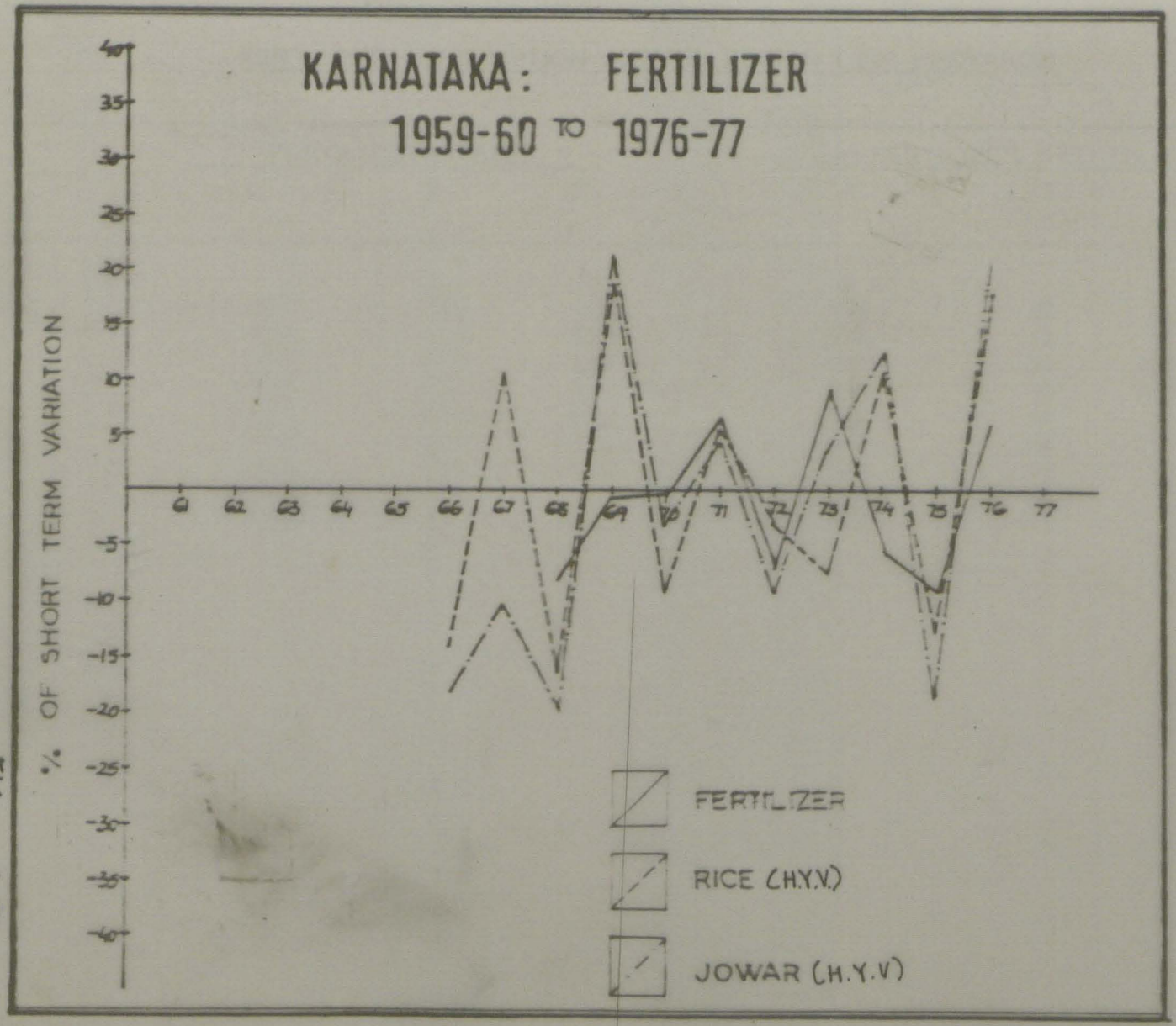
KARNATAKA: FERTILIZER
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
40
35
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
-35
-40
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
FERTILIZER
RICE (H.Y.V.)
JOWAR (H.Y.V)

FIG - 4.31

TABLE 4.31

TREND VALUE AND SHORT TERM DEVIATION IN

FERTILIZER CONSUMPTION : STATE, REGION I ('00 HECTARES)

Years	FERTILIZER (STATE)			FERTILIZER (REGION I)		
	1	2	3	1	2	3
1967-68	1024	125	- 7.91	272	32	- 13.54
1968-69	1239	9	- 0.96	316	12	- 4.07
1969-70	1595	6	- 0.38	437	31	- 7.79
1970-71	1834	131	6.71	525	76	12.72
1971-72	2077	129	- 6.65	628	59	- 10.54
1972-73	2100	216	9.33	645	68	9.63
1973-74	2150	112	- 5.50	671	17	- 2.68
1974-75	2277	182	- 8.71	726	80	- 12.45
1975-76	1498	101	6.80	508	71	11.18

TABLE 4.32

TREND VALUE AND SHORT TERM DEVIATION IN FERTILIZER CONSUMPTION FOR REGIONS II, III, IV

Years	REGION II			REGION III			REGION IV		
	1	2	3	1	2	3	1	2	3
1967-68	556	68	- 14.08	101	14	- 7.12	93	8	- 10.66
1968-69	667	9	1.47	129	1	0.05	125	6	- 5.89
1969-70	849	12	- 1.46	155	17	8.04	153	20	11.79
1970-71	975	58	5.68	181	17	- 8.98	152	14	8.75
1971-72	1095	41	- 3.90	200	7	3.41	152	35	- 12.36
1972-73	1113	85	7.10	208	22	0.93	153	39	11.74
1973-74	1127	39	- 3.68	208	21	-10.31	143	31	- 13.52
1974-75	1194	99	- 9.06	208	1	0.10	147	3	- 2.11
1975-76	832	69	4.62	146	14	7.56	110	26	7.90

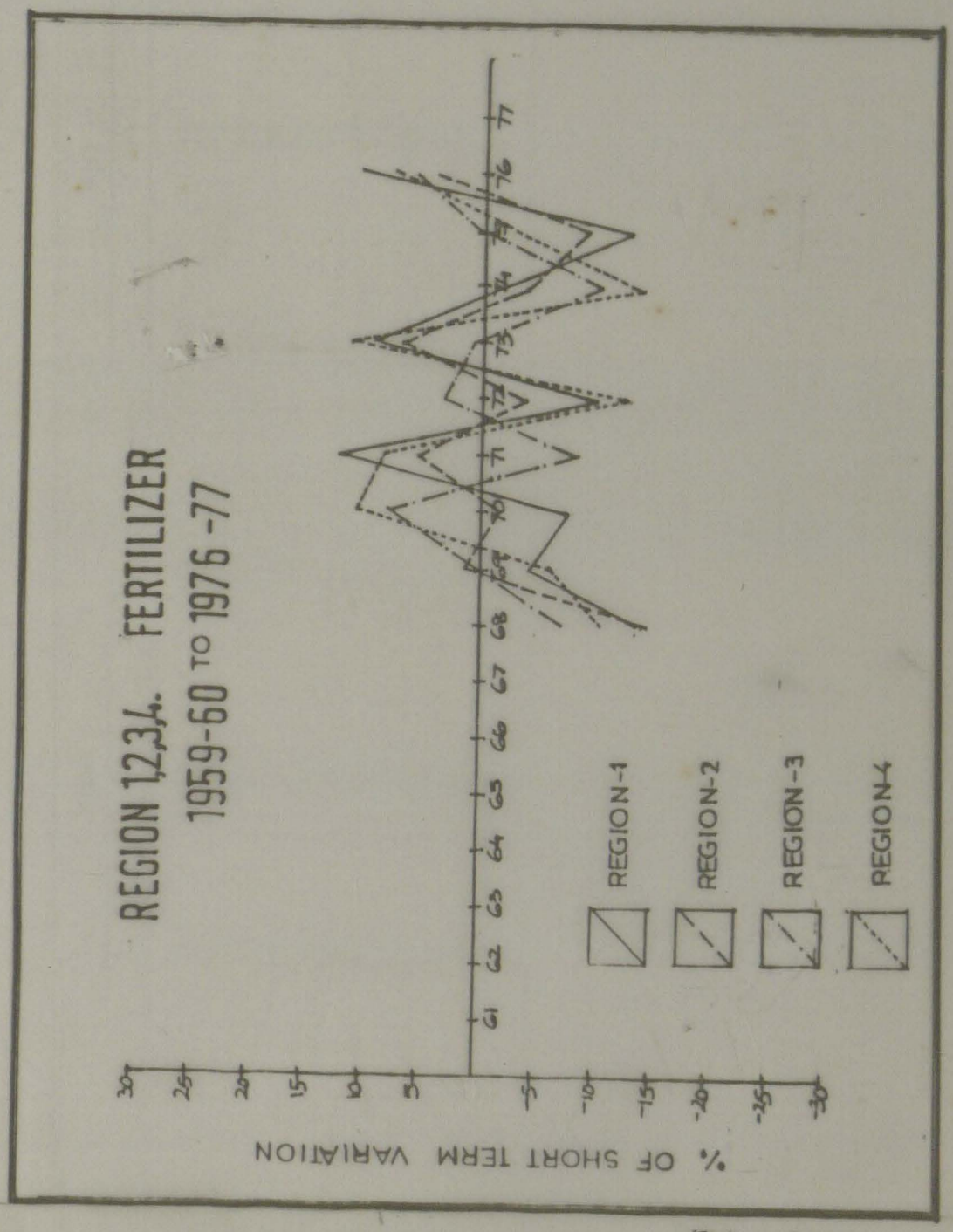
REGION 1,2,3,4. FERTILIZER
1959-60 TO 1976-77
% OF SHORT TERM VARIATION
30
25
20
15
10
5
-5
-10
-15
-20
-25
-30
61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77
REGION-1
REGION-2
REGION-3
REGION-4

