GROWTH PATTERN AND DETERMINANTS OF FERTILISER USE
A Case Study of Karnataka

ANANTH S PANTH

CENTRE FOR DEVELOPMENT STUDIES
TRIVANDRUM

1989

GROWTH PATTERN AND DETERMINANTS OF FERTILISER USE
A Case Study of Karnataka

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

ANANTH S PANTH

CENTRE FOR DEVELOPMENT STUDIES
TRIVANDRUM

1989

I hereby affirm that the research for this dissertation titled "Growth Pattern and Determinants of Fertilizer Use: A Case Study of Karnataka" being submitted to the Jawaharlal Nehru University for the award of Master of Philosophy was carried out entirely at the Centre for Development Studies, Trivandrum.

ANANTH S PANTH

Trivandrum
29/12/89

Certified that this dissertation is the bonafide work of Ananth S Panth and has not been considered for the award of any other degree by any other University. This dissertation may be forwarded for evaluation.

Supervisor: P S GEORGE
Fellow.

Director
CENTRE FOR DEVELOPMENT STUDIES.

ACKNOWLEDGEMENT

For his invaluable guidance, inspiration and support I am extremely grateful to Prof. P S George, who to a great extent shaped my approach to the problem and enriched the analytical input that has gone in accomplishing the thesis work with fortitude and fairness. My special thanks are due to Dr. Jessy John, though the association was for a short period, whose moral support during the formative stages of the study and patient tackling of statistical problems were of immense help.

The sincere and deep involvement of Dr. Shakti Prasad Padhi helped me in settling down at this topic. The series of discussions with Dr. K. Pushpangadan during the course of my work provided me with many theoretical insights and clarified many doubts. Mr. D. Narayana gave very useful and valuable sugesstions in both the data analysis and statistical problems. I am very much thankfull to all of them.

I acknowledge the cooperation of my student friends, who helped me in my thesis work through many informal discussions.

I offer my sincere thanks and gratitude to the Director of Bureau of Economics and Statistics, Bangalore for providing me with the massive data and copies of the Statistical Abstract. I am equally grateful to the statistical officers for the patience and kind cooperation in supplying the data records, which made my data collection work very simpleand worth while.

I thank the library staff of the Centre for providing all the required materials whenever necessary. I appreciate all the academic and non-academic staff for creating a friendly atmosphere which made my stay lively.

It would be incomplete without due acknowledgements to my family members, especially my elder brother Mr.Chinmay Panth, for the cooperation and moral support given to me during my stay. And also my sister Mrs.Modini S Rao who gave many valuable suggestions and provided a lot of useful reading materials. Last but not the least, to my parents who were the main source of inspiration in my joining the course.

Ananth S Panth

C O N T E N T S

List of Maps

List of Graphs

List of Tables

contd.

Chapter One

INTRODUCTION

Agriculture is the largest sector in the Indian economy in terms of its contribution to the national income. Agricultural policy in India has been evolved keeping in view the objective of increasing food production to meet the demand of the growing population. The use of inorganic fertilizers was the first break through in the process of increasing agricultural production, and then came the introduction of the high yield variety seeds during the sixties.

The objective of increased agricultural production can be achieved by following strategies emphasizing on extensive approach or intensive approach. The extensive approach depends on increasing the area under cultivation and the intensive approach depends on increasing the productivity from the given area. However, the scope of bringing more area under cultivation is very limited because of the existing land use pattern. So, the next alternative is to increase productivity, which can be achieved through changes in the cultural practices such as utilization of irrigation facilities, extending area under high-yielding varieties and applying higher doses of fertilizers. Though yield realized from high-yielding varieties is high it is achieved with a high level of fertilizer application and proper water management. In the multiple cropping system, the plants

exhaust the nutrients in the soil which need to be replenished through fresh application of fertilizers. Thus, the use of fertilizers in crop production plays an important role in the strategy for increased agricultural production. From the farmer's point of view, fertilizer use is a means to increase income through more efficient production process. Apart from increasing the income, for a given level of investment he would like to maximize his profits. The farmer has the choice to substitute technical inputs such as fertilizer and HYV seeds for land, and capital for labour. The profit (difference between the gross revenue and cost) can be symbolically represented as

$$\pi = y * p - I * p' \quad \text{-------} \quad (1)$$

where, 'π' is the profit, 'y' is the output quantity , 'p' is the output price, 'I' is the input quantity, "p' " is the input prices.

In a situation of profit maximization the level of fertilizer application will depend on the fertilizer response function and the prices of inputs and outputs.The input levels would be chosen such that the marginal cost equals the marginal revenue. If the output price increases relative to the price of fertilizers, the response being the same, the farmers would demand more fertilizer. Similarly, relative price remaining the same, higher the fertilizer response, greater will be the optimal dosage of fertilizer. Thus given the equation (1), the farmer would choose the mode of production depending upon the values of the parameters. Therefore, the demand for an input would depend on the input prices, output prices and the level of output.

$$D = f(P(1), P(2), ---, P(n), Y)$$

where, $P(i), (i=1,2,...n)$ represent prices of inputs and outputs and Y is the level of output.

The factors influencing fertilizer consumption are usually identified by estimating some variant of a functional relationship between fertilizer consumption and explanatory variables such as prices of crops, prices of fertilizer, level of irrigation, cropping pattern, seed varieties, etc.

The level of fertilizer application is dependent on a number of factors such as water availability, variety of seed, crop price, fertilizer price and credit availability. Among these different variables, level of irrigation and relative prices are often included in analyzing the use of fertilizers. The demand for fertilizers is influenced by a number of other considerations such as availability of fertilizer at the right time, right place and right quantity. The physical factors like rainfall, irrigation and soil conditions influence the use of fertilizers. Further, institutional factors like agricultural credit, agricultural extension, size of land holding and distribution network do play a major role. Also the economic factors, which include the input and output prices, would influence the cropping pattern and intensity of fertilizer use for individual crops.

The Institutional factors involve certain processes. Firstly, there are processes that convert the potential into effective demand for fertilizers by generating knowledge about fertilizer response functions and profitability of use. Secondly, there are processes that establish and geographically expand the

fertilizer distribution system. Thirdly, the availability factors of fertilizer (through domestic production and imports) are also important.

However, the characteristics of the distribution network especially (i) availability of fertilizers (ii) distribution efficiency, and (iii) cultivator's effective demand are often left out in the analysis.

Given the availability of fertilizer and nature of distribution of network, the actual level of fertilizer is decided eventually by the farmer. The farmer's decision would involve answers to questions such as (i) Whether to use fertilizer (ii) To which crop it should be used, and (iii) The rate of application. In a given region the growth in fertilizer use is influenced by the proportion of farmers using fertilizer, proportion of area fertilized, and intensity of fertilizer application.

Recommendations for fertilizer application are often based on estimates of requirement for raising agricultural production considering the physical production function, and consideration of effective demand based on farmer's decision process are often ignored. Before the start of a season, an estimate of demand is obtained on the basis of cropping pattern and the recommended dose of fertilizer by the Department of Agriculture. But the actual quantity of fertilizer demanded by cultivators would depend on the level of technology, parity between output and fertilizer prices and availability of

complimentary inputs. The rate of returns from fertilizer use can be considered as an important factor determining the rate of adoption. A change in any of these three conditions would change not only the optimal quantity towards which the effective demand is growing, but also the cultivator's returns from fertilizer use and hence the rate of growth in effective demand.

As mentioned above, the level of fertilizer application is influenced by the availability of the complimentary inputs such as irrigation and management. The rate of fertilizer application would also depend on the degree of moisture content in the soil,(through canal irrigation, well irrigation, rainfall, tanks etc). Areas which depend only on rainfall would be characterized as un-irrigated areas. It is but natural that the fertilizer consumption in the un-irrigated areas would be substantially less than irrigated areas. When the land distribution is skewed, with majority of the farmers in the small and marginal category, the use of fertilizer would tend to be quite low due to high degree of risk and uncertainty, lack of credit facilities, etc. In the case of users, who are not convinced about the efficiency of using recommended dosage might reduce the risk by spreading the fertilizers on the entire farm than concentrating it on a smaller acreage according to the recommendations. The fact is that the physical response function and prices of crops which are important for decision making about fertilizer use are uncertain, the cultivator's expected returns would be usually lower than those estimated from realized production function and realized crop price. If the subjectively estimated returns, discounted for yield and price uncertainty are

very small, then the cultivator may not adopt fertilizer use. On the other hand, if the returns over the cost of fertilizer are significant and opts to use fertilizer, his effective demand is still likely to be lower than the optimum use. This may be due to the fact that the farmer does not apply at optimum rate under conditions in his farm or if the fertilizer production function is unstable due to variations in the weather conditions.

Constraints in the Use of Fertilizers

There are a number of constraints involving agroclimatic, technological socio-economic and infrastructural factors that prevent the optimum use of fertilizer. Among the agro-climatic factors, uncertainty and variability of rainfall is the most serious problem. Droughts and floods of varying degrees of intensity are quite significant especially in the multiple cropping system. With regard to the soil conditions, constraints are due to nutrient and moisture stress. Poor drainage, soil salinity, soil alkalinity etc, are also important considerations. Nutrient stress is a major limiting factor for crop production under tropical soil conditions. An important feature of the nutrient regime of tropical soils, which must be taken into consideration is their highly dynamic pattern of nutrient supply/availability. The moisture stress is equally serious. Thus every farmer must be aware of the importance of moisture conservation (e.g, controlling runoff to reduce water loss, soil conservation measures, measures to diminish evapo-transpiration, etc.), water harvesting and reuse of water.

The socio-economic factors which could come in the way of optimum use of fertilizers include items such as, unfavorable price ratios, shortage of credit, tenancy patterns, size of land holding, and education. The farmer's investment decisions would depend on the expected marginal income and marginal cost of input. In the developing countries the access to institutional credit is a common problem especially for the small farmers. The procedures are very lengthy and often tenant farmers may not be able to produce the surety required in support of their loan applications. The lack of legal titles to land ownership and forms of land tenure such as share cropping make access to agricultural credit difficult, especially for those farmers whose credit needs are crucial.

The infrastructural facilities include shortages of aggregate supply at the national level, inadequate distribution network at the village level, inadequate transport and storage facilities at all levels. It is essential for encouraging use of fertilizer that they should be available within an easily accessible distance of the farmers.

The main reasons for the inadequate supply of fertilizer at the village level are the absence of local dealers or distance to the nearest sale point and insufficient stock of required fertilizer type at the village outlet. Since fertilizer demand indicates a somewhat seasonal pattern, the farmers do not keep adequate stock, and during peak season the dealers may not be in a position to meet the cultivators demand.

Agricultural extension services may not be able to provide proper service to the farmers due to many bottlenecks such as lack of adequate staff, poor working conditions of the

staff, lack of transportation facility resulting in insufficient contact with the farmers, lack of interest among the staff in their work and their inadequate knowledge.

A quick glance at some indicators in Table 1.1 shows that 28 per cent of cultivated area was irrigated during 1980-81 at the all India level and the percentage of cultivated area fertilized was 33 per cent. The states like U.P, Haryana and Punjab, where the irrigation level is high, the rate of application is also high. With just 15 per cent of the total area irrigated in Karnataka, the fertilizer consumption per hectare of cropped area is 34 kgs compared to the all India average of 35 kgs. The percentage area under fertilizer use is 33.4. It is infact, higher than the all India average of 32.9 per cent.

Table1.1 Fertilizer use pattern in selected states

State	%frtlsd area	% of frtlsr users	% of gca irrigated (1980-81)	area under HYV's 1980-81	frt.use in frtld area (kgs/ha)
Punjab	76.3	91.9	83	91	90.8
T.Nadu	55.4	69.7	50	93	128.1
A.P	41.7	61.8	36	57	111.7
K'taka	33.4	49.9	15	51	104.6
All India	32.9	45.1	28	48	78.0

Source: 1. Column 2,3,4,6; NCAER demand survey,1975-76
2. Column 4,5; Statistical abstract, BES Karnataka.

Thus, inspite of the relatively low level of irrigation in Karnataka, area fertilized is relatively high. It can also be noted that the fertilizer use per hectare of fertilized area is 104.6 kgs compared to the all-India average of 78 kgs. Karnataka

stands third in the country in respect of the fertilizer consumption per hectare of fertilized area which indicates that the fertilizer consumption in the state is quite high inspite of the low level of irrigation. Nearly 65 per cent of the cropped area in Karnataka, receives annual rainfall of less than 750 mm. In the states such as Punjab and Tamil Nadu, irrigation facilities and use of HYV's have induced the farmers to adopt higher levels of fertilizer application.

A comparative picture of the index of fertilizer consumption in Karnataka and all-India(Table 1.2), indicates that the growth rate of fertilizer consumption in Karnataka (10.25 per cent) is higher than all-India rate (9.27 per cent) during 1968-69 to 1986-87[1].

Table 1.2 Comparison of Fertilizer consumption
Index base = 1968-69

Year	Karnataka	All-India
1968-69	100.00	100.00
1969-70	94.66	112.57
1970-71	140.81	128.16
1971-72	208.65	150.89
1972-73	207.64	157.20
1973-74	206.62	161.22
1974-75	245.94	146.15
1975-76	216.22	164.35
1976-77	221.98	193.72
1977-78	285.38	243.41
1978-79	387.57	290.61
1979-80	378.12	298.48
1980-81	364.74	313.26
1981-82	405.34	344.62
1982-83	425.30	363.57
1983-84	688.19	437.90
1984-85	626.06	466.35
1985-86	589.10	496.22
1986-87	599.97	498.66

Note: Figures based on Fertilizer Statistics data.

[1] Logarithmic growth rates.

The consumption rate of fertilizer in Karnataka and at all-India level are almost same(table 1.3). This is inspite of the fact that the percentage of irrigated area is higher at the all-India aggregate than in Karnataka. The percentage of cultivated land under irrigation in India is about 3Ø per cent compared to 15 percent in Karnataka.

Table 1.3
Fertilizer consumption per unit of cropped area

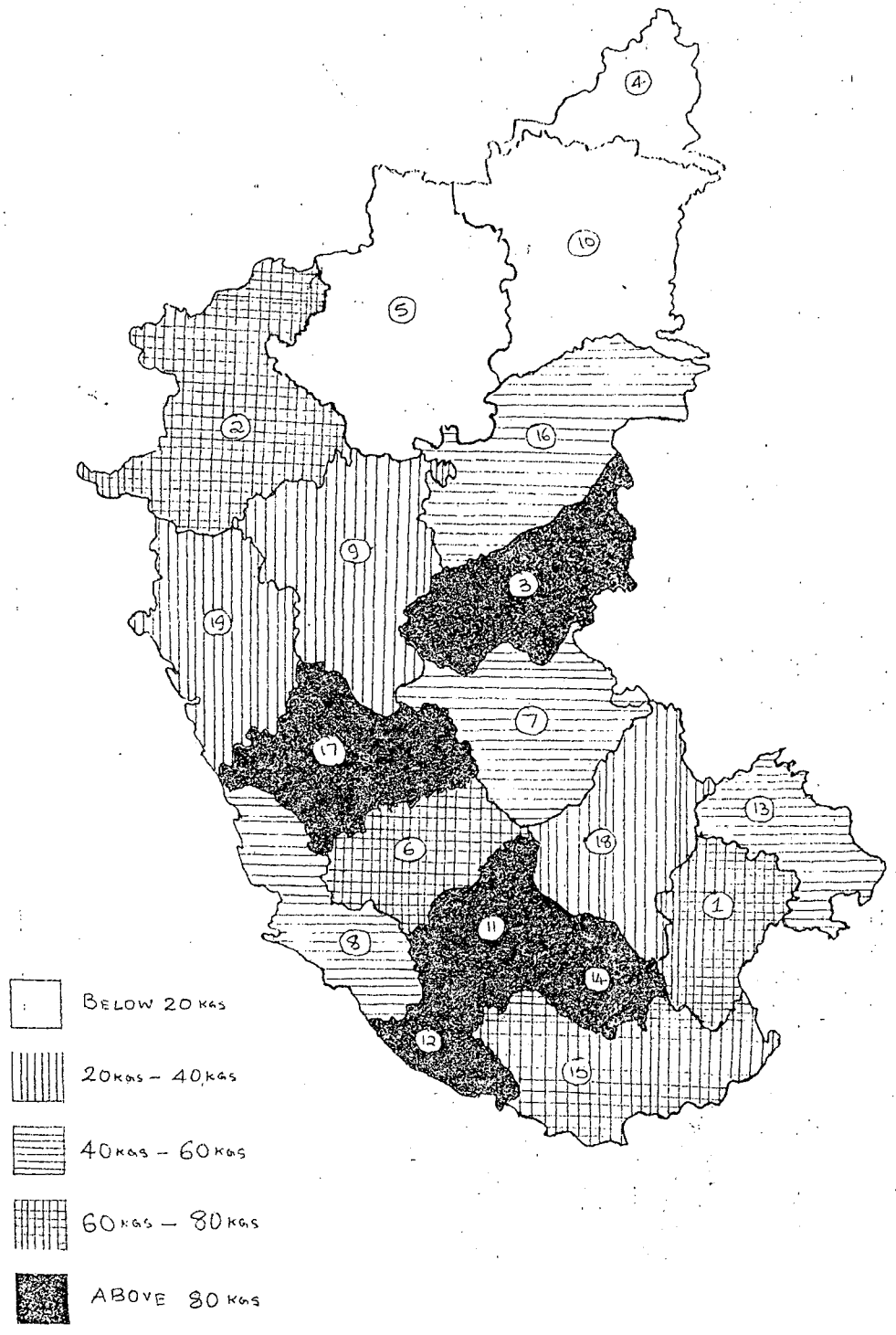
Year	Karnataka	All-India
	('kgs)	('kgs)
1982-83	34.2	36.2
1983-84	43.4	43.5
1984-85	51.5	45.5
1985-86	48.4	48.4
1986-87	49.3	48.7

Source: Fertilizer Statistics, FAI.