FIG - 4.32

TABLE 4.33

TREND VALUE AND SHORT TERM DEVIATION IN HYV AT STATE LEVEL FOR JOWAR AND RICE ('000 TONNES)

Years	JOWAR			RICE		
	1	2	3	1	2	3
1965-66	11	5	- 18.89	21	11	- 15.00
1966-67	21	2	- 10.53	34	4	10.53
1967-68	79	41	- 19.65	84	30	- 16.79
1968-69	143	39	21.43	125	36	19.63
1969-70	211	2	- 3.28	174	14	- 9.17
1970-71	238	6	4.46	214	12	5.94
1971-72	302	41	- 9.84	288	8	- 3.10
1972-73	387	14	3.57	413	29	- 7.55
1973-74	395	104	12.93	453	122	11.22
1974-75	461	177	- 19.44	491	91	- 12.92
1975-76	294	305	20.89	300	100	18.00

4.5 Trend Deviation in Fertilizer and HYV

Apart from irrigation the other technical inputs that matter most in the production are fertilizer and HYV. In this section we try to study the trend deviation in these two inputs. One of the limitations of this analysis is that the data for the variable is available only 1966-67 onwards. So between 1966-67 to 1976-77 is a small period to study the temporal behaviourof these inputs. However, with this limitation in mind we would note some important trend in their use.

Taking fertilizer first it is noticed that the trend with regard to the total fertilizer use has not been a smooth,it has faced ups and downs during this period at the state level particularly during the drought year of 1971-72(see. fig.4.31). At the regional level, however, one notice some differences in the level of deviation. The trend deviation in regions I and III are much less pronounced as compared with regions II and IV(see. fig. 4.32).

As regards HYV, the picture is slightly different. The area under HYV seed is relatively lower in the state and mostly confine for rice and jowar. The other crops such as cotton allocate a small proportion to the HYV seed. From the figure 4.31, which shows trend deviation for area under HYV for rice and jowar shown that over a time there has been a gradual increase in the under HYV of these two crops. But proportion area has not been free from the year to year ups and downs. The area under both the crops has shown a regular deviation and surprisingly or same magnitude during the period. The positive deviation of course being more eminent.

Summary

In studying about the pattern of agriculture in Karnataka for a period of 18 years (1959-60 to 1976-77), various inputs and outputs have been studied. Some conclusions have been reached. Prominent among them being -

1. ***Rainfall is not** evenly distributed in the State. Region I having lowest rainfall (< 600 mm) and Region II with low to moderate rainfall (600 - 1000 mm) are subjected to a high level of variability and fluctuations. On the other hand Region III could be said to be moderate in nature (1000 - 2000 mm) followed by Region IV which has the maximum rainfall (> 2000 mm). Rainfall in the latter regions is highly dependable and so factor of instability is decreased. Irrigation pattern shows that Region I is basically a well irrigated area, interspersed by canals (Krishna and Tungabhadra) and therefore prone to instability. Region II is a tank irrigated area supported by well irrigation. In fact it is the most unstable area. Region III can be said to be the most stable of regions, with high irrigation of canals, tanks and wells. Region IV , a coastal area has a low level of irrigation as compared to the others. Canal and tank irrigation take control of the area. Apparently the variation in the level of irrigation at the State level seems to be **dependent** on the behaviour of the rainfall. Regions I and II suffer from the phenomenon of instability in the annual rainfall which in turn has a serious implication on the stability and otherwise in the **output,** yield and area.*

2. The Fertilizers have only been introduced towards the end of the period and have shown some increase in their use. Trend deviations in Regions I & III are less pronounced as compared with Regions II & IV.

3. HYV exists only for jowar and rice should be introduced for cotton also, as it could help cotton become a prominent crop for Regions I & II.

Based on these above inputs, a final look at the outputs would lead us to believe that -

a) Rice has its area under increase, but is basically cultivated in well irrigated areas with loamy soils, i.e. Regions III & IV. Region III is the major producer of rice.

b) Jowar has its area decreasing though it still holds around 25% of the NSA. Increase in yield in the area is basically due to use of HYV particularly in Regions I & II.

c) Cotton has no HYV which is the basic reason for its low yield. It is basically grown in Regions I & II, though Region III did make an attempt to introduce it.

d) Overall area in the State has decreased, while yield per hectare has increased. Yield is the basic factor which has led to an increase in production.

CHAPTER V

FLUCTUATIONS IN AREA, OUTPUT AND YIELD AND ITS CORRELATES : A CORRELATION ANALYSIS

5.1 Introduction

In the preceding chapter, we analysed the pattern of fluctuation in area, output and yield. We also examined the nature of fluctuation in some of the inputs such as annual rainfall, irrigation sources of irrigation, fertilizer and HYV at the State and the regional level. Having examined the variation in output, area and yield, and the inputs over time, it would be in the fitness of things to see the association between these two set of variables. It may be mentioned that we have not really tried to study the dependencies of one with the other, with statistical techniques, such as multiple regression, for the want of data. But we thought it appropriate to use the techniques of correlation to estimate and establish the pattern of relation between the 2 sets of variable. Accordingly, we have worked out the correlation matrix -

(a) between output and rainfall, sources of irrigation (canal, tank and wells, irrigation level, fertilizers and HYV);

(b) between yield and these seven variables; and

(c) finally between area and the seven variables.

The correlation matrix has been derived for aggregate output as well as for individual crops, in the State and four regions. What follows is the interpretation of correlation matrix for output, area and yield separately.

5.2 Output

We first begin with the correlation matrix of aggregate output at the level of the State and regions. Matrix reveals the fluctuations in aggregate output are positively and significantly related with rainfall (.46), irrigation (.52), canal irrigation (.58), fertilizer (.61) and HYV (.72). Among them however, canal irrigation fertilizer and HYV were significant at 99% level, while rainfall and irrigation at 95% level. The other variable namely tank and well irrigation have weak correlation with fluctuations in output. The results clearly indicate that variation in water supply, either through natural rainfall or artificial irrigation as such are more dependable sources of canal and essentially govern the fluctuation in output.

The association of fertilizers and HYV is caused by rainfall and irrigation, particularly canal irrigation. So their effect is indirect. This is very clear from the inter-correlation between canals, irrigation and fertilizer (.65 at .01 significance level) and HYV (.69 at same) on one hand, and of total irrigation on the other with HYV (.51 significance at 95% level). Since the use of fertilizer and HYV depends heavily on availability of water, their positive association with rainfall, canal irrigation and overall irrigation was quite natural and understandable. This dependability was also brought out by significant correlation between rainfall and irrigation (.50 significance at 95% level).