If we examine the fertilizer consumption pattern prior to 1968-69(refer figure 1,appendix), we do not find any significant growth of fertilizer consumption in the early sixties. It was a steady growth in the consumption but was not a significant one. From the mid sixties onwards, incidence of green revolution can be noticed in figure 1(appendix). Though the fertilizer consumption per hectare of GCA in Karnataka is close to the all-India average, in terms of growth rate, the consumption of chemical fertilizers has gone up in the state by nearly five times during the period 1968-69 to 1986-87 at an annual growth rate of 1Ø.25 per cent per annum(Table1.4). For a detailed picture refer to map.1 which shows the fertilizer consumption per hectare of cropped area in the districts.

MAP 1

CLASSIFICATION OF DISTRICTS ACCORDING TO FERTILIZER CONSUMPTION PER HECTARE OF CROPPED AREA



P.T.O

Number	District
1	Bangalore
2	Belgaum
3	Bellary
4	Bidar
5	Bijapur
6	Chikamaglur
7	Chitradurga
8	Dakshina Kannada
9	Dharwad
10	Gulbarga
11	Hassan
12	Kodagu
13	Kolar
14	Mandya
15	Mysore
16	Raichur
17	Shimoga
18	Tumkur
19	Uttara Kannada

Table 1.4 Pattern of Fertilizer Consumption in Karnataka

Year	N	P	K	Total
		(in 'ØØØ kgs)		
1968-69	58227	24460	11570	94257
1969-70	56161	16074	16991	89226
1970-71	82147	31038	19545	132730
1971-72	109008	52873	34783	196664
1972-73	108014	50583	37116	195713
1973-74	107020	48290	39450	194760
1974-75	130000	53996	47818	231814
1975-76	131300	38100	34313	203713
1976-77	132881	43659	32701	209241
1977-78	160821	56045	52115	268981
1978-79	204100	86598	74612	365310
1979-80	193456	86567	76384	356407
1980-81	193041	80923	69836	343800
1981-82	215882	92281	78963	387126
1982-83	221202	96827	82844	400873
1983-84	264555	121381	96194.	482130
1984-85	311009	169286	109870	590165
1985-86	295035	164713	95465	555213
1986-87	302409	160744	102993	566146

Source : Fertilizer Statistics, F A I

In terms of nutrients in Karnataka, the use of K type fertilizer has grown at a faster rate at 9.41 per cent than N type and P type at 6.83 per cent and 8.84 per cent respectively. The same can be analyses from figure 2(appendix). In absolute terms the N type fertilizer consumption is on an average two times the consumption of P type and three times that of K type fertilizer. Across the districts, the growth rates indicated substantial variations.

The growth rates in regions classified according to rainfall and irrigation indicates that it is highest in region with least rainfall and irrigation facility(refer to Table 1.5). It is likely that in regions with high irrigation and rainfall, the growth rates would be low but the level of consumption would be high unlike in the regions with low irrigation or rainfall regions where the consumption would be comparatively low

Table 1.5 Growth of fertilizer consumption in classified regions of districts according to rainfall and irrigation

	< 75Ø mm	75Ø-115Ømm	115Ø >mm	Average
Ø1-15 %	13.4	11.68	11.33	12.13
15-3Ø %	Ø8.54	1Ø.42	Ø8.89	Ø9.28
3Ø-45 %	Ø6.7Ø	*	Ø7.18	Ø6.94
Average	Ø9.54	11.Ø5	Ø9.13	Ø9.68

* indicates no districts classified.

but the growth rates would tend to be high. One reason could be that in regions with high rainfall and irrigation have a high base level where as in regions with low irrigation and rainfall have a low base level. There are eight districts which have growth rates of fertilizer consumption higher than the state average of which three districts belong to the region with high irrigation levels, two with low irrigation and two with medium irrigation and rainfall.

OBJECTIVES OF THE STUDY

Given the background, about the physical, institutional and economic factors that influence the growth in fertilizer use in general, the major objective of this study is to identify the factors influencing the growth in fertilizer use in Karnataka state. In particular, the following objectives are kept in mind.

1. To analyze the growth in consumption pattern of fertilizer in the state during 1968-69 to 1986-87.
2. To identify major factors influencing the use of fertilizers.
3. To highlight the major policy implications of the study.

METHODOLOGY

The analysis in the study is carried out in two levels: (1) Karnataka state aggregate level and (2) disaggregated at the district level. The period covered in the study is from 1968-69 to 1986-87.

Initially, a partial analysis is carried out for each of the explanatory variables using time series and cross-section data. Then a complete model is tested taking all the factors into consideration.

The following explanatory variables are considered for analyzing the use of fertilizers.
(1) Rainfall (2) Irrigation (3) Loan advancement (4) Area under HYV seeds (5) Crop prices (6) fertilizer prices (7) Sale points (8) Number of machines and implements used (9) Yield of food grains (10) Gross cropped area and (11) Farm size.

The rainfall data used in the analysis corresponds to annual rainfall recorded by the meteorological department. Data on irrigation include net irrigated area by various sources (canals, tanks, wells and others). Institutional credit advanced by the agricultural credit co-operative societies as short term loans, is considered for loans advancement. The number of sale points includes the private, co-operatives and the Farmer's agro-based societies. The prices of crops consists of weighted average harvest prices of the principal crops. The fertilizer prices include the weighted average of the fertilizer nutrient wise. The

cropping pattern includes the area under principal crops.

To study the factors influencing the use of fertilizers, multiple correlation analysis and multiple regression analysis are used. Initially, a partial analysis is carried out where in each of the independent variables is related with fertilizer consumption. Fertilizer consumption is taken as the dependent variable and the independent variables include, rainfall, irrigation, relative prices of crops to fertilizers, loans advanced, sale points, cropping pattern, area under HYV seeds, number of implements and yield of food grains. For the state aggregate data then a complete model was used taking all the factors into consideration at the same time. The data on the farm machineries and implements is not considered due to non-availability of time-series data.

Organization

Following this chapter on introduction, a review of work done by different authors is dealt in chapter two. Chapter three gives a brief outline about Karnataka's agriculture and other general information. The analytical frame work of the study has been explained in the fourth chapter which includes variables and data used in the study along with an explanation of the logical and theoretical basis for including the variables. The results of the partial analysis based on time series and cross-section data for has been analyses and are explained in the fifth chapter. The sixth chapter includes the results of the analysis for the complete model where in all the independent variables are jointly taken.The summary and recommendations based on the study is dealt in the last chapter.

Chapter Two

REVIEW OF LITERATURE

There are a number of studies, both theoretical and empirical, regarding the determinants of fertilizer use. These studies include different geographical coverage i.e., national, state, district and farm levels. Some of the major studies, including the work by G M Desai(1969), A.Parikh(1965), G M Desai and Gurudev Singh(1973), Desai,Chary and Bandopadhyay(1975) have made systematic attempts to analyze the mechanism that work at the micro level which influences the use of fertilizers and identifies the determinants of fertilizer use at the macro level. There are certain studies on demand projections which also try to find the causes for the gap between the recommended consumption and the actual consumption levels,e.g., Desai(1969), and NCAER(1974,1979).

G M Desai(1969), analyses the forces behind the cultivator's use of fertilizers in order to assess the likelihood that the cultivator's demand may attain the optimum level. He estimated the growth of fertilizer demand for the seventies. Desai hypothesized that the major determinants of growth in fertilizer use were :-

(i) The spread of fertilizer practices and increase in the rates of application on land already fertilized.

(ii) Development of irrigation.

(iii) Growth in area under high yielding variety seeds, and

(iv) change in relative prices.

The empirical analysis was carried out at three levels namely, farm level survey, district level (cross section and time series) and the state level (cross-section and time series). With farm level data for Gujarat and all-India, he has tried to trace the diffusion of fertilizers in terms of characteristics of users and non-users and attempted an analysis of pattern of usage. A sample of 800 cultivators from Gujarat state was selected to study (1) characteristics of the users and non-users of fertilizer (2) fertilizer practices of users, and (3) the forces behind the use pattern. The Institute of Agricultural Research Statistics conducted sample surveys between 1954-55 and 1963-64 in 19 districts of the country and this data was compared with the survey data from Gujarat. It was found that in Gujarat, a high proportion of the non-users were owning less than two acres of land and were owner-cultivators. Large proportion of the users with small farms had irrigation facility, where as a vast majority of the non-users with small farms did not have irrigation facilities. Only a small proportion of the non-users grew commercial crops and superior grains. Among the users, the non-food commercial crops were more fertilized than the food grains. The proportion of area under food grains was substantial compared to that of non-food grains but did not receive the same proportion of fertilizers. Desai attributes this to the physical response and the prices of crops grown. The all-India picture was not found to be much different from that of Gujarat's regarding

the cropping pattern and level of fertilizer application. Certain non-food grain commercial crops were more fertilized than the food grains. But cotton and ground nuts were fertilized at a lower level than rice and wheat. It was found that over time, the rates of fertilizer application changed. This is attributed to the declining price ratios of fertilizer to crops. Thus the improvement in the price situation increased the incentive to adopt fertilizer use, but did not raise the marginal returns. This was due to the nature of the fertilizer response functions of the prevailing varieties of food grains.

Desai attempted to analyze inter-state variation in the nitrogenous fertilizer consumption over the years 1957-58 to 1964-65. He found that there was no substantial change in the level of fertilizer use in Rajasthan and Madhya Pradesh versus Madras and Andhra Pradesh and the level remained substantially below the average use. The growth patterns also varied drastically from very low in Rajasthan and Madhya Pradesh to very high in Punjab and Madras state(Tamil Nadu). These features were mainly due to the inter-state variations in irrigation level and relative prices of nitrogenous fertilizer and crops. But irrigation played an important role compared to the relative prices. The irrigation level though was high, the crop price was a hinderance to growth in fertilizer use but once the price situation improved, the growth rates in places with high level of irrigation was tremendously high. Where as in states with low levels of irrigation, a similar improvement in the price situation did not lead to growth at comparable rates. He concludes that the analysis of past demand would help to meet the

future demand and the fact that the past use pattern reveal the importance of absolute size of returns in generating effective demand for fertilizer and the crucial role irrigation and cropping pattern play in determining the returns under the old technological conditions.

The rapid growth in effective demand for nitrogenous fertilizer would mainly depend on three factors. They are :-

(1) Continuous improvement in the varieties of food grain crops

(2) Development of new fertilizer responsive varieties of major food grains suited to un-irrigated Conditions.

(3) Increasing the level of application to the optimum.

In another micro level study by Gunavant Desai, Bandopadhyay and Chari(1973), the authors have made a careful analysis of the factors influencing the use of fertilizers using data from a sample of 240 cultivators selected at random from Guntur district of Andhra Pradesh during 1968-69 and 1969-70. The cultivators were grouped into five categories:- (i) continuous users (ii) non-users (iii) discontinuing in the first year (iv) discontinuing in the second year (v) users in the second year only. The study attempted to bring out the characteristics of each of the farmer categories and also to find out if there existed any relationship between tenancy, literacy, size of land holding to the use of fertilizer and time lag in the use of fertilizers.

The major finding was that seventy percent of the growth in fertilizer use was accounted by the continuous users.

Inspite of the favorable price situation, there were drop outs in the use of fertilizers which has been explained separately. The major factor behind the growth in fertilizer during the period of study was the increase in the rates of application. The reason was the sudden rise in the prices of crops. Chillies and tobacco were the two crops which experienced the hike and hence the rate of application also increased. It was noticed that there were fluctuations in the consumption pattern because, the farmers alternately used high rates and low rates of fertilizer to improve the quality of the crop and the prevailing soil conditions. Though all the farmers experienced the same price situation the levels of consumption were different on account of the previous year's application rate. There was an association between the cropping pattern and rates of application. It was found that in the first year area under paddy and tobacco influenced the use of fertilizer and in the second year chillies and tobacco accounted for nearly 90 percent of the total growth in fertilizer use. There was an increase in the area under cultivation and hence, the consumption also increased. The average rates of application increased substantially for the crops over time.

As explained before, there were continuous users and dis-continuous users of fertilizer and it was found that irrigation was the main obstacle to the growth in fertilizer use. It so happened that the cultivators discontinued the use of fertilizers in the un-irrigated area as well as in the area that was under irrigation just before stopping of irrigation. This happened inspite of favorable price conditions. The subsequent

changes in the cropping pattern also forced the farmers to decrease the consumption. Characteristics such as literacy, education, tenancy status and size of land holding did not have any correlation with discontinuation of fertilizer use. But literacy had a significant relationship with the spread of awareness.

In 1972-73, Gunavant Desai and GuruDev Singh made a district wise study for India to look into the main features of growth of fertilizer in 286 districts and to make inter-district comparisons. The selected districts were grouped into agro-climatic zones, the growth pattern and its influence on fertilizer use were studied. There was a decline in the growth of fertilizer use between 1969 and 1971, and the study attempted to looked into the reasons for this decline. They hypothesized that the amount of fertilizer used would be influenced by three forces namely, (i) the availability of fertilizers (ii) efficiency of distribution network and (iii) cultivator's effective demand. The growth in the level of fertilizer use in a particular district occurred as a result of (a) adoption of fertilizer by increasing the number of cultivators (b) increase in the area of fertilizer use by cultivators already using fertilizers and (c) changes in the rate of application.

The major findings of the study was that less than 15 per cent of the total districts accounted for about 50 per cent of the total fertilizer consumption. More than 50 per cent of the districts consumed less than 10 percent of the total consumption. The growth in fertilizer use varied widely among the districts

during the period of the study. The districts were grouped into five geographical regions and it was found that the performance of the southern region with respect to growth of N and P variety was very good, where as that of central and eastern region were very poor. The western region performed relatively better with respect to growth of P variety as compared to N type. On the other hand, the performance of the northern region was relatively poorer with respect to growth of P type use than that of N type. A comparative study of growth performance of districts covered by IADP, IAAP and that of districts not covered by either of the two programmes revealed that majority of the districts with low growth rates were not covered by either of the two programmes. Among districts with high growth rates more than one-fourth were not covered by either of the two programmes. A number of districts had growth rates of fertilizer use higher than that of districts covered by the programmes.

By grouping the districts according to agro-climatic characteristics, namely, soil, rainfall, irrigation, and cropping pattern it was found that there existed a strong association between the growth rates of N and P type use and soil conditions. It was inversely related to rainfall. The growth rates of fertilizer use was high where the normal annual rainfall was less than 750 mm. More than half of the districts with low or very low growth rates had rainfall greater than 1150 mm per annum. Similarly, the growth rates of fertilizer use had inverse relationship with irrigation.

The study on the growth pattern between 1969-71

revealed that the growth in fertilizer use decreased after 1968-69 despite the prices were favorable with no shortage of fertilizers. Nearly 46 per cent of the districts had fertilizer use below the projected one and 28 per cent of the districts had level above the projected level. The main reasons behind the slowing down of growth were :-

(1) Deceleration in the diffusion of HYV variety seeds in districts with high level of irrigation.

(2) Deceleration in the scope for fertilizer use in irrigated areas.

(3) No rapid diffusion of fertilizer use in rainfed areas.

In Gujarat, the use of fertilizers were determined mainly by the amount of moisture in the soil and the type of fertilizer was determined by the cropping pattern and the high yielding variety seeds adopted for those crops. Madhukar Maharaja in his study on demand for fertilizers explains the use of fertilizer as a function of moisture content either through rainfall or irrigation, area under high yielding variety seeds for each crop, average size of the farm, relative prices and literacy.The study was done using farm level data. It was observed that the total consumption of fertilizers, (i.e., sum of N type, P type and K type), was dependent on the rainfall and irrigation. The cropping pattern determined the type of fertilizer used. The level of each type of fertilizer was determined by the quality of seeds adopted for each type of crop grown. Cereals, mainly crops like paddy and wheat, and sugarcane were fertilized more than that of the inferior cereals like bajra, jowar, and maize. The size of the farm was not an

important factor in the long run since all farmers irrespective of all the size group had become aware of the fertilizer use and had practiced fertilizer application. For a given level of technology the level of fertilizer use depended on the relative prices of fertilizer to crops. The adoption of high yielding variety seeds was mainly due to the increasing crop prices.

In a study by Jawahar Thakur and D K Sinha, they have analyses the growth pattern and determinants of fertilizer use in Bihar using time-series data from 1968-69 to 1981-82. The seventeen districts in Bihar have been grouped into three agro-climatic zones. The study focuses on the comparative performance of each of the zones, the main factors influencing the use of fertilizers for each of the zones. The authors infer that irrigation and the use of HYV seeds are significantly correlated to fertilizer use. Rainfall is comparatively less significant. Prices of fertilizers had no impact on the use of fertilizers.

R.Nagraj (Unpublished,198Ø), in his study on the determinants of fertilizer consumption has used a macro level analysis on an all-India basis, based on data from 1951-52 to 1977-78. Over the twenty five year period it has been found that there has been a gradual decline in the growth of fertilizer use and the actual consumption has fallen short of target since 1961-62. For the purpose of analysis, Nagraj has grouped the factors influencing the use of fertilizers into three groups :-
(1) Technological factors (2) Economic factors (3) Institutional factors. The study reveals that irrigation is the dominant factor among the technological factors and rainfall is relatively un-important. The proportion of area under HYVs and fertilizer

intensive crops was found to have a positive effect on fertilizer consumption, but relative prices had inverse relationship. He has compared all-India data with farm level data and has found that over a period of time the variability in yield was closely associated with level of fertilizer use and weather conditions. Fertilizer use was highly correlated with agricultural credit.

The NCAER and FAI had done a joint study on "Fertilizer use on selected crops in India ", in 1974. The study was based on a sample survey to analyze the use of fertilizers with respect to selected crops. As a part of the study, they attempted to determine factors influencing the use of fertilizers for individual crops. These factors included educational background, age of the head of household, per capita income, and family income. Overall it was found that area under irrigation and HYVs' and family income had statistically significant influence on fertilizer use.

For paddy cultivation, the variables with a significant positive influence were (i) percentage of area irrigated to gross cropped area under rice (ii) area under HYVs of paddy to the total area under paddy and (iii) income level of the house hold. For wheat the variables with a positive influence were, (i) percentage of area under HYVs to the gross cropped area (ii) percentage of area irrigated to the total cropped area and (iii) income level of the house hold.

(3) For jowar cultivation, only the percentage of area under irrigation had an influence on fertilizer use.

(4) In the case of maize,two variables, (percentage of area under HYVs and size of land holding) had influenced the use of

fertilizers.

(5) For sugar cane income was the main factor.

(6) percentage of area under irrigation was the major determinant for cotton.

Two reasons were suggested for non-application of fertilizers:- (i) Lack of irrigation facilities, and (ii) Inadequacy of funds or credit to fertilizers. There had been a small percentage of farmers not using fertilizer due to risk and uncertainty, and non-availability on time.

Chapter Three

REVIEW OF KARNATAKA'S AGRICULTURE

Karnataka, " Magic region on earth ", " Wales of India", as described by a western traveller[2], is endowed with rich abundant natural resources for development of the economy. Karnataka is considered as a miniature of India as it exhibits most of the features of India in climate, rainfall, soil types, crops grown and variety of natural resources. The state is unique in Indian sub-continent in having a wide range of agro-climatic conditions. The soil, rainfall, and climatic conditions of Karnataka are ideal for agriculture. Physiographically, the state may be divided into four regions, namely, the coastal region, malnad hilly region lying east of the western ghats edge , northern undulating plateau and the southern broad archaean undulating plateau. The state was re-organised in 1956 with 19 districts and 175 taluks.

Karnataka shares the wider climatic pattern of the country as a whole. The climate is tropical monsoon type as the state is exposed to both south-west and north-east monsoons. The state receives its major share of rains from south-east monsoon. The normal annual rainfall is 1315 mm. Across the state, the rainfall ranges between 380 mm in the eastern and north-eastern parts of the state and 7620 mm in the western ghats. Agriculture

---

[2] K.Puttaswamaiah,"Economic Development of Karnataka: A treatise in Continuity and Change", Vol.1, page 9, O U P, New Delhi, 1980.

forms the backbone for the economic development of Karnataka. The income from the agricultural sector has been quite substantial as much as 5Ø per cent of the state total income. The net domestic product from agriculture increased from Rs 969.6 crores in 197Ø-71 to Rs 1223.65 crores in 1981-82 at 3 per cent per annum(at constant prices). The net domestic product of agriculture forms nearly 5Ø percent of the state total income. But its percentage in total has reduced 53.67 percent in 197Ø-71 to 45.26 percent in 1981-82(Table 3.1).

Table 3.1 State Net Domestic Product

year	agricultural income [current prices] [in Rs.crores] (1)	state income [current prices] [in Rs.crores] (2)
197Ø	963.76	1566.4Ø
1971	984.95	1632.12
1972	1122.2Ø	2141.91
1973	148Ø.49	2994.54
1974	1954.17	3384.72
1975	16Ø4.18	322Ø.49
1976	1458.Ø5	3282.22
1977	1845.21	3779.95
1978	1794.59	3886.18
1979	2Ø4Ø.62	4321.21

Source : Statistical abstract,Bureau of Economics and Statistic Karnataka State.

Area and Population

The total area of the state is 1.92 lakh sq-km. The population increased from 2.35 crores in 1961 to 2.92 crores in 1971 and to 3.71 crores in 1981. The population density which was about 123 per sq-km in 1961 increased to 153 per sq-km in 1971 and is presently 194 per sq-km according to 1981 census. About 75 per cent of the population live in the rural areas.

Land Holdings

The total number of holdings in the state were 38.1 lakh in 1976-77 with an area of 11.36 million hectares. According to 1976-77 census, 84 per cent of the holdings were less than 5 hectares. The maximum number of holdings lie in the range of 1 to 2 hectares comprising of 23 per cent of the total holdings. The operational holding is skewed towards the small and marginal farmers. The number of holdings in the range of 1 to 2 hectares was 25.11 in per cent in 1980-81 compared to 23 per cent in 1976-77. The percentage of holdings below 2 hectares increased from 56.74 per cent in 1970-71 to 60.49 per cent in 1980-81. The detailed district wise land holding is given appendix 1.

Land Utilization

The net area sown accounts for about 54 per cent of the total geographical area. 15 per cent of the geographical area is under forests which is situated in the western parts of the state. The area under forests has remained the same over a long period of time. The land utilization pattern is shown in table 3.2. The area under un-cultivable land was as high as 22 per cent in 1975-76 and it reduced to 10.23 per cent in 1985-86. The net sown area constitutes nearly 54 per cent of the total geographical area. The increase in the net sown area has not been substantial in the twenty year period between 1965-66 to 1986-87(It has increased from 100.42 lakh hectors in 1965-66 to 101.72 lakh hectors in 1986-87). Though the land not available for cultivation has decreased by more than 50 per cent it is not reflected in the net area sown. In fact there is an increase in the fallow land by 1.65 per cent.

Table 3.2
Land utilization pattern,Karnataka

Land Classification	1975-76	1985-86
	(in 'ØØØ hectors)	
Geographical area (reported)	19116	19Ø49
Fallow land	1567 (8.17)	1884 (9.82)
Forest area	29Ø7 (15.16)	3Ø57 (15.94)
Net area sown	1Ø36Ø (54.Ø2)	1Ø172 (53.Ø4)
Land not available for cultivation	4288 (22.36)	1962 (1Ø.23)
Geographical area	19177	19177

Note : figures in the bracket indicate the percentage to the total.
Source : Statistical Abstract,Bureau of Economics and statistics.

Cropping Pattern

The state of Karnataka is ideally located with favorable agro-climatic regions and suitable cropping patterns for achieving an impressive performance in the country. A variety of crops are grown in the state. The state has its forest wealth, the coastal belt, the plantation pocket, the dry and transition region for cereals and millet, the predominant paddy potential patches, the sprinkled spots of sugarcane fields, the capacious cotton belts, coconut groves and the areca gardens uniquely uphold the agricultural status of the state. The cropping pattern has been shown in table3.3. The important crops grown in the state are paddy, jowar, and ragi. Jowar has been traditionally occupied the largest cultivated area. The other important crops are maize, wheat, cotton and sugarcane.

Paddy is an important food crop of the state covering an area of 11.12 lakh hectares. It is cropped twice or thrice in a year, i.e., kharif, rabi and summer seasons depending on the exogenous factors. Jowar is another important food crop with an area of 23.81 lakh hectares. This is grown largely in the northern districts as a rainfed crop. Though hybrid maize is grown at any point of the year it is mainly a rainfed crop grown during the second season. It has an area of 1.7 lakh hectares under the crop. Ragi is the staple food crop apart from rice in the southern districts of the states. It extends over an area of 11.Ø6 lakh hectares. This is also a rainfed crop with local variety and in regions with good irrigation facility, HYV is used.

Table 3.3 Cropping Pattern 1986-87

Districts	Paddy	Ragi	Jowar	Bajra	Maize	Wheat	Pulses	Sugar	Cotton	Others	N S A
					(in '000 hectares)						
Bangalore	20.77	201.47	0.02	0.00	0.17	33.14	2.36	18.53	0.00	96.88	378.40
Belgaum	66.77	6.20	265.61	49.15	53.02	95.87	63.64	96.30	56.59	110.17	898.37
Bellary	34.47	46.22	163.69	22.45	1.45	50.87	6.72	50.37	62.35	45.99	531.49
Bidar	9.19	0.02	128.10	19.51	6.84	97.97	15.70	5.66	2.10	62.23	358.52
Bijapur	1.93	0.00	534.67	126.96	84.69	102.78	18.17	85.08	71.15	231.62	1261.86
Chikamagiur	50.80	55.32	29.67	0.10	0.43	14.40	1.19	4.97	1.90	114.14	276.76
Chitradurga	47.39	131.64	117.20	17.26	1.71	60.80	3.12	65.93	22.97	29.82	539.08
Dak.Kannada	155.49	0.02	0.00	0.00	0.00	21.00	3.44	3.04	0.00	34.06	217.06
Dharwad	86.93	16.43	257.01	1.15	104.73	165.97	1.94	127.91	145.40	10.20	947.80
Gulbarga	10.35	0.76	374.90	118.16	29.37	345.42	3.58	98.25	33.04	196.46	1255.76
Hassan	46.62	113.23	19.12	0.00	0.00	47.49	2.08	1.62	3.78	103.71	339.20
Kodagu	44.33	3.10	0.00	0.00	0.00	1.17	0.00	1.61	0.00	97.42	147.62
Kolar	10.81	125.06	4.12	3.36	0.22	49.93	3.27	59.05	0.00	83.54	353.32
Mandya	69.01	76.42	6.00	0.00	0.00	45.62	27.00	5.24	0.00	21.05	252.21
Mysore	59.78	108.45	75.76	1.85	0.04	92.00	6.41	38.32	17.51	112.85	515.17
Raichur	79.42	0.01	369.39	98.67	23.33	118.07	1.76	131.55	95.13	24.80	977.90
Shimoga	193.20	49.65	30.80	0.01	0.22	21.10	8.60	14.72	14.27	18.30	316.10
Tumkur	22.87	172.57	3.57	3.10	0.23	76.94	2.25	104.77	0.52	95.46	504.29
Utr.Kannada	85.54	0.39	0.96	0.00	0.01	6.44	1.77	5.77	0.38	7.97	109.24

Source : Statistical Abstract of Karnataka,Bureau of Economics and Statistics,Karnataka.

Wheat is an important crop for the northern districts of the state extending over an area of 3.Ø6 lakh hectares. It is ideally suited in black cotton soil for dry cultivation. Mexican varieties are recommended with irrigation. Bajra is an important crop of low rainfall belts of northern districts in the state covering over 4.51 lakh hectares. The area under the crop has decreased by nearly one lakh hectares between 1974-75 and 1985-86. Bajra is mainly a rainfed crop but gives better yield with irrigation. Sugarcane is an important cash crop of the state with an area of 1.73 lakh hectares. This is a highly water and fertilizer intensive crop. Almost 1ØØ per cent of the sugarcane is under irrigation. Cotton is another important cash crop which gained importance during the late fifties when the Tunga Bhadra canal was constructed in Raichur district. Cotton was treated as a rainfed crop and grown mainly in the dry regions, after the canal was initiated, with better yields, it has gained lot of importance. For example the major crops in Raichur districts have been cotton and paddy and nearly 3Ø per cent of the area under cotton is irrigated. Groundnut and Tobacco are the other cash crops which are generally grown in dry regions as a rainfed crop. In a few pockets mulberry is an important crop, for example, Mysore district, where sericulture is practiced on large scale. This is preferred to food crops due to high returns.

Use of Modern Inputs

(a) HYV's :- Seed is one of the most important inputs contributing considerably towards increased agricultural production. The Department of Agriculture implemented schemes such as Intensive Agricultural Area Programme and Intensive

Agricultural District Programme in order to increase the agricultural production in the state. As a part of the scheme, to insure proper availability of hybrid and HYV seeds, 56 seed farms were setup during the second plan period and another 27 during the third plan period. They were distributed to the registered seed growers for multiplication and the resultant known as registered seeds were inturn supplied to the farmers. The total quantity of seed sold increased from 43 thousand quintals in 1965-66 to 20.66 lakh quintals by 1979-80. The area under HYV's increased from 66.04 thousand hectares in 1966-67 to 9.53 lakh hectares in 1973-74 and further to 20.03 lakh hectares in 1979-80. In 1986-87 the area under HYV's was around 25.78 lakh hectares. Maize crop was totally brought under HYV's in the early seventies and paddy and jowar were the other crops with significant area under HYV's.

(b) **Irrigation** :- The main rivers of Karnataka are Tungabhadra, Krishna and Kaveri. The other rivers are Ghata Prabha, Mala Prabha, Kabini, Nethravathi, Kali and Sharavathi.

Out of 102 lakh hectares of net sown area the state, 12.34 lakh hectares of land was irrigated during 1968-69 which constitutes only 12. 27 per cent of the net sown area. By 1974-75 the major and minor irrigation projects which were taken up during the first and second five year plan period were completed. With that 16.6 hectares of land were irrigated. By 1985-86 an additional 16.75 lakh hectares were irrigated. This includes the tank and well irrigation. Canal irrigation, on an average, forms 35 per cent of the total irrigation followed by tank and well irrigation.

(c) **Fertilizers** :- Trials of application of Ammonium Sulphate on paddy and coconut were carried out during 1916-17. By the end of first five year plan about 6 thousand tons of fertilizers were distributed which increased to 22 thousand tons by the end of second five year plan period. 2.Ø4 lakh tons of fertilizers were distributed in 1974-75 and a target of 5.65 lakhs was reached in 1986-87. As per some of the field studies done, apart from chemical fertilizers, organic manures like compost, green manure are generally used by small and medium farmers.

Extension :- Agricultural extension work in the state began during the end of last century and beginning of this century. Schemes were started for practical training in schools; agricultural schools were started in 1911-12 onwards and agricultural college at Hebbal, Bangalore, was started. To teach the use of agricultural machinery, seeds, and other inputs like pesticides, they were demonstrated by the government agencies in close cooperation with the owners of the field. During the plan periods, two agricultural colleges and seven agricultural schools were set up. Gram sevak training centers were also set up where gramsevaks and gramsevikas were employed to train the farmers. Block demonstrations were introduced as a new innovation envisaging a community approach to extension work for bringing about efficiency in management of inputs. This gathered momentum from 1974-75 onwards and spread to all the districts of the state. The state department of agriculture has played a vital role in mobilizing farmer's participation and in co-ordinating extension efforts of University of Agricultural Sciences, and the participating input agency. The structure of the agricultural

extension has been explained in chapter four.

Agricultural Production

In the pre-plan period, agricultural production was quite sufficient to meet the state's requirements except in 1942 , and "Grow More Food " was launched to increase the food production in the country due to food shortage by the reduction in imports from Burma and the famine in the country. Cultivation of hybrid maize from USA, and hybrid ragi such as Indaf-5 and Indaf-7 was taken up to raise the food production. The food production exceeded the target by 2 lakh tons during the end of first five year plan. Agricultural production was estimated to touch 95 lakh tons by 1986-87. The cropping intensity has also remained more or less the same over the period 1968-69 to 1986-87. It increased from 1.Ø5 in 1968-69 to 1.15 in 1986-87. So, this gets reflected from the cropped area which did not increase effectively during the entire decade. The increase in the production could be attributed to the adoption of high yielding variety seeds.

Chapter Four

ANALYTICAL FRAME WORK

The review of literature and the background information on Karnataka provide some basis to specify the analytical frame work which can explain the use of fertilizers in the state. As pointed out before, some studies had indicated that rainfall had no effect on the use of fertilizers and also that the relative prices to certain extent did not influence the use of fertilizers. It was also observed that the results derived from a micro-level study (sample survey), are sometimes quite different from those of aggregate level study using secondary data. Inter-relationship between different variables is more explicit in the case of micro-level studies such as those by G M Desai, Chary and Bandopadyay study(1973). Further, there are certain other variables like, age of head of the house hold, family income, educational status, per capita income, etc which cannot be easily included in the aggregate analysis using secondary data.