At the regional level, the results vary from one region to another. In Region I, the correlation matrix (Table 5.2), reveals canal irrigation (.31), fertilizer (.43) and HYV (.42) positively and

TABLE 5.1

CORRELATION MATRIX

FACTORS ASSOCIATED WITH OUTPUT FOR AGGREGATE CROPS : STATE

Variable	1	2	3	4	5	6	7
Output	0.58 *	0.48	0.29	0.46 @	0.52 @	0.61 *	0.72 *
Canal	1.00	0.39	0.35	0.13	0.51	0.65	0.69
Tank	--	1.00	0.31	0.39	0.32	0.45	0.54
Well	--	--	1.00	0.29	0.46	0.39	0.37
Rainfall	--	--	--	1.00	0.21	0.52 @	0.49 @
Irrigation Level	--	--	--	--	1.00	0.39	0.56 @
Fertilizer	--	--	--	--	--	1.00	0.23
HYV	--	--	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.2

CORRELATION MATRIX

OUTPUT : REGION I (AGGREGATE)

Variable	1	2	3	4	5	6	7
Output	0.31 @	0.26	0.21	0.30	0.29	0.43 @	0.42 $
Canal	1.00	0.08	0.19	0.21	0.36	0.46*	0.41 *
Tank	--	1.00	0.13	0.42	0.27	0.39	0.23
Well	--	--	1.00	0.16	0.18	0.21	0.16
Rainfall	--	--	--	1.00	0.38	0.29	0.30
I. Level	--	--	--	--	1.00	0.53 $	0.55 $
Fertilizer	--	--	--	-	--	1.00	0.19
HYV	--	--	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.3

CORRELATION MATRIX

OUTPUT : REGION II (AGGREGATE)

Variable	1	2	3	4	5	6	7
Output	0.12	0.36 @	0.49	0.35	0.25	0.31 $	0.57 @
Canal	1.00	0.12	0.31	0.22	0.19	0.49	0.32
Tank	--	1.00	0.21	0.38	0.29	0.37 $	0.35 $
Well	--	--	1.00	0.39	0.38	0.35	0.19
Rainfall	--	--	--	1.00	0.41	0.21	0.37
Irrigation Level	--	--	--	--	1.00	0.29	0.26
Fertilizer	--	--	--	--	--	1.00	0.17
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.4

CORRELATION MATRIX

OUTPUT : REGION III (AGGREGATE)

Variable	1	2	3	4	5	6	7
Output	0.56*	0.96@	0.30	0.59 *	0.48 *	0.62*	0.71*
Canal	1.00	0.29	0.16	0.67 *	0.69*	0.78*	0.83
Tank	--	1.00	0.27	0.54 *	0.41	0.63@	0.69 @
Well	--	--	1.00	0.28	0.23	0.42	0.38
Rainfall	--	--	--	1.00	0.52	0.39	0.52
Irrigation Level	--	--	--	--	1.00	0.51	0.79 *
Fertilizer	-	--	--	--	--	1.00	0.20
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.5

CORRELATION MATRIX

OUTPUT : REGION IV (AGGREGATE)

Variable	1	2	3	4	5	6	7
Output	0.32$	0.21@	0.19	0.63*	0.59@	0.75*	0.81*
Canal	1.00	0.24	0.12	0.44	0.21	0.63@	0.53
Tank	--	1.00	0.33	0.53	0.39	0.70@	0.69@
Well	--	--	1.00	0.31	0.19	0.61	0.58
Rainfall	--	--	--	1.00	0.60	0.75*	0.81*
Irrigation Level	--	--	--	--	1.00	0.46	0.52
Fertilizer	--	--	--	-	--	1.00	0.65*
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

significantly related with fluctuation in aggregate output. While the first two are significant at 5% level, the last one is significant at 10% level. Contrary to the expectation, annual rainfall shows a weak relation in region I which is a low rainfall area. Given the low rainfall, it is the fluctuation in area under canal, which is a major source in this region, which really matters most from the point of view of fluctuations in output. The effect of fertilizer on the output is essentially via canal irrigation, and it is well brought out by a positive and significance (.46 at 5% level) between these two variables.

In Region II, however, the pattern is slightly different. In this region, the fluctuation in output indicates a positive and significant correlation with area under tank irrigation (.36), fertilizers (.31) and HYV (.51) while correlation co-efficient for HYV and tank irrigation is significant at 5% level, significance level is .10 in the case of fertilizers. It may be noted that for obvious reasons, the variables for fertilizer and HYV are positive and significantly related with the tank irrigation, although the level of significance is low. So in Region II, which is a low-medium rainfall region, tank irrigation plays an important role in governing the fluctuation in output.

In Region III which is medium rainfall area, the correlation matrix indeed revealed a very systematic and ideal pattern of relationship. Correlation matrix (Table 5.4) reveals that all variables like canal irrigation (.58), total irrigation (.48), tank irrigation (.46), rainfall (.59), fertilizers (.62) and HYV (.71), show a positive and significant relation with the fluctuation in the regions output. An interesting fact is that, except tank irrigation, which is significant

at 5% level, the rest of the variable inputs are significant at 1% level. This region provides an opportunity to all input variables to interact with the output. This is well brought out in a sysstematic inter-correlation between various inputs among themselves, particularly between canal on the one hand and rainfall (.67), tank irrigation, fertilizer (.78) and HYV (.83) on the other. In a technologically developed area, the modern inputs such as irrigation, fertilizer and HYV, the output provided a rise together. So they are always used in a package form. Therefore, variation in a basic variable like irrigation, particularly canal, (which is a perennial source of irrigation) brings the variation in other inputs and collectively they affect the output. This is what precisely seems to happen in Region III.

Region IV which, possesses a more or less identical situation (as that existing in Region III) with regards to rainfall and irrigation reveal exactly the same pattern as was noticed in Region III. Correlation matrix (Table 5.5) reveals a positive and significant correlation between output and all variables except well irrigation. These variables are rainfall (.63), irrigation (.50), canal irrigation (.32), tank irrigation (.21), fertilizers (.75) and HYV (.81). While rainfall, fertilizer and HYV are significant at 1% level, the input, irrigation/ tank irrigation and canal irrigation are significant at 5% and 10% levels respectively. Like Region III, there is also higher inter-correlation between the inputs among themselves. For instance, the area under canal is positively related with fertilizer input (.63). The correlation between fertilizer and HYV with tank irrigation work out to be .70 and .69 respectively. These three correlation co-efficients were significant at 5% level. While the correlation co-efficient of rainfall with fertilizer (.75) and HYV (.21) were significant at 1% level.

Having examined the pattern of correlation between aggregate output and selected inputs at State and regions, now repeat the same at the crop level data.

Having examined the pattern of correlation between aggregate output and selected input at State and regional level, now repeate the same at the crop level data. We now study the correlation for rice, jowar and cotton for the State and for each region separately. Let us start with rice.

Rice

The correlation matrix reveals that (a) at State level, the variable irrigation (.75), rainfall (.57), fertilizer (.75) and HYV (.65) are positively and significantly related with the output of rice while the first one was significant at 1% level the last three were significant at 5% level.

(a) In Region I only irrigation (.35) and fertilizer (.59) have shown significant relation with output both being significant at 5% level. The rainfall bears a weak correlation with output. Between the inputs level of irrigation under a crop and fertilizer use has shown a positive correlation of .65 at 5% level of significance.

(b) In Region II, all the three variables, namely, irrigation (.31), rainfall (.58) and fertilizer show significant relation with output the first being significant at 5% level while the others are significant at 10% level. Strangely enough, irrigation bears a negative animation with output.

(c) In Region III, the results are more clear and systematic. The input crop level irrigation (.62), rainfall (.69) and fertilizer (.81) bears a strong and significant relation with output and what

TABLE 5.6

CORRELATION MATRIX

OUTPUT : STATE (RICE)

Variable	1	2	3	4	5
Output	0.75*	0.57@	0.59@	0.78@	0.65@
Crop-wise Irrigation	1.00	0.51	0.43	0.79*	0.61*
Rainfall	--	1.00	0.46	0.89@	0.51@
Irrigation Level	--	--	1.00	0.63@	0.45*
Fertilizer	--	--	--	1.00	0.59@
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.6 (a)

CORRELATION MATRIX

OUTPUT : REGION I (RICE)

Variable	1	2	3	4
Output	0.35@	0.50	0.58	0.59@
Crop-wise Irrigation	1.00	0.68	0.88	0.63@
Rainfall	--	1.00	0.37	0.39
Irrigation Level	--	--	1.00	0.42
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.7

CORRELATION MATRIX

OUTPUT : REGION II (RICE)

Variable	1	2	3	4
Output	0.31@	0.58$	0.46	0.31$
Crop-wise Irrigation	1.00	0.53	0.34	0.41
Rainfall	--	1.00	0.59	0.16
Irrigation Level	--	--	1.00	0.67
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.8

CORRELATION MATRIX

OUTPUT : REGION III (RICE)

Variable	1	2	3	4
Output	0.62*	0.69*	0.75*	0.81*
Crop-wise Irrigation	1.00	0.61*	0.89*	0.86*
Rainfall	--	1.00	0.53	0.77@
Irrigation Level	--	--	1.00	0.71*
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.9

CORRELATION MATRIX

OUTPUT : REGION IV (RICE)

Variable	1	2	3	4
Output	0.53@	0.75*	0.61*	0.89*
Crop-wise Irrigation	1.00	0.69@	0.64@	0.83*
Rainfall	—	1.00	0.53@	0.85*
Irrigation Level	—	--	1.00	0.93*
Fertilizer	—	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

is important is that all the correlation coefficients are significant at 1.00% level. Another important thing is that unlike in regions I and II, inter-correlation between irrigation on the one hand and rainfall (.61) and fertilizer (.86) on the other hand is quite high. The rainfall also bears a high correlation with fertilizer. Inter-input dependability which was also noticed at aggregate level in Region III is seen here too.