This chapter provides details of the framework used for the current study. In addition to the variables mentioned here, it is proposed to add a few variables which are not included in the other studies. These are - (i) Number of sale points (ii) Credit advancement (iii) Number of implements and machinery used. The variables which are proposed in this study are grouped into five categories as follows :-

(i) Physical factors

(ii) Technological factors

(iii) Economic factors

(iv) Institutional factors

(v) Government policies

I. PHYSICAL FACTORS

1. Rainfall

Rainfall is an important factor to be considered because, in the case of rainfed areas, cropping pattern would depend on the amount of rainfall received and if the rainfall is consistent over the a period and well distributed during the year, the crop cultivation could be an intensive one. It is generally felt that in areas where the rainfall is low, especially in the rainfed areas the fertilizer use would be less due to high risk and uncertainty.The fertilizer consumption per hectare of cropped area would increase with increase in rainfall initially,and after a certain required amount of rainfall is received, the consumption would reach a plateau. And as the rainfall increases further, the consumption level starts decreasing, mainly because the farmers may not want excess rainfall to wash away the fertilizers used. Hence we could find that the growth of fertilizer use would be low in areas where the rainfall is greater than 1150 mm per annum and high where the rainfall is less than 750 mm per annum. Thus the hypotheses would be that rainfall should have a positive relationship upto 750 mm and then an inverse relationship with fertilizer consumption beyond 1150 mm, so that the growth in fertilizer consumption would start decreasing with increase in amount of rainfall.

2. Irrigation

It is often visualized that fertilizers have a complementary relation with irrigation. In the absence of fertilizer use there is a limit to increase the agricultural production through irrigation and similarly in the absence of irrigation there is a limit to the use of fertilizers. In the process of agricultural production, during the first phase, where there is not much of modern inputs use and scarce irrigation and rainfall, crops get only protected from drought and the productivity is very less.In the second phase, the role of irrigation becomes important as it increases the production with the other modern inputs. Here the productivity reaches a plateau. In the third stage, when the fertilizer is used with the other modern inputs and irrigation, the role of irrigation becomes very important since irrigation would mean an assurance of regular water supply. So, for the same level of fertilizer application the yield increases with the increase in irrigation level. At the aggregate level we could hypothesize that with increase in area under irrigation the consumption of fertilizer would go up.

3. Cropping pattern

The soil conditions, rainfall and level of irrigation differ from region to region and hence depending on these factors the crops grown too differ and consequently the fertilizer consumption also differ. Further, within the possible crops that can be grown, the cropping pattern also would depend on the relative profitabilities of the crops. The cropping pattern is likely to change over time depending on any of the above factors and hence the fertilizer application would change accordingly.

II. TECHNOLOGICAL FACTORS

1. Use of High - Yielding - variety seeds

The use of HYV seeds has been a technological break through in the agricultural development. This is mainly to increase the yield levels. Since the scope for area expansion is limited, intensive cultivation achieves great importance. These varieties are highly fertilizer responsive and hence require very high level of fertilizer compared to the local variety seeds. Thus, the increase in area under HYV seeds, is likely to be associated with an increase in the fertilizer consumption.

2. Agricultural Machinery

Raising agricultural productivity has historically been linked with technological changes such as higher levels of mechanization. The use of agricultural machinery is a proxy for mechanization in agriculture. The increased use of the machinery and implements would partly indicate farmer's awareness of intensive agricultural operations and hence the fertilizer use. One can say that mechanization in agriculture is the input for all inputs[3]. Each of the various agricultural operations demand an appropriate group of machines and implements, which in turn fall into several categories, differentiated one from the other by their level of complexity. The use of machinery like tractors, threshers, weeders,etc., require a certain minimum size for its viability and therefore it is linked with size of holding, the cropping pattern and the intensity of cultivation. In this study, the number of the agricultural machineries with the farmers is

---

[3] S.P.SeethaRaman and Modini.S.P(1985)," Marketing environment for agricultural Machinery", IIM, Ahmedabad.

used.

III. ECONOMIC FACTORS

1. Relative prices

One of the basic assumptions in determining the production decisions at the farm level is that the farmers allocate their resources on a rational manner and that they try to maximize the net returns on their resources. Following the maximization process it is possible to show that the demand for fertilizers, which is a derived demand, is based on input prices and output prices. However, some farmers may respond more towards output price as compared to input prices. One reason is that the farmer would like to increase his income by increasing the production through higher levels of fertilizer application. And for the other inputs, the share of purchased inputs is relatively small. A large part of the component which is not purchased and has an imputed value (especially family labour and own livestock labour) comes from within the family and the farm. Seed input constitutes an approximately constant proportion of output. Since its imputed price would vary in proportion to the price of the product, its value would also appear to be a constant proportion of the value of the output. Hired labour employed for harvesting, sowing, weeding, etc., is usually paid a certain customarily determined proportion of the quantity harvested assuming that the farmers desire to get maximum benefit, other inputs remaining constant, the quantity of fertilizer use will depend on the fertilizer response function and the ratio of prices of fertilizer to prices of crops. For a given response function, the farmers will use fertilizers till the returns to investment on

fertilizers equals its cost.

IV. INSTITUTIONAL FACTORS

1. Credit advancement

The agricultural production operations require a lot of capital which forms the operational cost of the farm. It includes cost for buying seeds, fertilizers, pesticides, transportation costs during marketing of the produce, fuel costs for the machinery, etc. This is more crucial in the case of small and marginal farmers since their savings are very less and hence the investment would be less without the help of institutional credit. In the absence of institutional credit from co-operatives or regional rural banks, etc., the farmer may have to take loans from professional money lenders, which means that they have to pay heavy interests and hence may not find it economical to apply fertilizers. Thus we can expect to find an increase in the consumption of fertilizers with increase in the loans issued from commercial sources.

2. Extension effort

Agricultural extension is one of the most important factors influencing agricultural development. Research and development has been a continuous process in research farms and universities. But these information have to be diffused to the farmers. There are various media like, radio & television network, documentary films, etc, for spreading the information . Also, there are various agencies such as the extension wing of the agricultural department, fertilizer firms,etc, which carry the information to the farmers. Extension methods help the

farmers to make use of the available resources to the optimum from the given technology. Of course, the other fact is that the small farmers take advice from the progressive farmers regarding the technical aspects. In extension efforts, we have the lab to land programmes where in the marginal farmers are given inputs. Secondly, there is the T & V system or where the agricultural extension worker visits the farms and diffuses the latest technology and gives guidance.

3. Sale Points

Sale points, in the study refers to the sale point of fertilizers and is also known as the outlets. There are various types of agencies such as co-operatives, private dealers including the fertilizer company dealers, agro based companies and farmer's co-operatives establishing sales points. Sale point is important in the sense that if they are in an easily accessible distance it would be an incentive to the farmers to purchase fertilizer. The measure of spatial distribution at macro level is determined either as number of sale points per unit area or number of villages per sale point. The proposition made in the study is that there is a positive association between the density of sale points and sales volume. The underlying assumption made is that the small farmers would be benefited in such a situation since, it would not be possible for them to travel long distances, especially since their consumption level would be low.

V. GOVERNMENT POLICIES

Subsidies :- Subsidy is being given to the agricultural sector directly or indirectly for all the major inputs including fertilizer, irrigation, power and credit. Availability of subsidy would influence fertilizer consumption since the other inputs

mentioned are complementary. Fertilizer was brought under the Essential Commodity Act since it represented a major input for agriculture and a major output of the fertilizer industry. Government has introduced a control over the stocks (production and imports) and prices at the industry level and at the farmer's level. The prices of fertilizer were fixed product wise and firm wise depending on the capacity utilization, vintage and the type of inputs used. Subsidies are provided to the industries and to the farmers. The subsidy to the industries are at times passed on to the farmers.

SOURCES AND LIMITATIONS OF DATA

The data source for the purpose of this study include the following:-

1. Fertilizer Statistics, FAI.
2. Annual Season Crop Report of Karnataka.
3. Statistical Abstract, Bureau of Economics and Statistics.
4. Fertilizer and Agricultural Statistics, FAI.

The study confines itself to inter-temporal analysis of fertilizer consumption with the set of explanatory variables of state aggregate data and cross-sectional analysis for four different periods of time using the published data. Data on size of land holdings, institutional loans for agricultural purposes and number of sale points were not available district wise. Also time-series data on the size of land holdings were not available for the analysis purpose. Data on the number of pump sets and tractors used are available separately upto 1979-80 after which they are clubbed. The data were available at four different time points. The relative prices of fertilizers to crops have been considered as a variable. The weighted average of crop prices and

weighted average of fertilizers nutrient-wise have been considered for the calculation of the relative price. Short-term agricultural loans is being used as a proxy for the loans to buy fertilizer assuming that a constant proportion of the loan is spent for the purchase of fertilizers.

Here it is also important to mention the statistical problems confronted in the empirical study. Multicollinearity is a commonly observed phenomenon in time series data. It represents the tendency of one or more variables to move in the same direction over a given period. Thus if one or more explanatory variables in a given model are highly correlated, it becomes very difficult to dis-entangle their influences and obtain precise estimate of their effects[4]. The presence of high correlations not only 'biases' the net regression coefficients but also produces the tendency towards indeterminency on account of unduly large sampling errors[5].

However, the sampling error of an individual coefficient depends on both intercorrelations with other explanatory variables. The extent of multicollinearity needs to be examined vis-a-vis overall correlation of the equation if the prime objective is to determine the relative importance of individual factors in determining the levels of fertilizer consumption in the model[6].

---

[4] Discussion on effects of multicolliniearity, see J Jhonston, "Econometric methods", pp. 201-206.

[5] See Karl A Fox and James F Coney, "Effects of inter-correlations on multiple correlation and regression measures", AMS-341, United States department of Agriculture, Agricultural marketing service, Washington 1954.

[6] J Jhonston, "Econometric methods", op.cit, p.207.

Chapter Five

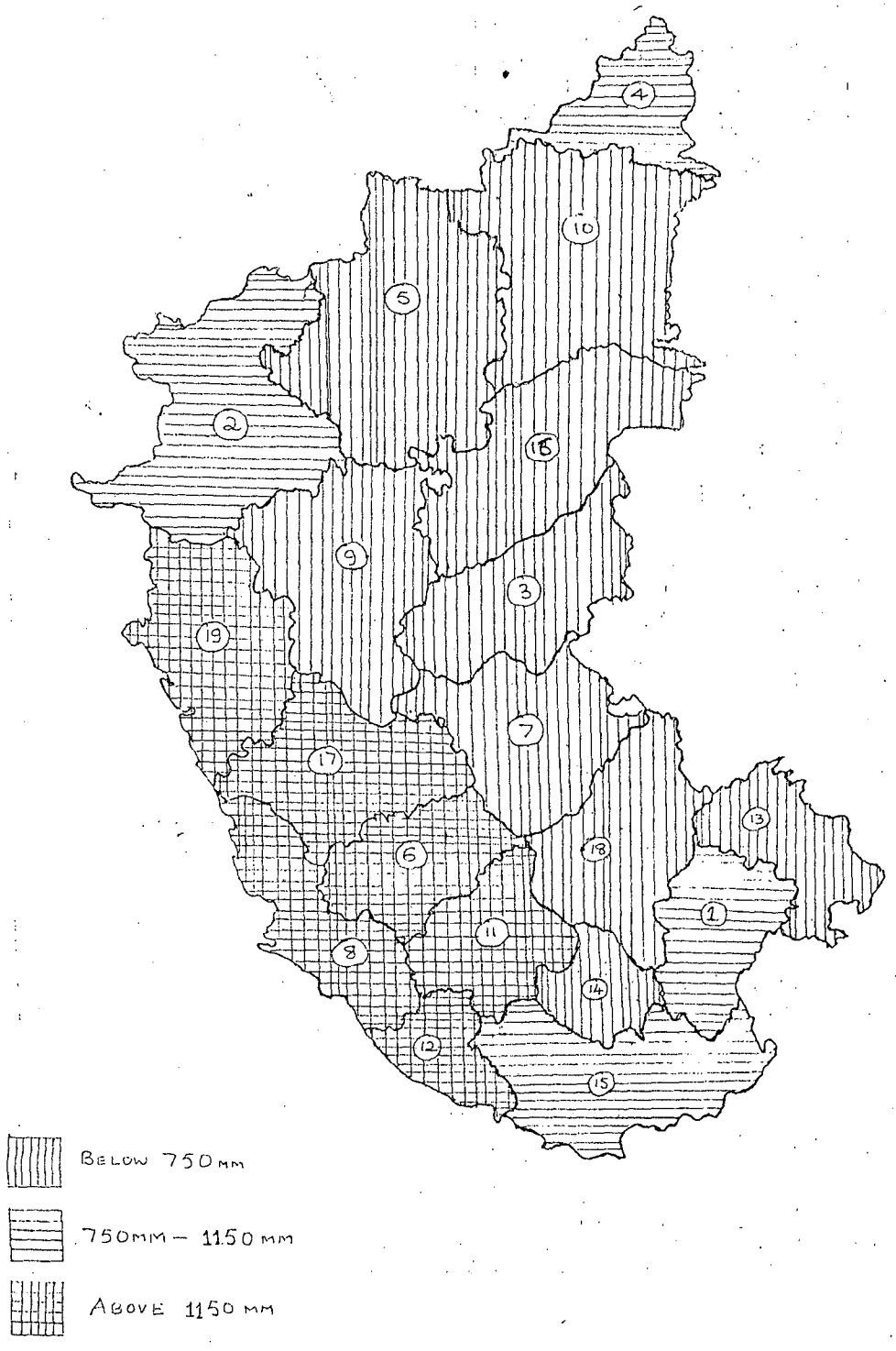
RESULTS FROM PARTIAL ANALYSIS

RAINFALL

Rainfall is one of the major sources of water supply which could affect the use of fertilizers. Karnataka receives rainfall during the two major seasons i.e., south-west monsoon and north-east monsoon. The amount of rainfall received during the south-west monsoon which is roughly during June-September, is comparatively more than the amount of rainfall received during the north-east monsoon. For the purpose of this analysis, the total rainfall is taken into consideration. Simple correlation analysis between fertilizer consumption and rainfall using the district wise data and state aggregate data in table 5.1 indicates significant correlation coefficients in five districts. The total rainfall in the state has decreased from 1794.31 mm in 1968-69 to 1Ø98.93 mm in 1986-87(graph 5.1). The index of rainfall with base 1968-69 decreased to 82 in 1986-87. The districts were classified into three categories. The rainfall distribution in the state (district wise) can be visualized in map.2. In the first category, there are six districts which forms 31.6 percent of the total geographical area and it has 38.55 percent of the total gross cropped area of the state. These districts receive less than 75Ø mm of rainfall per year. The fertilizer consumption has grown at a rate of 7.38 percent per annum. The second category has five districts, accounting for 29.97 percent of the total cropped area of the state. This region

CLASSIFICATION OF DISTRICTS ACCORDING TO AVERAGE RAINFALL

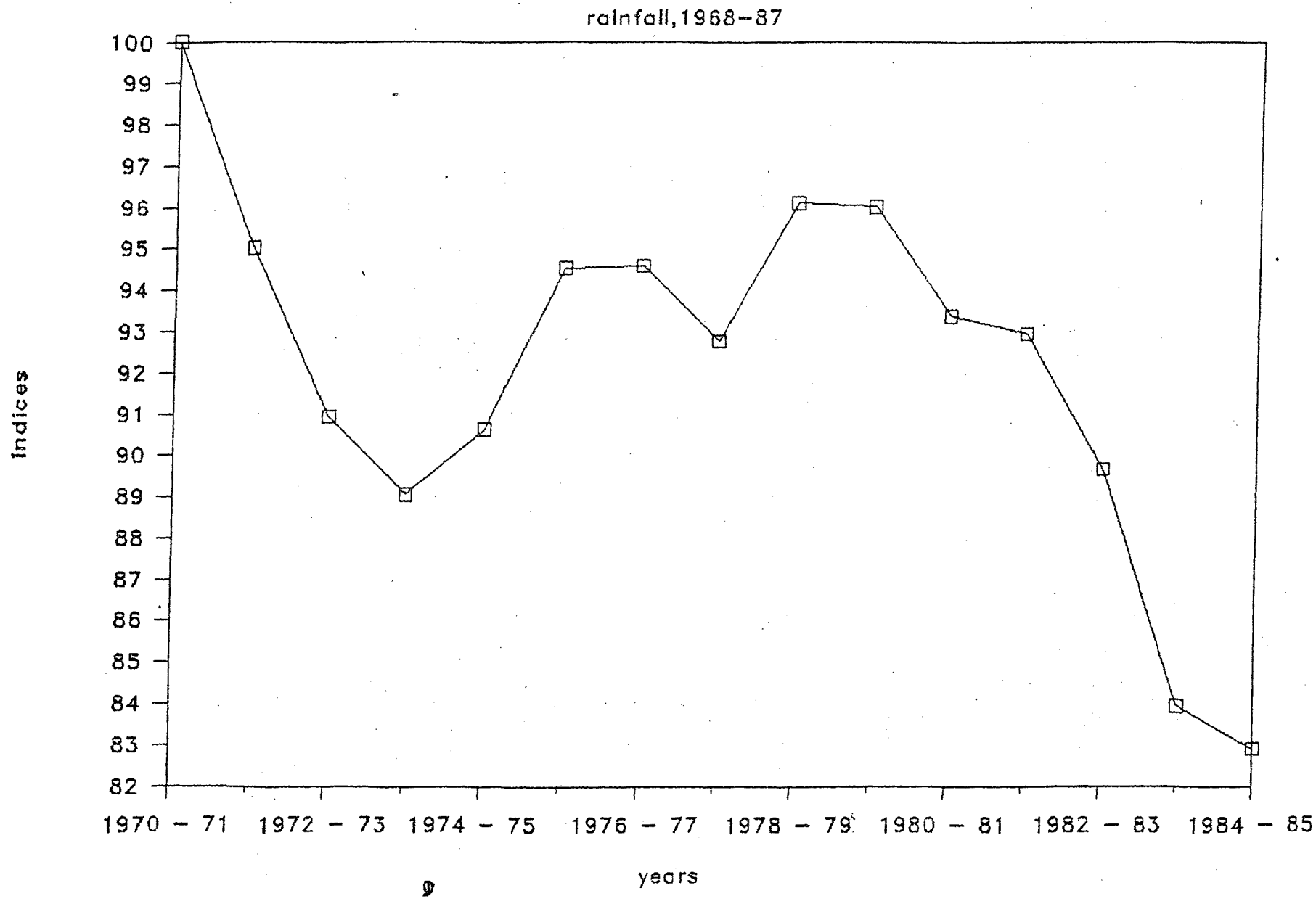
MAP 2



Number	District
1	Bangalore
2	Belgaum
3	Bellary
4	Bidar
5	Bijapur
6	Chikamaglur
7	Chitradurga
8	Dakshina Kannada
9	Dharwad
10	Gulbarga
11	Hassan
12	Kodagu
13	Kolar
14	Mandya
15	Mysore
16	Raichur
17	Shimoga
18	Tumkur
19	Uttara Kannada

GRAPH 5·1

five year moving average graph



receives 750 mm to 1150 mm amount of annual rainfall in a year. The fertilizer growth rate is 9.51 percent per annum. The third category constitutes of eight districts, accounting for 38.48 per cent of gross cropped area had rainfall of more than 1150 mm. The growth rate of fertilizer use is 8.29 percent.