(d) In Region IV the pattern more or less is identical with Region III. The inputs irrigation (.53), rainfall (.75) and fertilizer (.89) show a high and significant correlation with output of rice. Further, these inputs are also significant and inter-connected with each other.

What do these results indicate as far as the output fluctuations in rice are concerned. The results clearly indicate that rice being a wet crop it requires more of water than jowar and cotton crops. The fluctuations in its output are nearly dependent on the fluctuation in rainfall and irrigation, the other factor such as fertilizer comes latter, because the use of fertilizer itself depends on the farmer. These two input variables along with fertilizer had constantly emerged in all regions as important variables. However, we must note one major difference between Regions I and II (low and low-moderate rainfall area) on the one han and Regions III and IV on the other. In Regions III and IV, the inter-correlation among the inputs themselves was found to be higher while it was quite weak in Regions I and II. This was quite natural that irrigation/ rainfall and fertilizer should show a close connection in their use, as latter depends on the farmer heavily for its proper application and the result.

Jowar

Correlation matrix for Jowar (Table 5.10) show the ratio correlation coefficient at the State level. The variables having high and significant correlation with output are irrigation (.67), rainfall (.54) and fertilizer (.75), all of which are significant at 10% level. We also notice an inter-relation between irrigation and fertilizer, which is significant at 5% level. This is so because irrigation plays an important role in the use of chemical fertilizers.

(a) In Region I, the only significant correlation between any input and output is singled out by irrigation alone. The fluctuation in output for jowar in this region is therefore determined to a large extent by irrigation as other variables show a weak correlation with output.

(b) In Region II on the other hand correlation matrix shows both irrigation (.49) and rainfall (.39) to be important variables which are significant at 10% level. This being a low irrigated area, and low rainfall, any variation in them caused significant variation in output.

(c) Region III is a high rainfall area with high irrigation network. Therefore, one sees a high correlation between inputs like irrigation (.56), rainfall (.63) and fertilizers (.74) with the output of jowar. All of them are highly significant at 1% level. Further their variables are mutually inter-dependent and together affect the level of output. This fact is very well brought out by a significant correlation between themselves (See Table 5.13).

TABLE 5.10

CORRELATION MATRIX

OUTPUT : STATE (JOWAR)

Variable	1	2	3	4
Output	0.67$	0.54$	0.53	0.75$
Crop-wise Irrigation	1.00	0.49	0.31	0.63@
Rainfall	--	1.00	0.36	0.79
Irrigation Level	--	--	1.00	0.65$
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.11

CORRELATION MATRIX

OUTPUT : REGION I (JOWAR)

Variable	1	2	3	4
Output	0.54$	0.49	0.56	0.63
Crop-wise Irrigation	1.00	0.37	0.54	0.31
Rainfall	--	1.00	0.43	0.65
Irrigation Level	--	--	1.00	0.54
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.12

CORRELATION MATRIX

OUTPUT : REGION II (JOWAR)

Variable	1	2	3	4
Output	0.49$	0.39$	0.57	0.59
Crop-wise Irrigation	1.00	0.23	0.43	0.53
Rainfall	--	1.00	0.36	0.43
Irrigation Level	--	--	1.00	0.67
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.13

CORRELATION MATRIX

OUTPUT : REGION III (JOWAR)

Variable	1	2	3	4
Output	0.56*	0.63*	0.43$	0.74*
Crop-wise Irrigation	1.00	0.54*	0.39@	0.81*
Rainfall	--	1.00	0.36	0.64*
Irrigation Level	--	--	1.00	0.32
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.14

CORRELATION MATRIX

OUTPUT : REGION IV (JOWAR)

Variable	1	2	3	4
Output	0.59	0.75	0.43	0.83
Crop-wise Irrigation	1.00	0.69	0.39	0.86
Rainfall	--	1.00	0.51	0.79
Irrigation Level	--	--	1.00	0.65
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.15

CORRELATION MATRIX

OUTPUT : STATE (COTTON)

Variable	1	2	3	4
Output	0.32$	0.40$	0.23	0.31$
Crop-wise Irrigation	1.00	0.30@	0.16	0.23@
Rainfall	--	1.00	0.21	0.19
Irrigation Level	--	--	1.00	0.16@
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.16

CORRELATION MATRIX

OUTPUT : REGION I (COTTON)

Variable	1	2	3	4
Output	0.46@	0.57	0.36	0.58@
Crop-wise Irrigation	1.00	0.36	0.21	0.54
Rainfall	--	1.00	0.17	0.31
Irrigation Level	--	--	1.00	0.23@
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.17

CORRELATION MATRIX

OUTPUT : REGION II (COTTON)

Variable	1	2	3	4
Output	0.39$	0.43@	0.23	0.45$
Crop-wise Irrigation	1.00	0.29	0.27	0.21$
Rainfall	--	1.00	0.31	0.21$
Irrigation Level	--	--	1.00	0.16
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.18

CORRELATION MATRIX

OUTPUT : REGION III (COTTON)

Variable	1	2	3	4
Output	0 .53	0.61	0.32	0.63
Crop-wise Irrigation	1.00	0.51	0.46	0.61
Rainfall	--	1.00	0.39	0.52
Irrigation Level	--	--	1.00	0.16
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.18 (a)

CORRELATION MATRIX

OUTPUT : REGION IV (COTTON)

Variable	1	2	3	4
Output	0.41	0.75	0.43	0.83
Crop-wise Irrigation	1.00	0.50	0.39	0.75
Rainfall	--	1.00	0.95	0.61
Irrigation Level	--	--	1.00	0.32
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

Cotton

This is another crop grown which is mostly grown in dry condition and a very small proportion is cultivated through artificial irrigation sources. Table 5.15 shows the correlation matrix for cotton at the State level. All the three inputs of irrigation (.32), rainfall (.40) and fertilizers (.31) show a significant relation with output of cotton, all of them being significant at 10% level. Rest of the variables show a weak correlation with output.

(a) In Region I also, the input variables irrigation (.46) and fertilizer (.58) show a significant relationship with the output. The rest of the variables bear a weak relationship with output of cotton.

(b) Region II follows the State level pattern. Like the State level result the inputs irrigation (.39), rainfall (.43)a and fertilizer (.45) show positive and a significant relation with the output of cotton. As this area is devoid of an assumed supply of irrigation, rainfall becomes the most significant variable in governing the variation in the output.

5.3 Area

This section intreprets the correlation result of fluctuation in area of aggregate and crop level for the State and for the regions.

At the State level, the correlation matrix revealed a significant relation of the input variable, canal irrigation (.54), tank irrigation and well irrigation (.43), the first being significant at 1% level while the last two are significant at 5% level. The other variable indicates a weak relationship in the fluctuation in aggregate area.