There exists substantial variations between districts with regard to rainfall and fertilizer consumption. As pointed out in table 5.1, most of the districts have indicated an inverse relation between rainfall and fertilizer consumption. There are only two districts namely, Dakshina Kannada and Kodagu, with statistically significant positive correlation between rainfall and fertilizer consumption.

Table 5.1 Rainfall and Fertilizer Consumption analysis results

Districts	Correlation Coefficient	R^2	Growth rates in fertilizer use@
BANGALORE	-.5577	.3110	07.26
BELGAUM	-.1663	.0276	14.13
BELLARY	-.3363	.1130	11.57
BIDAR	-.0062	.0000	09.88
BIJAPUR	-.6285*	.3950	14.53
CHIKMAGALUR	-.0777	.0060	10.43
CHITRADURGA	-.2801	.0784	06.22
DAKSHINA KANNADA	.5571*	.3103	05.18
DHARWAD	-.3449	.1189	13.47
GULBARGA	.0457	.0020	13.48
HASSAN	.0715	.0051	09.86
KODAGU	.5915*	.3498	14.24
KOLAR	-.0746	.0055	07.84
MANDYA	.0748	.0055	06.70
MYSORE	-.5574*	.3106	09.69
RAICHUR	-.4040	.6131	12.27
SHIMOGA	-.7265**	.5278	09.19
TUMKUR	-.2810	.0789	07.15
UTTARA KANNADA	.4338	.1881	08.10

@ The growth rates are based on time series data from 1968-69 to 1986-87.
* significant at 10 % level
** significant at 05 % level

Dakshina Kannada district is located on the south western part of Karnataka adjoining the Arabian sea and receives very heavy rainfall during the south-west monsoon season and the use of fertilizer in terms of absolute value is quite high but in terms of growth rate it is quite low which holds good with our hypothesis. Kodagu is situated in the south interior part with heavy rain mainly due to the environmental conditions.

The important crops in this area are plantation crops like coffee, tea and rubber. The level of fertilizer had been very low in the early seventies and increased rapidly over time. In Bijapur, Mysore and Shimoga there is a high negative correlation between fertilizer consumption and rainfall. The growth rates of fertilizer consumption increased from 7.38 to 9.51 with the increase in amount of rainfall received.

Table 5.2 Fertilizer Consumption in the three regions

fertilizer/rainfall	Rainfall < 750 MM region1	Rainfall 750-1150 MM region2	Rainfall >1150 MM region3
Number of districts	6	5	8
Fertilizer use(kgs) per GCA(1975-76)	31.932	19.262	18.799
Fertilizer use(kgs) per GCA(1985-86)	67.637	50.746	51.638
Growth rate of fertilizer consumption(per cent)	7.38	9.51	8.89

The growth rate declines with further increase in the rainfall. This is because, a high amount of rainfall implies assurance of water supply and the level of application would generally be high or would be almost at the optimal level. So, an

increase in the consumption would mean an increase in the gross cropped area or an increase in the area under high yielding variety seeds. In a ten year period, between 1975-76 and 1985-86 the level of consumption has doubled in region1 and increased nearly two and a half times in region2 and region3. There has been a decline in the fertilizer consumption with increase in the amount of rainfall received. The same pattern is seen in both the years(refer table 5.2). The region with lower rainfall has higher level of use and vice versa. It may be useful pointing out that any conclusion on this would not be very precise since the level of application and the percentage of area fertilized would vary from region to region and from district to district in a given region. Apart from the amount of rainfall, irrigation levels also differ within the region defined here. But within this limitation the hypothesis of inverse relationship between rainfall and fertilizer use appears valid.

IRRIGATION

The effect of irrigation has been analyses using the state aggregate data according to source of irrigation, i.e., canals, tanks, wells and other sources. In absolute terms the area under irrigation has increased from 12.34lakh hectares in 1968-69 to 16.75 lakh hectares in 1986-87, but the percentage of gross cropped area increased from 11 per cent in 1968-69 to 18 per cent in 1986-87 which is still low. In terms of the source of irrigation, the canal irrigation has been dominating with an average of 35 per cent of the total irrigation. This is due to the new projects developed in the mid sixties and the late seventies. The tanks and well irrigation depend more on the rainfall which on the whole has decreased over time. This has

reflected in the low availability of ground water from tanks and wells. The area under well irrigation has decreased by nearly 49 per cent compared to 25 per cent decline in tank irrigation. The irrigation intensity in Karnataka has increased from Ø.1ØØ5 in 1965-66 to Ø.1857 in 1986-87. This shows an increase of 84.77 per cent or an annual rate of 3.Ø6 per cent. The gross irrigated area increased from 1Ø.371akh hectares in 1965-66 to 16.74 lakh hectares in 1986-87. This shows an increase of 61.73 per cent at 2.4 per cent growth per annum(see table 5.3). The gross cropped area increased only by 12.59 per cent compared to 61.73 per cent of gross irrigated area.

From graph 5.2 it can be noticed that the irrigation has developed only after 198Ø-81 onwards and the fertilizer consumption curve has also taken a steep curvature during the same period. The cropping intensity has grown at a slower pace as compared to irrigation intensity. Compared to a cropping intensity of 1.8 in Punjab, Karnataka's cropping intensity is only 1.1.

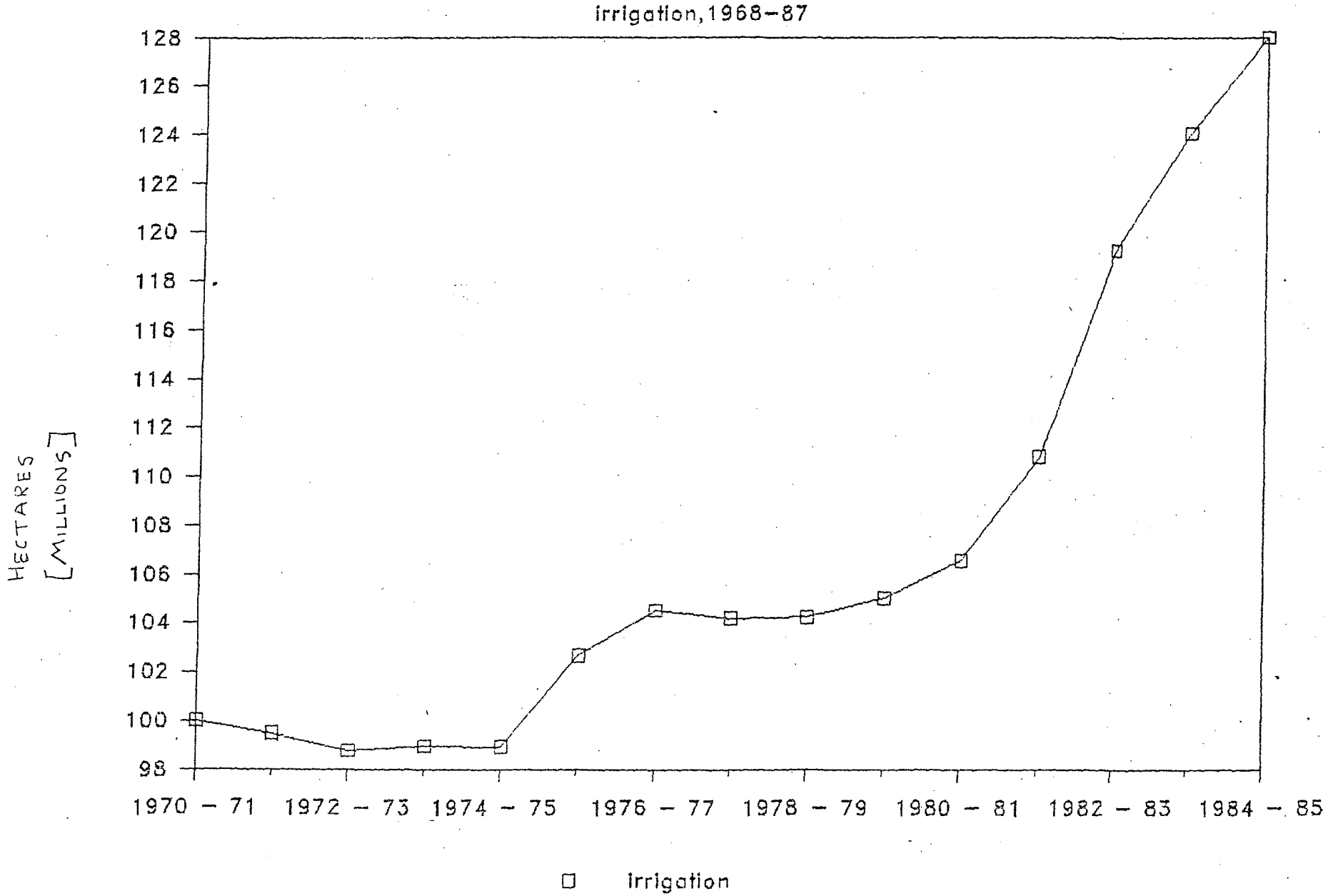
Table 5.3 Intensity of Irrigation in Karnataka

year	GIA ('ØØØha)	NSA ('ØØØha)	GCA ('ØØØha)	GCA/NSA	GIA/GCA
1965-66	1Ø38	1ØØ42	1Ø329	1.Ø285	.1ØØ5
197Ø-71	1584	1Ø248	1Ø887	1.Ø623	.1455
1975-76	17Ø7	1Ø36Ø	11159	1.Ø771	.153Ø
198Ø-81	1675	9899	1Ø66Ø	1.Ø769	.1571
1985-86	1675	1Ø172	11561	1.1365	.1449

Note: GIA= Gross Irrigated Area, NSA= Net Sown Area and GCA= Gross Cropped Area.
Source : Statistical Abstract of Karnataka,Bureau of Economics and Statistics,Bangalore.

The irrigation distribution across the districts, except for a few districts indicated statistically significant

Five year moving average graph



coefficients between fertilizer use and irrigation intensity. The district wise results are given in table 5.4.

A comparison between the performance of Karnataka and Punjab in terms of irrigation facilities in table 5.5 indicates that in Punjab irrigation has helped and given good scope for the use of high yielding variety seeds which is as high as 93.82 per cent of the total cropped area and thus this is reflected in the level of fertilizer. This shows that there is a wide scope for increasing the level of fertilizer application through improvement in the irrigation and also increase the area under high yielding variety seeds.

Table 5.4

Correlation Coefficient between fertilizer use and irrigation intensity in the districts of Karnataka

District	Correlation Coefficient	R^2
Bangalore	.7364**	.54225
Belgaum	.8368**	.70026
Bellary	.9604**	.92231
Bidar	.8738**	.76354
Bijapur	.8828**	.77934
Chikmaglur	.8902**	.79238
Chitradurga	.4857	.23879
Dakshina Kannada	.7567*	.57264
Dharwad	.8964**	.80358
Gulbarga	.9320**	.86861
Hassan	.8900**	.79205
Kodagu	.9194**	.84524
Kolar	.7346*	.53970
Mandya	.8419**	.70874
Mysore	.8946**	.80038
Raichur	(-).1877	.03523
Shimoga	(-).3044	.09267
Tumkur	(-).5599*	.31345
Uttara Kannada	.0651	.00424
State	.9995**	.99892

* significant at .01 % level
** significant at.001 % level

Table 5.5 Comparison of Agricultural Performance 1983-84

	KARNATAKA	PUNJAB
Area under HYV's (%)	37.81#	93.82@
Percentage of GIA	13.85	86.Ø8
Cropping Intensity	Ø1.Ø7	Ø1.71
Percentage of area under food grains	64.Ø8	67.52
Average fertilizer use per Hectare(kgs)	56.67	43.42

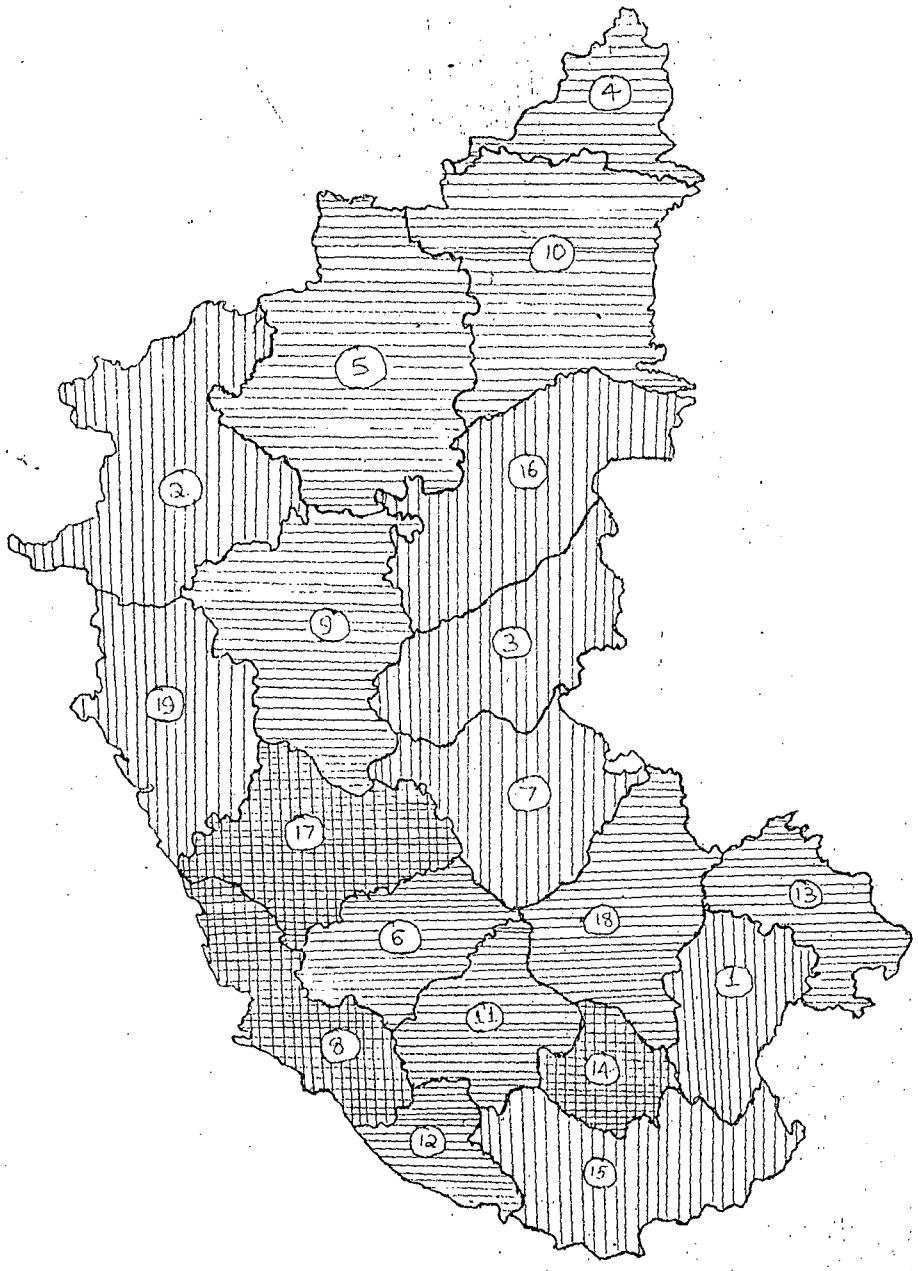
includes Paddy, Jowar, Maize, Ragi and Wheat.
@ includes Paddy,Wheat and Jowar.
Source : 1. Statistical Abstract of Karnataka,Fertilizer Statistics(1983-84) and Annual Season Crop report,Karnataka.
2. Table No.2.6, Region wise-crop wise fertilizer consumpti A study of Punjab,R.P.S.Mallik,1988.

The fertilizer consumption per gross cropped area for the districts of Karnataka are classified into three regions based on the average irrigation level. The regions R_1 and R_2 consists of eight districts, their growth rates in fertilizer use are 12.13 per cent and 9.28 per cent respectively. The third region (R_3) consists of three districts having a growth rate of 7.Ø4 per cent in fertilizer use. The classification of districts according to irrigational levels is shown in map.3. The nutrient wise fertilizer consumption per hectare of cropped area is given in Table 5.6. As per the table the average consumption has been increasing with increase in the level of irrigation. The same trend is observed for the years 1975-76 and 1985-86. When we compare this with the regions classified according to rainfall(see,Table 5.2), it can be noted that the average fertilizer consumption per unit of gross cropped area, is

KARNATAKA STATE

CLASSIFICATION OF DISTRICTS ACCORDING TO IRRIGATION INTENSITY

MAP 3



1·1. – 15·1.

15·1. – 30·1.

30·1. – 45·1.

P. T. O

Number	District
1	Bangalore
2	Belgaum
3	Bellary
4	Bidar
5	Bijapur
6	Chikamaglur
7	Chitradurga
8	Dakshina Kannada
9	Dharwad
10	Gulbarga
11	Hassan
12	Kodagu
13	Kolar
14	Mandya
15	Mysore
16	Raichur
17	Shimoga
18	Tumkur
19	Uttara Kannada

declining with increase in the amount of rainfall received. Similar trend is noticed for both the years,i.e., 1975-76 and 1985-86.

Table 5.6 Fertilizer Consumption per gross cropped area
(Units: 'kgs/ha)

Nutrient variety	1975 - 76			1985 - 86		
	R_1 1-15	R_2 15-30	R_3 30-45	R_1 1-15	R_2 15-30	R_3 30-45
N	06.22	17.23	29.21	18.78	34.18	49.80
P	02.16	05.07	08.19	11.89	16.22	21.26
K	01.83	04.09	11.05	10.30	11.03	16.13
Total	10.21	26.39	48.45	40.97	61.42	87.19
Number of districts	8	8	3	8	8	3

Note: The class range refers to percentage of gross irrigated area the gross cropped area.

To get a better picture of the effects of rainfall and irrigation on the fertilizer consumption, the districts have been cross classified according to rainfall and irrigation. The effect of rainfall and irrigation on the consumption of fertilizers is highlighted in table 5.7. The nineteen districts have been classified according to rainfall and irrigation into eight categories. The average fertilizer consumption per gross cropped area indicates that there is an increasing pattern on moving down the column, implying the increase in the level of irrigation. Analysing column wise, a decreasing pattern on moving left to right of the row is noticed, implying increase in the level of rainfall. The same pattern is noticed for the year 1975-76 and 1985-86. So, the effect of irrigation has been more than that of rainfall. The combination of (R_3,Region1), consists of only one district,i.e., namely, Mandya, thus the value in the particular

region could be slightly biased . But this particular district happens to be the one with highest consumption of fertilizer per hectare of gross cropped area.

Table 5.7 Fertilizer use per hectare of GCA
(units: 'kgs)

Irgn/Rainfall	1975 - 76 region1	region2	region3	1985 - 86 region1	region2	region3
R1	10.68	08.28	10.97	37.80	34.84	45.61
R2	33.81	26 .59	14.97	67.33	69.59	48.20
R3	68.80	*	38.28	128.24	*	66.67

* No districts classified in region.
'Irgn' refers to the percentage of area irrigated.
Source : Fertilizer and Agricultural Statistics,FAI Southern Region

Thus, comparison of the relative effects of rainfall and irrigation, brings out the conclusion that irrigation is an important factor that determines the use of fertilizers. This holds good with the original hypotheses. Karnataka has a good potential to improve the irrigation systems, especially canal. This is because the well and tank irrigation depend more on the amount of rainfall received in that region. From the state data it is noticed that the area under tank irrigation and well irrigation have decreased considerably between 1968 and 1986.

CROPPING PATTERN

As pointed out in chapter three, the important crops grown in Karnataka are paddy, jowar, bajra, ragi, maize, pulses, sugar cane and cotton. Among the food grains, paddy is the most popular crop. Ragi is mainly confined to the southern districts; Jowar, bajra and wheat are confined to the northern districts of Karnataka. In most districts the area under food grains is dominant in the cropping pattern. Table 5.8 gives the district

wise cropping pattern for the year 1980-81 in percentages to the total cropped area of the districts. Among the major food crops only paddy is grown thrice in a year, i.e.,Kharif, Rabi and Summer seasons. For cropping seasons details refer appendix 2. Among the three seasons the net area sown is highest during the Kharif season and seconded by the Summer season but not as much as in the Kharif season. This is partly because of the rainfall distribution during the year. In Karnataka, the major share of annual rainfall occurs during the south-west monsoon and the rainfall is conducive to take a paddy crop during the season. Crops like groundnut, Ragi, Jowar, Oil seeds, etc., which are not water and fertilizer intensive crops,are grown during the next season.

Table 5.8 CROPPING PATTERN IN DISTRICTS OF KARNATAKA 1980 - 81
(PERCENTAGES)

DISTRICTS	PADDY	JOWAR	RAGI	PULSES	FOODGRAIN TOTAL	SUGAR CANE	COTTON
BANGALORE	08.42	0	52.45	12.41	78.37	00.83	0.003
BELGAUM	06.12	20.13	01.52	11.39	64.01	04.55	06.56
BELLARY	05.19	25.20	05.93	08.86	67.92	01.31	17.30
BIDAR	02.56	27.56	00.02	32.67	76.85	02.76	02.44
BIJAPUR	00.23	32.60	0	10.04	69.19	00.57	15.80
CHIKMAGLUR	19.85	07.58	16.97	08.73	55.22	00.56	00.74
CHITRADURG	09.15	13.23	19.38	12.20	73.53	00.84	08.18
DAKSHINA KANNADA	56.23	0	00.10	04.62	61.05	00.71	0
DHARWAD	07.16	20.85	01.23	09.67	54.28	00.19	21.68
GULBARGA	01.20	24.88	00.08	24.97	69.05	00.17	10.05
HASSAN	18.59	03.71	41..87	18.32	85.24	00.83	00.89
KODAGU	30.43	0	03.15	00.74	34.33	00.02	00.17
KOLAR	10.97	00.28	40.78	10.29	69.30	00.94	00.02
MANDYA	20.62	02.11	31.41	21.45	77.38	07.14	0
MYSORE	11.55	15.86	21.09	20.87	71.80	00.96	01.20
RAICHUR	05.80	21.56	00.01	11.40	56.55	00.35	27.09
SHIMOGA	53.62	08.32	13.25	05.32	82.09	01.67	02.93
TUMKUR	08.57	03.63	31.42	16.82	69.91	00.57	00.11
UTTARA KANNADA	74.04	00.42	00.50	03.10	78.50	01.62	0.003

Source : Statistical Abstract, Bureau of Economics and Statistics, Karnataka.

On an average, the area under food grains which includes cereals and pulses form nearly seventy five percent of the total cropped area. A similar pattern is found in almost all the districts.

In Karnataka, generally, multiple cropping or crop rotation system is followed in the irrigated area. Paddy and ragi are grown in the first season followed by Ragi-Sugarcane or Paddy-sugar cane or single crop. Ragi is a less water intensive and fertilizer intensive crop compared to paddy and sugarcane. Sugar cane is the most fertilizer intensive crop. Its acreage is found comparatively high in high irrigated districts like Mandya, Shimoga and Uttara Kannada. In the district of Mandya, apart from irrigation, the soil condition favours the growing of sugar cane. With regard to the marketing of the commodity, there are locally situated sugar manufacturing industries which purchase the commodity from the farmers. Similarly this takes place in Shimoga district. When we look at the price movements of sugarcane crop, it has increased by 1.84 times between 1973-74 and 1985-86 compared to the acreage which increased by 1.58 times during the same period. Gram and ground nut are also grown during the second season mainly because fertilizers applied during the first season would hold good for the second season for growing these crops.Otherwise, the soil nutrient level may not be sufficient to grow any superior cereals and may have to be replenished again. A similar situation is found in the Guntur district of Andhra Pradesh where chillies and tobacco are grown in the second season[7].

---

[7] G M Desai, Chari and Gangopadyay,"Growth in fertilizer use: A micro level analysis,Case study of Guntur district",1973.

INSTITUTIONAL CREDIT

Though agricultural credit includes the short-term, medium-term and long-term loans, for the purpose of this study only short-term and medium-term loans are considered. Loans are disbursed for various purposes for example, seasonal operation, purchase of implements, marketing of crops, processing, etc,. In this study only the loans advanced by the agricultural credit co-operative societies as crop loans is considered. It is assumed that a proportion of the total crop loan is utilised for the purchase of fertilizers.

The growth of crop loans advanced between 1968-69 to 1986-87 can be visualised from table 5.9 and graph 5.3. The index numbers with base 1968-69 indicates that credit has become an important input in agriculture like any other inputs. It is hypothesised that credit facilities would stimulate and increase the use of fertilizers.

The issue of crop loan has increased at 10.38 per cent per annum from Rs.261.23 lakhs in 1968-69 to 14879.04 lakhs in 1986-87. It may be recalled that the agricultural "package program" was introduced in India to improve the agricultural production. The package contained the major inputs and credit as per the farm plan proposed for each farmer. Credit under the package program secured as short term loans increased by about forty per cent and medium term loans by about 300 per cent during the early stages of its implementation[8]. The tempo seems to have

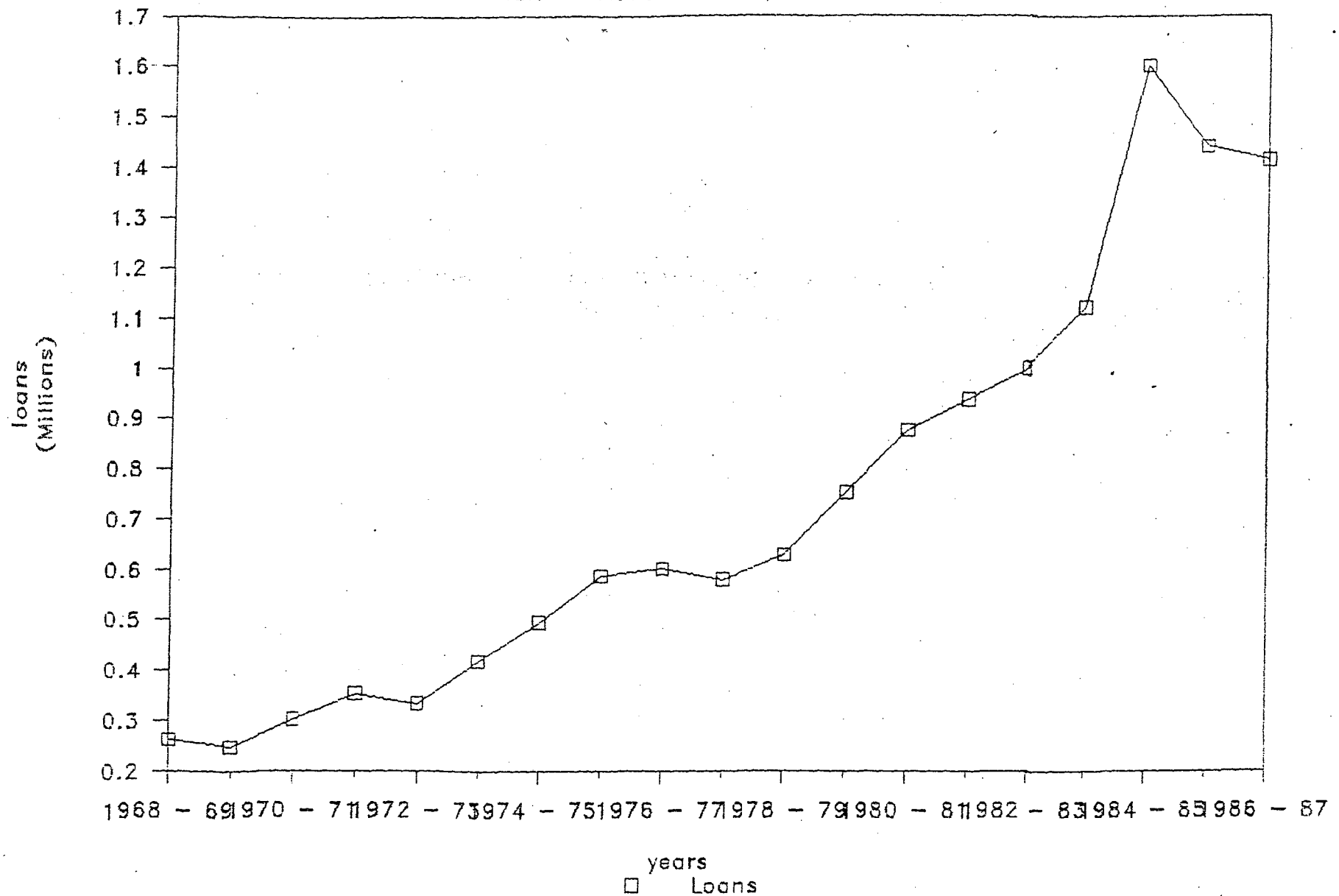
---

[8] J A Mollet,(1966),"Package programs",Agricultural plannin course,F A O. The analysis is based on 1961-65 data.

GRAPH 5·3

Growth of loans disbursed

Karnataka(institutional), 1968–87



been kept in Karnataka too. Medium term loans advancement also was quite substantial. The loans for digging of wells increased from 2.84 lakhs in 1968-69 to 53.21 lakh in 1978-79. The purchase of pump sets and other machineries increased from 11.Ø3 lakhs in 1968-69 to 16.92 lakhs in 1977-78. Overall the medium term loans increased from Rs 224.52 lakhs in 1968-69 to Rs 4331.93 lakhs in 1986-87. This is seen very well with the increase in the number of pumpsets and other farm machineries used. The number of electrical pump sets increased from 27,Ø42 in 1966 to 1.59 lakhs in 1972-73 the tractors and tillers increased from 12,444 in 1966 to 13,982 in 1979-8Ø. In total, the pumpsets and other equipments together have showed an increase of 1Ø.58 per cent in the twenty year period in comparison with that of agricultural credit which shows an increase of 1Ø.35 per cent during the same period. The nationalisation also has contributed towards increased use of agricultural credit. The agricultural credit co-operative societies decreased from 8931 in 1968-69 to 5184 in 1977-78 and to 4954 in 1986-87. The number of villages served by these were 25827 out of 26377 villages in 1968-69 to 28228 out of 26766 villages in 1977-78.

The slow expansion of these societies could be that despite the government policies regarding rural finance, prominence was not given to the development of primary co-operative credit societies.

The short-term loans advanced per hectare of gross cropped area increased from Rs 24.75 in 1968-69 to Rs 121.82 in 1986-87. This shows an increase of 392 per cent at a growth rate of 9.85 per cent per annum compared to the fertilizer consumption of 1Ø.Ø8 per cent.

Table 5.9 Institutional Credit Advancement

Year	Loans (Rs'ØØØ)	Index of loans advanced	Loans per GCA(inRs)
1968-69	261236	1ØØ.ØØ	24.75
1969-7Ø	247596	94.78	22.94
197Ø-71	3Ø3Ø93	116.Ø2	27.84
1971-72	353538	135.33	32.17
1972-73	333717	127.74	32.Ø6
1973-74	416556	159.46	38.24
1974-75	492215	188.42	44.76
1975-76	584161	223.61	52.39
1976-77	599728	229.57	6Ø.79
1977-78	578221	221.34	52.35
1978-79	628Ø5	24Ø.51	56.44
1979-8Ø	751581	287.7Ø	67.64
198Ø-81	874857	334.89	78.32
1981-82	936495	358.48	83.41
1982-83	998133	382.Ø8	89.51
1983-84	1121Ø9	429.27	97.72
1984-85	16Ø1592	613.Ø8	139.Ø5
1985-86	144Ø5Ø3	551.42	124.6Ø
1986-87	1413Ø8	541.Ø8	121.82

Source : col.1 Statistical Abstract, B E S, Karnataka

HIGH YIELDING VARIETIES

The technological change through the use of high yielding variety seeds was introduced as a means to increase the tempo of agricultural development. In Karnataka, the introduction of high yielding variety seeds of major food crops like paddy, maize, bajra, ragi, and wheat played an important role. Among the crops almost the entire area under maize was covered by HYV's. Crop wise data on high yielding variety seeds indicate a steep increase in the area under hyv's between 1965-66 and 1975-76, after which there has been a steady growth(refer table 5.1Ø). However,in the case of maize HYV variety seed has been already adopted to great extent at the early stages of agricultural development during the mid-sixties.