TABLE 5.19

CORRELATION MATRIX

AREA : STATE (AGGREGATE)

Variable	1	2	3	4	5	6	7
Area	0.54*	0.61@	0.43@	0.39	0.31	0.13	0.11
Canal	1.00	0.39	0.17	0.43*	0.52@	0.61*	0.37@
Tank	--	1.00	0.37	0.31*	0.32@	0.56@	0.26@
Well	--	--	1.00	0.19$	0.16	0.39	0.13
Rainfall	--	--	--	1.00	0.19	0.21	0.15
Irrigation Level	--	--	--	--	1.00	0.45	0.11
Fertilizer	--	--	--	--	--	1.00	0.02
HYV	--	--	--	--	-	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.20

CORRELATION MATRIX

AREA : REGION I (AGGREGATE)

Variable	1	2	3	4	5	6	7
Area	0.36$	0.49@	0.26	0.31	0.25	0.29	0.45
Canal	1.00	0.32	0.21	0.49$	0.61$	0.59	0.61
Tank	--	1.00	0.12	0.48$	0.49	0.31	0.42
Well	--	--	1.00	0.21	0.31	0.29	0.19
Rainfall	--	--	--	1.00	0.32	0.31	0.33
Irrigation Level	--	--	--	--	1.00	0.41	0.29
Fertilizer	--	--	--	--	--	1.00	0.31
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.21

CORRELATION MATRIX

AREA : REGION II (AGGREGATE)

Variable	1	2	3	4	5	6	7
Area	0.21	0.39$	0.45@	0.32	0.21	0.31	
Canal	1.00	0.10	0.13	0.29	0.22	0.12	
Tank	--	1.00	0.10	0.42@	0.36	0.29	
Well	--	--	1.00	0.45@	0.43	0.32	
Rainfall	--	--	--	1.00	0.39	0.21	
Irrigation Level	--	--	--	--	1.00	0.41	
Fertilizer	--	--	--	--	--	1.00	
HYV							

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.22

CORRELATION MATRIX

AREA : REGION III (AGGREGATE)

Variable	1	2	3	4	5	6	7
Area	0.58*	0.36@	0.21	0.48*	0.52@	0.61*	0.63@
Canal	1.00	0.21	0.17	0.56*	0.63*	0.62*	0.71*
Tank	--	1.00	0.31	0.49@	0.42@	0.49	0.56@
Well	--	--	1.00	0.33	0.27	0.31	0.29
Rainfall	--	--	--	1.00	0.56	0.51	0.53
Irrigation Level	--	--	--	--	1.00	0.73	0.81
Fertilizer	--	--	--	--	--	1.00	0.31
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.23

CORRELATION MATRIX

AREA : REGION IV (AGGREGATE)

Variable	1	2	3	4	5	6	7
Area	0.31$	0.39@	0.30	0.62$	0.49	0.70	0.51
Canal	1.00	0.20	0.13	0.52$	0.29	0.81	0.78
Tank	--	1.00	0.11	0.41$	0.39	0.59	0.61
Well	--	--	1.00	0.31	0.21	0.31	0.39
Rainfall	--	--	--	1.00	0.51	0.69	0.71
Irrigation Level	--	--	--	--	1.00	0.72	0.69
Fertilizer	--	--	--	--	--	1.00	0.31
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

Thus the irrigation parameter expert a strong impact on the year to year fluctuation in area, than the other variables.

At the regional level the results show somewhat different pattern. In regions I and II similar variable seem to govern the fluctuation in aggregate cropped area. While in Region I canal (.36) and tank (.49) show a significant relation with area (correlation coefficient being significant at 10% and 5% respectively for canal and tank). IN Region II tank irrigation (.39) and well irrigation bear a positive association with aggregte area with the level of significance being 10% and 5% respectively. So it is the variation in the area under important sources that bring the fluctuation in cropped area in regions I and II. It may however be noted that irrigation through canal in Region I (.49) and tank (.42) and well (.45) in Region II bear a positive association with rainfall indicating the dependence of the three sources of irrigation/natural rainfall. So rainfall did influence the area fluctuation via changes in canal, tank and well irrigation.

Unlike Regions I and II the results are typically different in other two regions, namely Regions I and II. In Region III for instance, all the variables except one (namely well irrigation) have shown positive and significiant relation with cropped area. While rainfall,fertilizer, and canal irrigation are significant at 1% level, the irrigation through tank and HYV are significant at 5% level. Thus it is clear that the water factor, either through natural or artificial source governs the fluctuation in the cropped area. The result reveal a significant relation of canal, annual rainfall and tank irrigation with area veriability. While the first two variables are significant at 10% level the last one is significant at 5% level.

TABLE 5.24

CORRELATION MATRIX

AREA : STATE (RICE)

Variable	1	2	3	4
Area	0.49*	0.53*	0.43@	0.37$
Crop-wise Irrigation	1.00	0.59*	0.32@	0.49$
Rainfall	--	1.00	0.29$	0.50
Irrigation Level	--	--	1.00	0.29
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.25

CORRELATION MATRIX

AREA : REGION I (RICE)

Variable	1	2	3	4
Area	0.35$	0.26	0.31	0.17
Crop-wise Irrigation	1.00	0.19	0.24	0.09
Rainfall	--	1.00	0.39	0.13
Irrigation Level	--	--	1.00	0.19
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.26

CORRELATION MATRIX

AREA : REGION II (RICE)

Variable	1	2	3	4
Area	0.29	0.17	0.27	0.11
Crop-wise Irrigation	1.00	0.15	0.27	- 0.31
Rainfall	--	1.00	0.21	0.19
Irrigation Level	--	--	1.00	0.16
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.27

CORRELATION MATRIX

AREA : REGION III (RICE)

Variable	1	2	3	4
Area	0.48*	0.55*	0.70*	0.61*
Crop-wise Irrigation	1.00	0.49*	0.61@	0.79*
Rainfall	--	1.00	0.68*	- 0.58$
Irrigation Level	--	--	1.00	0.53@
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.28

CORRELATION MATRIX

AREA : REGION IV (RICE)

Variable	1	2	3	4
Area	0.39@	0.76*	0.65@	0.83@
Crop-wise Irrigation	1.00	0.65*	0.43	0.89@
Rainfall	--	1.00	0.55@	0.96*
Irrigation Level	--	--	1.00	0.71@
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.29

CORRELATION MATRIX

AREA : STATE (JOWAR)

Variable	1	2	3	4
Area	0.57@	0.43$	0.62$	0.39
Crop-wise Irrigation	1.00	0.38	0.52	0.47
Rainfall	--	1.00	0.59	0.31
Irrigation Level	--	--	1.00	0.29
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.30

CORRELATION MATRIX

AREA : REGION I (JOWAR)

Variable	1	2	3	4
Area	0.16$	0.21	0.25	0.13
Crop-wise Irrigation	1.00	0.25	0.27	0.16
Rainfall	--	1.00	0.19	0.05
Irrigation Level	--	--	1.00	0.10
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.31

CORRELATION MATRIX

AREA : REGION II (JOWAR)

Variable	1	2	3	4
Area	0.09	0.13	0.11	0.06
Crop-wise Irrigation	1.00	0.17	0.13	0.06
Rainfall	--	1.00	0.15	0.01
Irrigation Level	--	--	1.00	- 0.11
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.32

CORRELATION MATRIX

AREA : REGION III (JOWAR)

Variable	1	2	3	4
Area	0.21@	0.19*	0.16$	0.34$
Crop-wise Irrigation	1.00	0.16@	0.15	0.29$
Rainfall	--	1.00	0.12$	0.39
Irrigation Level	--	--	1.00	1.17@
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.33

CORRELATION MATRIX

AREA : REGION IV (JOWAR)

Variable	1	2	3	4
Area	0.39$	0.52*	0.66@	0.77@
Crop-wise Irrigation	1.00	0.31$	0.62$	0.79$
Rainfall	--	1.00	0.35$	0.53@
Irrigation Level	--	--	1.00	0.61$
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.34

CORRELATION MATRIX

AREA : STATE (COTTON)

Variable	1	2	3	4
Area	0.59$	0.67@	0.43	0.19
Crop-wise Irrigation	1.00	0.54$	0.39	0.16
Rainfall	--	1.00	0.35	0.08
Irrigation Level	--	--	1.00	0.23
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.35

CORRELATION MATRIX

AREA : REGION I (COTTON)

Variable	1	2	3	4
Area	0.49$	0.52$	0.31$	0.09$
Crop-wise Irrigation	1.00	0.43$	0.19	- 0.10
Rainfall	--	1.00	0.26	- 0.03
Irrigation Level	--	--	1.00	- 0.01
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.36

CORRELATION MATRIX

AREA : REGION II (COTTON)

Variable	1	2	3	4
Area	0.35	0.39$	0.21	0.03$
Crop-wise Irrigation	1.00	0.12	0.17	0.06
Rainfall	--	1.00	0.13	0.09
Irrigation Level	--	--	1.00	- 0.10
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.37

CORRELATION MATRIX

AREA : REGION III (COTTON)

Variable	1	2	3	4
Area	0.53	0.59	0.36	0.61
Crop-wise Irrigation	1.00	0.16	0.31	0.67
Rainfall	--	1.00	0.23	0.54
Irrigation Level	--	--	1.00	0.31
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.38

CORRELATION MATRIX

AREA : REGION IV (COTTON)

Variable	1	2	3	4
Area	0.49	0.69	0.32	0.79
Crop-wise Irrigation	1.00	0.53	0.12	0.81
Rainfall	--	1.00	0.52	0.62
Irrigation Level	--	--	1.00	0.50
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

The role of fertiliser and HYV is insignificant in Region IV. It may be noted that even in Region III though fertilizer and HYV indicate positive association with area, it is mainly through the effect of rainfall and irrigation input.

So it appeared that irrigation (with various sources) in Regions I and II exert strong influence on area variability, while in Regions III and IV in addition to irrigation (with their source components) rainfall also affect the variability in area.

Crop level analysis

Let us now examine the pattern of association of selected variable with area at crop level. At the State level, it is interesting to note that practically for all the crops that is for rice, jowar, and cotton, the canal irrigation and annual rainfall have shown a positive and significant correlation with area. It is only in the case of rice that fertilization variation have also indicated positive and significant association with area variability. At the level of the region, however, the result brings out some what different pattern. In Region I, canal irrigation, rainfall and fertilizer have shown a significant relation with the area under cotton, while canal alone indicated a significant relation with area under rice and jowar. In Region II, except in the case of cotton where rainfall in association with fertilizer show a significant association with area for in the case of rice and jowar, however, the input variable selected for the correlation analysis did not show any association with area as such thereby indicating that the factor other than three included are more important in explaining the fluctuation in area in Region II.

TABLE 5.39

CORRELATION MATRIX

PRODUCTIVITY : STATE (AGGREGATE)

Variable	1	2	3	4	5	6	7
Productivity	0.54*	0.17$	0.12$	0.38@	- 0.39	0.80*	0.72*
Canal	1.00	0.47	0.41	0.04	- 0.72	0.78*	0.77*
Tank	--	1.00	0.52	0.56@	- 0.86	0.37	0.61*
Well	--	--	1.00	0.14	- 0.75	0.15	0.33
Rainfall	--	--	--	1.00	- 0.39	0.09	0.24
Irrigation Level	--	--	--	--	1.00	- 0.55	- 0.74
Fertilizer	--	--	--	--	--	1.00	0.94*
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.40

CORRELATION MATRIX

PRODUCTIVITY : REGION I (AGGREGATE)

Variable	1	2	3	4	5	6	7
Productivity	0.37@	0.35@	0.23	0.21	- 0.30	0.23@	0.45@
Canal	1.00	0.47	0.41	0.42	- 0.47	0.78*	0.77*
Tank	--	1.00	0.51	0.56$	- 0.98	0.37	0.61$
Well	--	--	1.00	0.14	- 0.45	0.15	0.33
Rainfall	--	--	--	1.00	- 0.59	0.09	0.24
Irrigation Level	--	--	--	--	1.00	- 0.43	- 0.66
Fertilizer	--	--	--	--	--	1.00	0.74@
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.41

CORRELATION MATRIX

PRODUCTIVITY : REGION II (AGGREGATE)

Variable	1	2	3	4	5	6	7
Productivity	0.10$	- 0.36	0.70@	- 0.10$	0.15	0.16	0.54$
Canal	1.00	0.04	0.18	0.44	- 0.16	0.84@	0.81@
Tank	--	1.00	- 0.18	0.51	- 0.70	0.31	0.50
Well	--	--	1.00	0.38	0.30	0.08	0.07
Rainfall	--	--	--	1.00	- 0.52	0.57	0.71@
Irrigation Level	--	--	--	--	1.00	0.26	0.47
Fertilizer	--	--	--	--	--	- 1.00	- 0.09
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.42

CORRELATION MATRIX

PRODUCTIVITY : REGION III (AGGREGATE)

Variable	1	2	3	4	5	6	7
Productivity	0.28@	0.50*	0.19	0.15	0.35	0.61*	0.90*
Canal	1.00	- 0.16	- 0.32	- 0.63	- 0.12	0.48	0.35
Tank	--	1.00	0.39	- 0.33	0.58$	- 0.49	0.78*
Well	--	--	1.00	0.09	0.23	- 0.40	0.48
Rainfall	--	--	--	1.00	0.20	- 0.06	0.44
Irrigation Level	--	--	--	--	1.00	- 0.20	0.46
Fertilizer	--	--	--	--	--	1.00	0.67*
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

TABLE 5.43

CORRELATION MATRIX

PRODUCTIVITY : REGION IV (AGGREGATE)

Variable	1	2	3	4	5	6	7
Productivity	0.27	0.13	0.49@	0.59*	0.24	0.67*	0.72*
Canal	1.00	0.15	0.45	0.49	- 0.18	0.47	0.49
Tank	--	1.00	0.13	0.09	- 0.08	0.32	0.54
Well	--	--	1.00	0.14	- 0.33	0.34	0.61$
Rainfall	--	--	--	1.00	0.14	0.24	0.31
Irrigation Level	--	--	--	--	1.00	0.43	0.55
Fertilizer	--	--	--	--	--	1.00	0.39*
HYV	--	--	--	--	--	--	1.00

* - .01 Significance Level

@ - .05 Significance Level

$ - .10 Significance Level

As regards Regions III and IV in both the regions canal irrigation, rainfall and fertilizer show a positive and significant association with the variability in area under rice and jowar. So some categories of factors affect the area under rice and jowar in Regions III and IV.

5.4 Productivity and Yield Rate

Productivity and yield rate per hectare is an important parameter on which the output of a crop depends. In this section we examine the correlation results related with the productivity and yield rates for the aggregate output and for individual crops.

Aggregate Level Analysis

To start with the productivity (i.e. aggregate level), it is observed that practically all the inputs namely canal, tank and well irrigation, rainfall, fertilizer and HYV bear a positive and significant correlation with productivity at the State level. At the regional level also with a minor exception same variable seem to govern the productivity behaviour. For instance, in Regions I and III input variable canal, tank fertilizer, and HYV show a positively significant relation with productivity. In Regions II and IV the pattern is somewhat different. While in Region II canal and well irrigation and HYV extort a more influence on productivity in Region IV, it is well irrigation, rainfall, fertilizer and HYV that determined the productivity behaviour. Thus most of the variables we selected tend to govern the productivity behaviour at the State as well as Region. level.

TABLE 5.44

CORRELATION MATRIX

PRODUCTIVITY : STATE (RICE)

Variable	1	2	3	4
Productivity	0.59*	0.52@	0.31	0.61*
Crop-wise Irrigation	1.00	0.41	0.21	0.43
Rainfall	--	1.00	0.16	0.35$
Irrigation Level	--	--	1.00	0.69*
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.45

CORRELATION MATRIX

PRODUCTIVITY : REGION I (RICE)

Variable	1	2	3	4	5
Productivity	0.37@	0.21	-0.39	-0.17	0.01$
Crop-wise Irrigation	1.00	0.15	- 0.75	0.15	0.33
Rainfall	--	1.00	- 0.39	0.09	0.49
Irrigation Level	--	--	1.00	0.21	0.09
Fertilizer	--	--	--	1.00	0.88@
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.46

CORRELATION MATRIX

PRODUCTIVITY : REGION II (RICE)

Variable	1	2	3	4	5
Productivity	0.56$	-0.17	0.37	0.06	- 0.14
Crop-wise Irrigation	1.00	-0.38	0.28	0.08	- 0.16
Rainfall	--	1.00	- 0.17	0.57$	0.84$
Irrigation Level	--	--	1.00	- 0.12	- 0.12
Fertilizer	--	--	--	1.00	0.86$
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.47

CORRELATION MATRIX

PRODUCTIVITY : REGION III (RICE)

Variable	1	2	3	4	5
Productivity	0.61*	0.05	0.50@	- 0.59	- 0.49
Crop-wise Irrigation	1.00	0.09	0.05	- 0.40	- 0.46
Rainfall	--	1.00	0.01	- 0.06	- 0.08
Irrigation Level	--	--	1.00	- 0.08	- 0.02
Fertilizer	--	--	--	1.00	0.81*
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.48

CORRELATION MATRIX

PRODUCTIVITY : REGION IV (RICE)

Variable	1	2	3	4	5
Productivity	-0.06	- 0.54*	0.24	0.10@	0.59*
Crop-wise Irrigation	1.00	0.14	- 0.33	- 0.34	- 0.56
Rainfall	--	1.00	0.15	- 0.25	0.53*
Irrigation Level	--	--	1.00	0.43	0.46
Fertilizer	--	--	--	1.00	0.46*
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.49