Table 5.1Ø Area under HYV's : Crop wise

YEAR/CROP	RICE	JOWAR	WHEAT	MAIZE
	('ØØØ hectares)			
1965-66	25.6 (1188.7)	22.Ø (2272.6)	Ø.7Ø (529.3)	17.8 (23.9)
1975-76	434.6 (1193.7)	51Ø.8 (2Ø16.Ø)	128.8 (4Ø7.2)	177.6 (177.6)
198Ø-81	685 (1114)	64Ø (16Ø6)	175 (322)	157 (157)

Source : Statistical Abstract,B E S,Karnataka
Note : The numbers in the bracket refers to the total area und the crop.

Area under paddy and jowar increased at almost the same rate and area under wheat and maize were not very substantial but in terms of percentage to the total area under the crop it was quite significant.

The use of HYV seeds is very limited during the Rabi and summer season. It may be pointed out that autumn rice is sown between May and August and this coincides with the south-west monsoon (June-September). The rainfall in the south-west monsoon season accounts for nearly seventy to seventy five per cent of the year's total rainfall. Therefore the cropped area is more during this season as compared to the other two seasons. Rainfall though does not show any effect directly, is indirectly affecting through cropping intensity and cropping pattern. When the area under HYV's for all crops in Karnataka is analysed it is observed that the growth rate has been as high as 11.49 per cent per annum in comparison with the fertilizer consumption rate of 1Ø.Ø8 per cent per annum. The graph.5.4 shows the similar pattern followed by the HYV's as that by fertilizer consumption. Thus, it is possible to infer that the growth of HYV's has helped in the growth of fertilizer use.

GRAPH 5.4

AREA UNDER HYV SEEDS

KARNATAKA, 1971-87

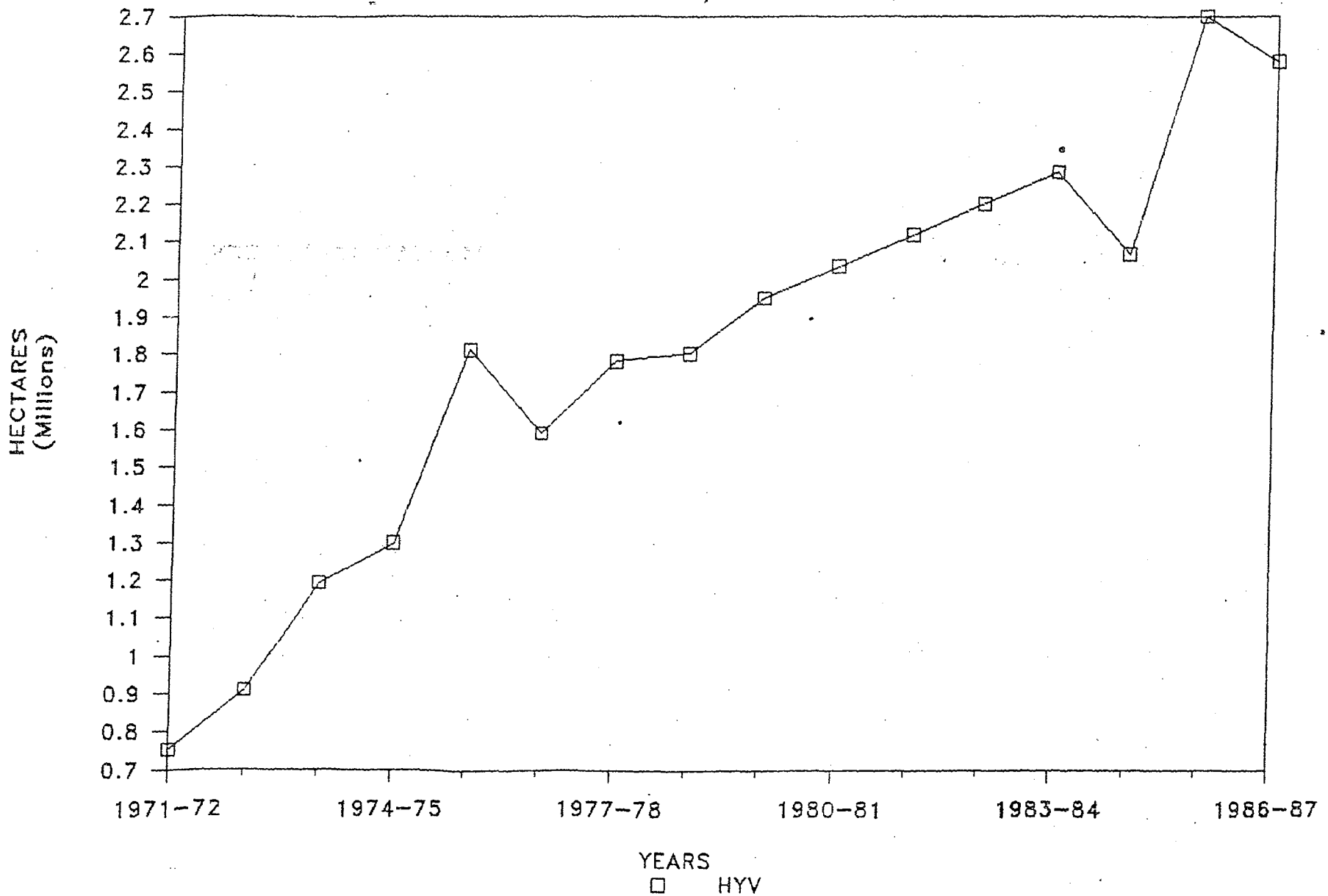


Table 5.11 Use of HYV's

YEAR	Area under HYV's ('ØØØ ha)	INDEX
1968-69	42Ø.Ø2	1ØØ
1969-7Ø	53Ø.81	126.38
197Ø-71	641.59	152.76
1971-72	752.39	179.13
1972-73	9Ø9.98	216.65
1973-74	1196.62	284.89
1974-75	13Ø2.94	31Ø.21
1975-76	1812.27	431.57
1976-77	1592.99	379.27
1977-78	1785.61	424.89
1978-79	18Ø2.97	429.26
1979-8Ø	1952.Ø1	464.75
198Ø-81	2Ø35.55	484.63
1981-82	2119.Ø9	5Ø4.52
1982-83	22Ø2.62	524.41
1983-84	2286.16	544.3Ø
1984-85	2Ø67.43	492.22
1985-86	2699.17	642.63
1986-87	2578.29	613.85

Source: Statistical Abstract,B E S,Karnataka

When the situation in Karnataka is compared with Punjab, it can be pointed out that Karnataka offers a good scope for increasing the fertilizer consumption with further increase in HYV coverage.

SIZE OF LAND HOLDINGS

It is sometimes assumed that the level of fertilizer application was directly proportional to the size of the farm.This is based on the assumption that the farmers may not be able to grow crops profitably due to the non-existence of economies of scale,and that they may prefer farm yard manure over chemical fertilizers.However, there are studies indicating that small farmers do use fertilizers optimally. One reason attributed to this pattern is the full utilisation of land through intensive operations on account of the small size of holdings. It is unlikely that land may be kept fallow and the cropping intensity would be high compared to the large farms. The incidence of land

being kept fallow increases with increase in farm size. Small farmers tend to use more of current inputs (labour,fertilizer,etc,) per acre. In situations characterised by constant returns to scale,(as indicated in studies such as Pranab Bardhan's study on size and productivity) the farmer in order to maximise his expected income, devotes a larger amount of labour per acre since his absolute risk aversion decreases but relative risk aversion does not decrease with increase in income and wealth[9]. The small farmers tend to have intensive cultivation because, they give more importance to productivity. In the case of large farmers, who are also to a certain extent subsistent, may not necessarily give too much importance to productivity since they may be following a less intensive cultivation practices. Users with high levels of fertilizer consumption generally have smaller farms due to two reasons. Firstly, the small farmers have to produce enough food for the family requirements since they cannot purchase them at the market. Secondly the farmers are in a position to provide closer supervision to the farm operations and thus gain more confidence in the use of fertilizers. To strengthen the idea, we can notice in Table 5.12 that the application of fertilizer per hectare of cropped area increases with decrease in the size of land holding. In a farm level study it has been found that people who own pump sets for irrigation tend to have a higher level of application of fertilizer than the farmers having canal irrigation[10].

---

[9]Pranab.K.Bardhan,"Size,Productivity and returns to scale:An analysis of farm-level data in Indian Agriculture";Journal of Political Economy,pp1370-86.

[10]K Subba Rao,"State policies and regional disparity in Indian agriculture",Development and Change, (Sage, London, Benerly and New Delhi) Vol 16, 1985, pp 523-546.

Table 5.12
Fertilizer consumption per hectare of fertilized area

size of holdings (hectares)	Number of users (%)	Area fertilized (percentage)	Consumption (in kgs/ha)
< - 1	47.4	46.Ø	169.1
1 - 2	52.5	43.Ø	131.7
2 - 4	57.6	4Ø.4	1Ø6.3
4 - 1Ø	43.Ø	26.6	97.4
1Ø - >	44.2	26.5	39.5
State	49.9	33.4	1Ø4.6
All India	4Ø.5	33.5	79.5

Source: Fertilizer demand study - 1975-76,NCAER.

The percentage of area fertilized gets reduced as the size of the farm increases and the rate of application is also decreasing with the increase in the farm size. The rate of application at all-India level also shows similar pattern as that of Karnataka. However, Karnataka has fared better compared to the All-India average. But the important factor to be discussed is that in both cases,the level of application has been decreasing with increase in the size of the farm.

SALE POINTS

The sale points here refers to the sale points of fertilizers (also called as outlets) which includes the co-operatives, private dealers, agro-kendras, etc,. The hypotheses we make here is that sale points would increase the use of fertilizers by making fertilizers available at more convenient locations to the farmers, in terms of spatial diversification. It can be visualised that with sale points nearer to the farmers, the chances of fertilizer application is increased. This is particularly applicable in the case of small farmers. The sale points, generally privately owned one's tend to be concentrated

in the cities or big towns nodal points due to the transportation facilities especially access to railway stations.

Between 1976-77 and 1986-87, the number of sale points increased by about 25 per cent from 7251 to 9017(for further details on number of sale points, refer appendix 3). The number of villages served by a sale point has decreased from 4.47 in 1977-78 to 3.71 in 1986-87.

It may be interesting to analyse whether the relationship between the sale points and fertilizer consumption is supply determined or demand determined. As indicated earlier, the demand for fertilizers is determined by input response function and the relative price of fertilizer to crops. In the case of small farmers the mixture of organic and inorganic fertilizer would depend on the relative price and accessability. Given the demand the actual consumption would depend on the availability of the commodity at the right time and right place. This is where the sale points play an important role. In Gujarat, the supply push factor has been more effective than demand pull factor. In 1981, Gujarat had 325 outlets per district and each sale point covering less than three villages, as compared to about five villages at the all-India level. It could be argued that the number of sale points would increase with the increase in the sales of fertilizers. It is more of a natural process as a part of the marketing strategy. Table 5.13 compares the gross cropped area coverage by each sale point for Karnataka and all-India. The cropped area covered and the amount of fertilizer sold per sale point have been higher in Karnataka as compared to all-India averages. The number of villages covered by each sale point

decreased between 1978 and 1987. The district wise changes can be noticed in Table 5.14.

Table 5.13 Fertilizer Consumption

Year	KARNATAKA		ALL-INDIA	
	GCA/sale point	NPK/sale point	GCA/sale point	NPK/sale point
1982-83	1694	57.9	1539	55.6
1983-84	1435	62.3	1353	58.9
1984-85	1349	69.4	1237	56.3
1985-86	1274	61.7	1158	56.1
1986-87	1228	60.5	1124	54.7

Comparing the number of villages served by a sale point between the periods 1978 and 1987 in the state, we find a decrease in ten districts, marginal increase in five districts and more or less stagnancy in rest of the four districts.

Table 5.14 District wise distribution of Sale points

Districts	Number of sale points		Number of village per sale point	
	1978	1987	1978	1987
BANGALORE	704	439	3.77	6.05
BELGAUM	840	844	1.40	1.39
BELLARY	318	435	1.93	1.41
BIDAR	96	234	6.45	2.65
BIJAPUR	479	340	2.67	3.77
CHIKMAGLUR	233	391	4.77	2.84
CHITRADURGA	283	348	5.23	4.26
DAKSHINA--KANNADA	147	559	4.32	1.13
DHARWAD	632	1028	2.15	1.32
GULBARGA	207	395	6.69	3.51
HASSAN	263	340	9.77	7.55
KODAGU	234	189	1.26	1.56
KOLAR	530	472	6.27	7.04
MANDYA	356	566	4.15	2.61
MYSORE	319	826	5.75	2.22
RAICHUR	379	598	3.99	2.53
SHIMOGA	402	466	4.91	4.24
TUMKUR	507	344	5.37	7.93
UTTAR --KANNADA	322	203	4.15	6.59

Sources: 1. Fertilizer and agricultural statistics
2. Statistical abstract, Karnataka.

The effect of sale points on fertilizer consumption was analysed using cross-section data for four time periods, i.e.,1970-71, 1975-76, 1980-81 and 1985-86. There was a positive correlation between the variables, insignificant in the first periodand but later the linkage seem to have got strengthened and thus was significant in the other three periods. The results of the statistical analysis between fertilizer consumtion and sale points given in table 5.15, indicates that to a certain extent it influenced the consumption of fertilizers. However, this conclusion is debatable, because of the cause-effect relationship.

Table 5.15
Correlation coefficient between fertilizer consumption and number of sale points

Year	Corr.Coeff.	R^2	2-T test	D-W Stat.
1970-71	0.0260	0.000676	0.916	1.515
1975-76	0.5293*	0.237802	0.020	1.417
1980-81	0.7855**	0.594510	0.000	1.568
1985-86	0.7524**	0.540537	0.000	1.794

Note: * significant at 10 % level
** significant at 01 % level

Government policies : Subsidies on Fertilizers and other inputs

At the All-India level, the subsidies to agriculture increased from Rs 7203 million in 1974-75 to Rs 15838 million in 1980-81(refer appendix 4). But the share of subsidy to agriculture in the total subsidies decreased from 94 per cent in 1974-75 to 62 per cent in 1980-81(refer appendix 4). In particular, the fertilizer subsidy increased by nearly 36 times between 1970-71 and 1982-83 at current prices and 13 times at

constant prices as per table 5.16. In Karnataka, the subsidies on fertilizer increased by nearly 25 times between 1970-71 and 1982-83 from Rs 1.25 crores in 1970-73 to 30.58 crores in 1980-83(refer table 5.17). According to Subba Rao[11], the distribution of subsidies have not been done systematically and there exists a regional disparity.

Table 5.16
All-India Fertilizer subsidy

Year	Current Prices (Rs.Crores)	Constant Prices (Rs.Crores)
1970-71	17	17
1971-72	20	19
1972-73	18	15
1973-74	33	22
1974-75	371	201
1975-76	242	149
1976-77	122	79
1977-78	266	157
1978-79	342	200
1979-80	603	313
1980-81	505	231
1981-82	375	154
1982-83	605	222

Source: Table 1.column 1,2,3.
Chotan Singh and Puran Chand (1988), IJAE:41:4 pp637-38

Table 5.17 Fertilizer subsidy in Karnataka (Rs.crores)

Year	Current Price	Constant Price
1970-73	1.25	1.16
1975-78	13.67	8.36
1980-83	30.58	12.59

Source: Table 2(a), row 6.
Same as in table 5.16

*

[11] K.Subba Rao; "State policies and regional study in Indian Agriculture", Development and Change, 1985,Vol16, pp523-544.