CORRELATION MATRIX

PRODUCTIVITY : STATE (JOWAR)

Variable	1	2	3	4	5
Productivity	0.23	0.29	0.31$	0.42@	0.52
Crop-wise Irrigation	1.00	0.19	0.41$	0.36*	0.51$
Rainfall	--	1.00	0.16	0.19	0.46$
Irrigation Level	--	--	1.00	0.13	0.39
Fertilizer	--	--	--	1.00	0.47
HYV	--	---	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.50

CORRELATION MATRIX

PRODUCTIVITY : REGION I (JOWAR)

Variable	1	2	3	4	5
Productivity	0.32@	0.12	- 0.33	-0.56	0.10
Crop-wise Irrigation	1.00	0.14	-0.75	0.15	0.31@
Rainfall	--	1.00	-0.39	0.09	0.61
Irrigation Level	--	--	1.00	-0.55	-0.71
Fertilizer	--	--	--	1.00	-0.90
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.51

CORRELATION MATRIX

PRODUCTIVITY : REGION II (JOWAR)

Variable	1	2	3	4	5
Productivity	0.58$	0.63$	-0.21	0.52	0.72$
Crop-wise Irrigation	1.00	-0.38	0.28	0.08	-0.07
Rainfall	--	1.00	-0.17	0.57	0.76
Irrigation Level	--	--	1.00	-0.12	-0.19
Fertilizer	--	--	--	1.00	0.92$
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.52

CORRELATION MATRIX

PRODUCTIVITY : REGION III (JOWAR)

Variable	1	2	3	4	5
Productivity	0.49*	-0.02	0.61@	0.53*	0.59*
Crop-wise Irrigation	1.00	0.09	0.05	-0.40	-0.38
Rainfall	--	1.00	0.01	-0.06	-0.02
Irrigation Level	--	--	1.00	-0.08	0.19
Fertilizer	--	--	--	1.00	0.84*
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.53

CORRELATION MATRIX

PRODUCTIVITY : REGION IV (JOWAR)

Variable	1	2	3	4	5
Productivity	0.32	0.55	0.06	- 0.33	0.08
Crop-wise Irrigation	1.00	0.14	- 0.33	- 0.34	- 0.51
Rainfall	--	1.00	0.14	- 0.24	0.41
Irrigation Level	--	--	1.00	0.43	0.63
Fertilizer	--	--	--	1.00	0.64
HYV	--	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.54

CORRELATION MATRIX

PRODUCTIVITY : STATE (COTTON)

Variable	1	2	3	4
Productivity	0.43@	0.39@	0.23	0.15
Crop-wise Irrigation	1.00	0.31	0.13	0.16
Rainfall	--	1.00	0.19	0.09
Irrigation Level	--	--	1.00	0.06
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.55

CORRELATION MATRIX

PRODUCTIVITY : REGION I (COTTON)

Variable	1	2	3	4
Productivity	0.62$	0.02	0.05@	0.77$
Crop-wise Irrigation	1.00	0.15	- 0.45	0.15
Rainfall	--	1.00	- 0.59	0.09
Irrigation Level	--	--	1.00	0.94$
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.56

CORRELATION MATRIX

PRODUCTIVITY : REGION II (COTTON)

Variable	1	2	3	4
Productivity	0.70$	0.48@	- 0.09	0.89$
Crop-wise Irrigation	1.00	- 0.38	0.30	0.08
Rainfall	--	1.00	- 0.52	0.57@
Irrigation Level	--	-	1.00	- 0.26
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.57

CORRELATION MATRIX

PRODUCTIVITY : REGION III (COTTON)

Variable	1	2	3	4
Productivity	0.59	- 0.28	0.04	0.86
Crop-wise Irrigation	1.00	0.09	0.23	- 0.40
Rainfall	--	1.00	0.20	- 0.06
Irrigation Level	--	--	1.00	- 0.20
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

TABLE 5.58

CORRELATION MATRIX

PRODUCTIVITY : REGION IV (COTTON)

Variable	1	2	3	4
Productivity	0.46	0.07	0.23	0.67
Crop-wise Irrigation	1.00	0.14	- 0.33	- 0.34
Rainfall	--	1.00	0.15	- 0.24
Irrigation Level	--	--	1.00	0.43
Fertilizer	--	--	--	1.00

* - .01 Significance level

@ - .05 Significance level

$ - .10 Significance level

Crop Level Result

At the crop level the pattern seem to vary a great deal not only among the crop but also among the regions under study.

At the State level, it is observed that the input variables, such as irrigation, rainfall and fertilizer show a positive and significant correlation with the yield rate under jowar and cotton. While in the case of jowar fertilizer alone seem to govern the behaviour of the yield rate.

Among the regions each of them shows a typical pattern associated with available resource base. In Region I, the yield rate under rice and cotton is governed by irrigation and the new input such as HYV (under cotton) and fertilizer (under cotton). While in the case of jowar, it is irrigation which alone governs the behaviour of yield rate. In Region II also, water base variable such as irrigation and rainfall along with fertilizer seem to control the yield fluctuation in the jowar and cotton. In the case of rice, however, it is irrigation which alone shows the effective relation with its yield rate. In Region III the same parameter, namely, irrigation and rainfall under rice and irrigation, fertilizer and HYV under jowar bear a significant relation with yield rate. The situation with regard to rice in region IV is not remarkably different from the one observed in Region III.

From the above analysis it appears that as far as yield rates are concerned, the water base variables reflected though irrigation and rainfall along with the new input such as HYV and fertilizer seem to govern the temporal behaviour over a period of time.

5.5 Summary

The following analysis of correlation between output area yield with the selected variables leads us to some interesting conclusion as summary of which is given below :

(1) A correlation analysis for output indicates a significant association between aggregate output on the one hand and irrigation (particularly from canal), rainfall, HYV and fertilizer on the other. At the regional level, however the pattern varies from region to region. In regions I and II irrigation through canal (Region I) and tank (Region II), fertilizer and HYV exert a significant influence on the overall output. In regions III and IV, however, all variabilities (except well in region III) seem to govern the output behaviour. This in last two regions (i.e. Regions III and IV) with fairly good water availability base (both through natural rainfall and artificial sources), all the relevant inputs share their influence on the output.

As regards the crop all the relevant variable which were included in the correlation exercises have shown a positive and significant relation with output of rice, jowar and cotton. The variables which particularly come out well were irrigation, rainfall and fertilizer. This was equally true for all regions and the crops in the regions.

(2) In the case of area, the input variable such as irrigation (with different sources), rainfall shows a positive and significant corelation with the variation in area under rice, jowar

cotton (as well as for the total area). This is equally true for all regions. In addition to these variables, the new input such as fertilizer have also shown a significant relationship with the area for cotton in regions I and II, jowar and rice in regions III and IV. However, the effect of fertilizer or HYV is mainly through rainfall or irrigation.

(3) In the case of productivity and yield rate, the important input variable, namely, irrigation (with its sources), rainfall and the new inputs such as HYV, fertilizer have shown a significant correlation with productivity level at the State as well as at the level of the regions. At the crop level, the pattern is not remarkably different from the overall level. Irrigation (and also rainfall) along with fertilizer and HYV (in a few cases) influences the yield level under rice, jowar and cotton.

CHAPTER VI

SUMMARY OF FINDINGS

Agriculture in Karnataka State is carried out mostly under dry conditions. About 45% of the GCA of the State is dependent on rainfall which is low and uncertain in nature. The severity of the problem is further aggravated because of its ill distribution among the regions . Year to year fluctuations in rainfall give rise to instability in output and yield in the State. It is but natural that the instability in agriculture has been of utmost importance in the State. The present work attempts to study the nature of instability in productivity in the State's agriculture. Therefore, a period of 18 years has been taken i.e. from 1959-60 to 1977-78 on a time series scale. Analysis has been done at the State and regional level for both aggregate and individual crops like area, output and yield.

Scheme of regionalisation has been developed for the State wherein the 4 regions emerge. Region I has the lowest rainfall level (< 600 mm) and is also low in terms of irrigation level. Main source of irrigation is tanks and canals. Crops grown here are mainly jowar and cotton. On the other hand, Region II which has low to moderate rainfall (600 - 1000 mm) is mainly irrigated by tanks and wells which lends more instability to the regions. Region III has moderate rainfall of 1000 - 2000 mm and is irrigated by tanks and canals. This is a moderately stable region with rice as its main crop. Lastly Region IV is a high rain fall area (> 2000 mm) as it lies on the windward side of the State (coastal belt). As is typical of this belt, the region faces low level of irrigation, mainly irrigated by tanks. Dominant crop here is rice which has to an extent been substituted by sugarcane.

Instability in production of the State has been highlighted by wide year to year fluctuations. Added to this, there has not been any significant increase in the use of inputs of new technology. But the major factor which has adversely affected production in the State is low and erratic rainfall. Irrigation therefore becomes a crucial factor in trying to reduce the instability level of the State. This one factor is also responsible for inducing severe changes in area, output and yield. Changes in area, production and yield variables have been studied at these points of time. Period I is the period before the influx of the inputs of the new agricultural strategy i.e. 1959-60 to 1965-66. Period II is the later part of the 18 year time series analysis, when new inputs like chemical fertilizers and HYV were introduced, resulting in increased overall production. Overall area has seen a decline between the two periods, however yield increased. Production can, therefore, be related to an increase in yield at an overall level. Also the cropping pattern has undergone a change. From being a rice and jowar dominated area, it has now diversified infact. Area under jowar has decreased though it still has the largest GCA under it. In region IV high value crops like sugarcane have captured area under other wet crops like rice. It is seen that by the end of the second period there has been a significant change in the cropping pattern. Wherever assured supply of irrigation exists, wet crops like rice have been introduced (like in region I, around the Tungabhadra canal).

Element of instability has been looked at in many different ways. First the level of variability is determined both in absolute terms and relative terms. Absolute dispersion is derived from standard deviation, while the relative dispersion comes through the coefficient of variation.

Another method of determining instability is by converting annual fluctuations into a three-year moving average series to approximate the fluctuations and develop a trend. Then this series of short-term deviations is derived by deducting the trend-value from observed annual value. The nature of short-term deviation was then critically evaluated. Lastly an attempt was made to study the correlation of the inputs to the output and also between the inputs themselves.

6.1 Change in levels of variability in area,output and yield

Here also the same scheme of periodization has been adopted as done previously. Variability levels were first studied for the aggregate crops and then at the regional level. At the aggregate level, period I showed the highest variability level in cropped area at 11.43, followed by Region II, where level of variation is at 10.96, stating that in both these regions(Region I , lowest rainfall and low irrigation, and Region IV highest rainfall with low irrigation), the level of variability is high. Yield rate on the other hand is almost similar to the variability pattern in the area, that is, the variability is highest for Regions I and IV(as seen in area). Though the trend for yield rate is similar to that of area, the general level of variability in yield rate is higher as compared to area.

Period II on the other hand, shows the variability level in area both at State and regional level & is low as compared to Region I, except for Region IV, which has shown an increase in variability between the 2 periods with a change at 29.04%. Yield rate value has shown a similar trend as in Period I,that is Regions I & IV show a high level of variability. But the change between the 2 periods for Region IV has declined by 31.33% level of variability for Region IV & was the lowest in terms of output at 2.10 level of variability in this period.

At crop level, the picture would be different. We took rice as the first crop. In Period I, the variability in area, is lowest in Region IV(2.16), while yield and output variabilities are both high. While in Period II,Region IV has shown a minimum level of variability at 2.30. Both yield and output for this region shows variability to be very low. Percentage change for output and yield in the state has decreased , while for area the variability has increased.

Jowar has shown maximum variability in Period I for Region III in area, output and yield, as this is not a jowar based area. On the other hand, between Regions I & II, the level of variability is higher for region II than I. This trend changes in Period II to the effect that area and output are lower than for Period I, as seen by the percentage change at - 75.93% (output) and - 47.59% for yield. Area shows an increase in variability level to the rate of 93.60% which is high.

Cotton is basically a crop for regions I and II. Period I shows higher variability level in terms of area, as compared to Region II. Yield shows more variability for Region II, rather than region I. Output is more instable in Region II than I. Therefore cotton is more stable in Region I than II. In Period II the situation is not very different. There is a similar trend to follow and thereby indicating region I again as a relatively more stable area. The main reason for this is that region I has a higher level of assured irrigation in the form of canals , then region II.

Overall the picture for regions I and II is dismal. They both have a high level of variability. Region III turns out to be the most stable region of all.

6.2 Trend analysis by short-term deviations

This analysis has been done for all inputs and outputs. The final analysis is discussed here.

In studying about the pattern of agriculture in Karnataka for a period of 18 years (1959-60 to 1976-77), various inputs and outputs have been studied. Some conclusions have been reached. Prominent among them being -

1. **Rainfall is not** evenly distributed in the State. Region I having lowest rainfall (< 600 mm) and Region II with low to moderate rainfall (600 - 1000 mm) are subjected to a high level of variability and fluctuations. On the other hand Region III could be said to be moderate in nature (1000 - 2000 mm) followed by Region IV which has the maximum rainfall (> 2000 mm). Rainfall in the latter regions is highly dependable and so factor of instability is decreased. Irrigation pattern shows that Region I is basically a well irrigated area, interspersed by canals (Krishna and Tungabhadra) and therefore prone to instability. Region II is a tank irrigated area supported by well irrigation. In fact it is the most unstable area. Region III can be said to be the most stable of regions, with high irrigation of canals, tanks and wells. Region IV , a coastal area has a low level of irrigation as compared to the others. Canal and tank irrigation take control of the area. Apparently the variation in the level of irrigation at the State level seems to be **dependent** on the behaviour of the rainfall. Regions I and II suffer from the phenomenon of instability in the annual rainfall which in turn has a serious implication on the stability and otherwise in the **output,** yield and area.

2. The Fertilizers have only been introduced towards the end of the period and have shown some increase in their use. Trend deviations in Regions I & III are less pronounced as compared with Regions II & IV.

3. HYV exists only for jowar and rice should be introduced for cotton also, as it could help cotton become a prominent crop for Regions I & II.

Based on these above inputs, a final look at the outputs would lead us to believe that -

a) Rice has its area under increase, but is basically cultivated in well irrigated areas with loamy soils, i.e. Regions III & IV. Region III is the major producer of rice.

b) Jowar has its area decreasing though it still holds around 25% of the NSA. Increase in yield in the area is basically due to use of HYV particularly in Regions I & II.

c) Cotton has no HYV which is the basic reason for its low yield. It is basically grown in Regions I & II, though Region III did make an attempt to introduce it.

d) Overall area in the State has decreased, while yield per hectare has increased. Yield is the basic factor which has led to an increase in production.

In the final analysis one can conclude that a study of trend deviation has nicely brought out the level of fluctuation in terms of outputs and inputs.

6.3 Correlation Matrix:

We had described the result of correlation exercise in Chapter IV. The analysis is led to a interesting finding some of which are summarised below:

i) The correlation analysis for output indicates a significant association between aggregate output and irrigation (particularly for canal), rainfall, HYV, and fertilizer..

At the regional level, however, the pattern varies from region to region. In regions I and II, irrigation through canal (region I) and tank(region II), fertilizer and HYV exert a significant influence on the overall outpout. In regions III and IV on the other hand almost all variables except well in region IV seem to govern the output behaviour. Thus in the last two regions (III and IV) which have a fairly good amount of water resource base(both through natural and artificial means), all inputs show strong correlation with output.

Regarding the crop, all relevant variables which were included in the correlation exercises have shown a very significant positive relation with output of rice, jowar and cotton. The variables which particularly show strong correlation with output are irrigation, rainfall and fertilizer. Such a pattern was also noticed for all regions and the crops in each of the regions.

ii) In the case of area, input variables such as irrigation (with different sources), rainfall have shown a positive and significant correlation with the variation in area under rice, jowar, cotton (as well as for total area)

This is equally true for all regions. In addition to these variables however the new inputs such as fertilizer have also shown a significant relationship with the area for cotton in regions I and II, jowar and rice in regions III and IV. It may be however noted that the effect of fertilizer or HYV is effected mainly through rainfall or irrigation.

iii) *In the case of productivity and yield rate, the important input variable namely irrigation (along with various sources) rainfall and the new inputs such as HYV , fertilizer have shown a significant correlation with productivity level at the state as well as at the level of regions. At the crop level, the pattern is not remarkably different from the overall level. Irrigation (and rainfall) along with fertilizer and HYV in few cases also influences the yield trend under rice, jowar and cotton.*

In the study we have examined the phenomena of instability in Karnataa agriculture particularly in output area, and yield and tried to identify its relevant coordinates. With the help of correlation analysis, however, the finding and the conclusion flowing out of the analysis should be studied causely because of the limitation of data and techniques used. Nevertheless the study points out dimension of instability which could be further examined at much more disagreeable level.

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