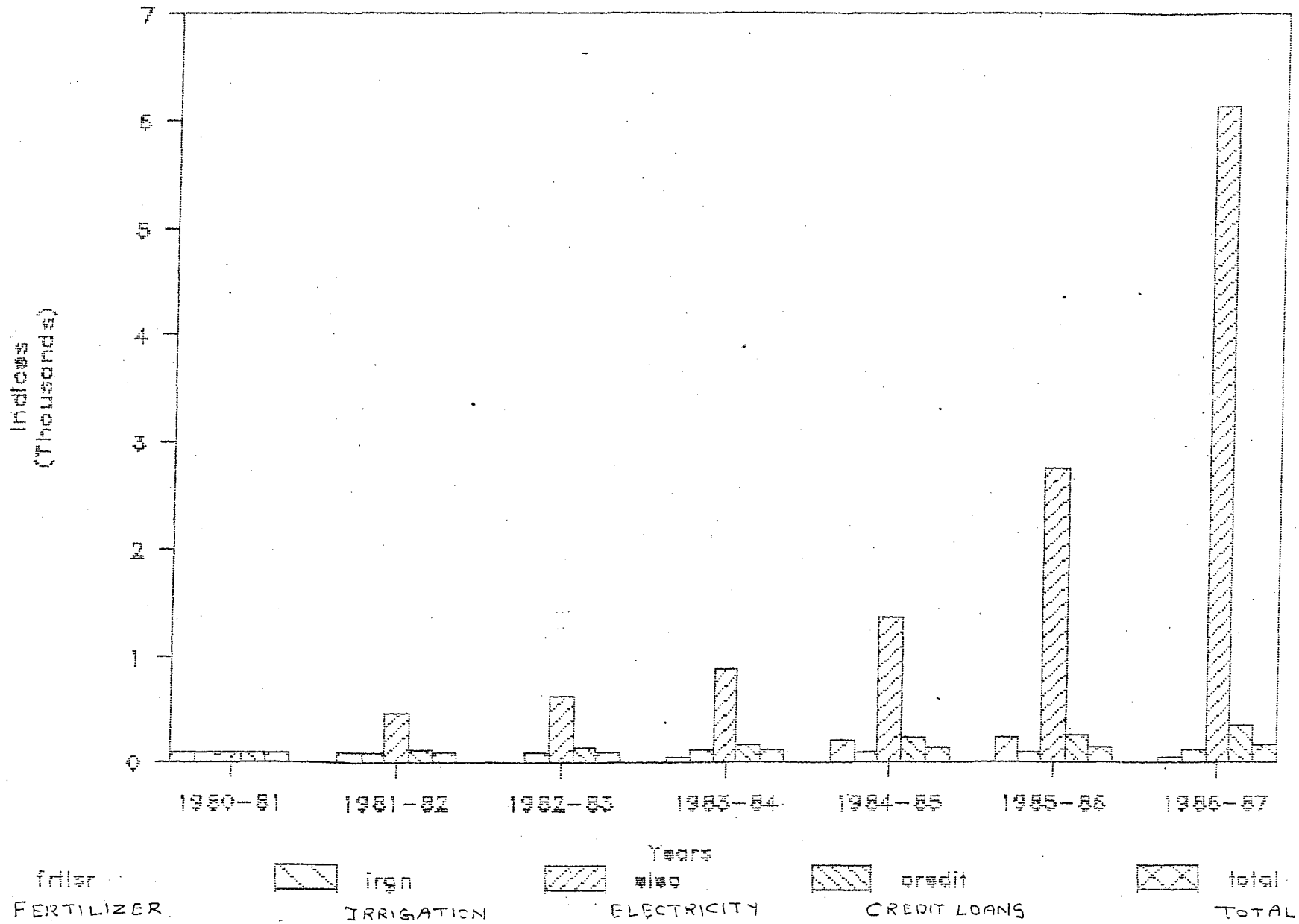
As per the Inter-state analysis, four states namely, Uttar Pradesh, Punjab, Andhra Pradesh and Tamil Nadu account for Half of the nation's gross sown area and claimed 55 per cent of total subsidy. Where as five states namely, Madhya Pradesh, Rajasthan, Bihar, Orissa and West Bengal with 4Ø per cent of India's gross sown area and 2Ø per cent of irrigated area claimed only 15 per cent of the total subsidies.

In Karnataka, the subsidy on agricultural inputs increased tremendously (refer appendix 5). If we examine the subsidy on the different inputs between 198Ø-81 and 1986-87, the highest percentage increase has been for electricity and then on credit followed by fertilizer subsidy. The same could be visualised from the graph 5.5 & graph 5.6. There was a sharp decrease in the subsidy for fertilizers from Rs 389.86 million to Rs 39.8 million in the year 1982-83 but did not affect the consumption to a large extent but the increase in the subsidy during the year 1983-84 from Rs 39.8 million to 215.Ø3 million made an impact in the consumption and after 1984-85 there had been a decline in the total consumption of fertilizers.

GRAPH 5·5

Subsidies for Agricultural inputs

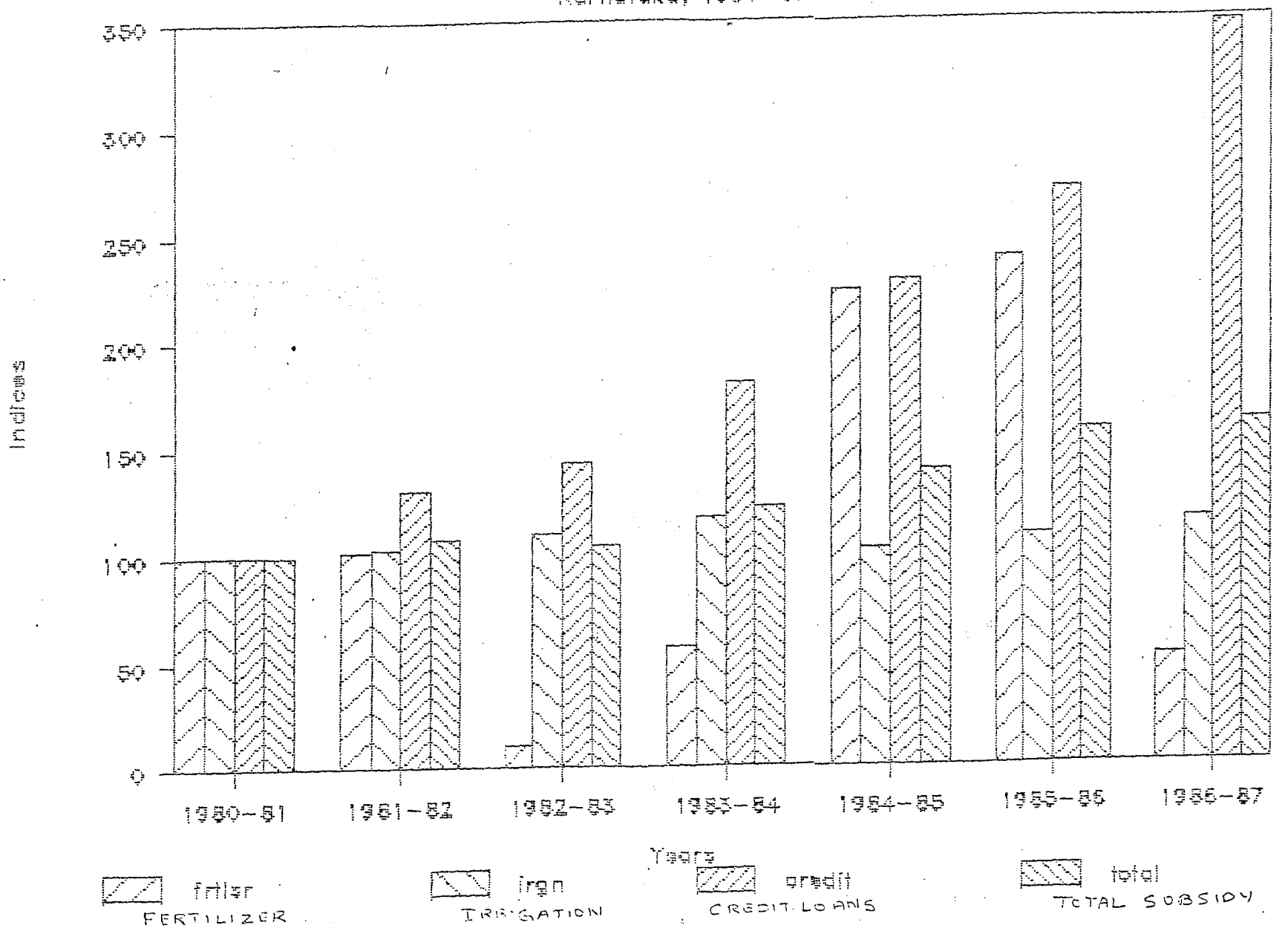
Karnataka, 1980–87



GRAPH 5.6

Subsidies for Agricultural inputs

Karnataka, 1980–87



Chapter Six

ANALYSIS OF THE COMPLETE MODEL

In the previous chapter, each of the variables has been analysed individually and their effect on the consumption of fertilizers were assessed. However, it is interesting to analyse the influence of these variables when considered together. This chapter provides the results of the analysis when the variables are jointly considered.

Annual data on a number of variables influencing fertilizer consumption and the variables are plotted in graph 6.1 and graph 6.2. First the time series data is explained through the graphs and then the results obtained through statistical analysis is explained. Later the cross-section analysis results for four time periods are explained.

Description of the model:-

In order to identify the relationship between the fertilizer consumption and the various factors affecting the same, log-linear model was formulated based on the time series data.

$$Ln(F) = C + \Sigma C_i * \ln(V_i) \quad (i = 1,2,...9)$$

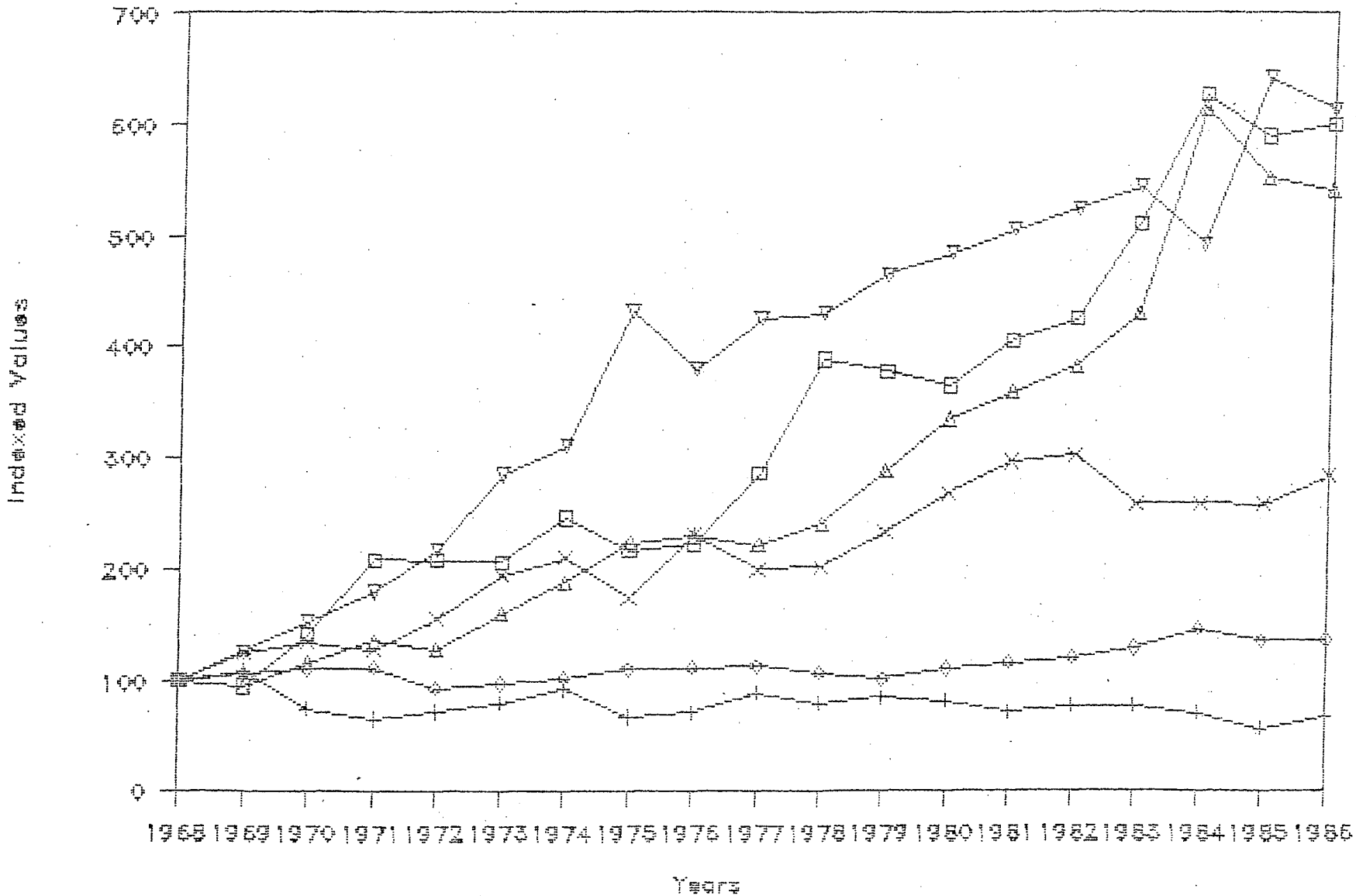
where

V_1 = Total annual rainfall
V_2 = Gross irrigated area
V_3 = Institutional loans advanced
V_4 = Fertilizer prices
V_5 = Harvest prices of crops
V_6 = Total area under HYV's
V_7 = Total number of sale points
V_8 = Total agricultural production
V_9 = Gross cropped area

GRAPH 6·1

Growth Comparison of

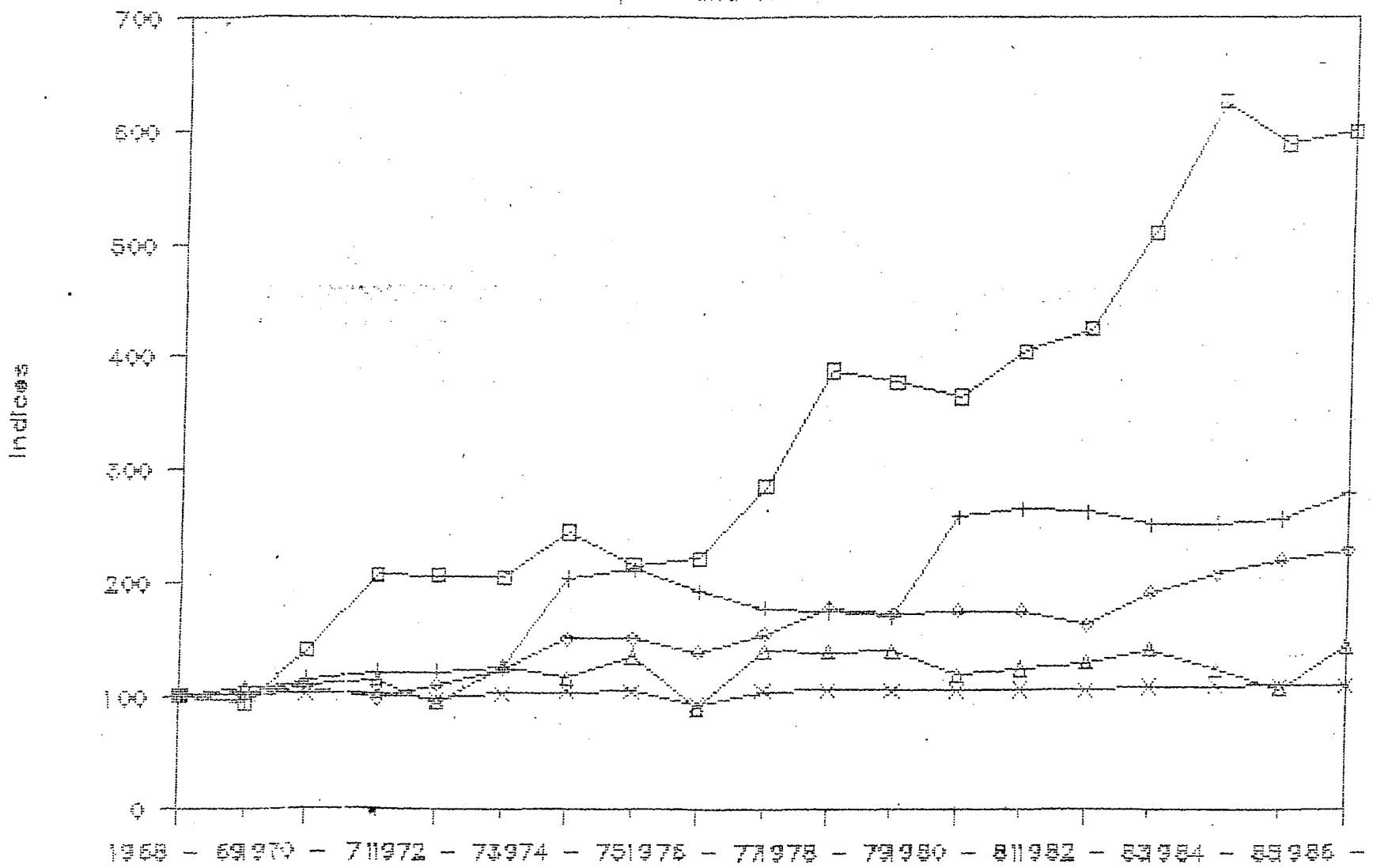
Fertiliser and other variables



GRAPH 6.2

Growth comparison of fertilizer

consumption and other variables



To begin with, each of the variables was found to be highly correlated with fertilizer consumption except rainfall which shows a negative relationship. From the multiple correlation matrix it can be observed that there exists a high degree of multicollinearity. In a five year moving average curve, the year to year fluctuations are smoothened which is only helpful to set a trend. This is because fertilizer consumption is not influenced by any one set of variables through out the period but in each phase[12] different variables have influenced. The index of the explanatory variables based to 1968-69 data represented in the graph for 1968-69 to 1970-71 indicates that there has been a sudden increase in the fertilizer consumption which was quite stagnant till 1975-76. From 1976-77 to 1978-79 there has been a slight increase in the consumption and a decline till 1980-81 after which there has been a steep increase in the consumption rate. The growth of the explanatory variables also do not show a consistent pattern. In the late sixties and early seventies, the green revolution had just set in and the area under high yielding varieties was on the increase. The diffusion of knowledge about the latest technology usually takes place at a slow rate. Initially, the progressive farmers with large holdings generally take up such tasks and in particular in the irrigated areas. The crop price movements indicate that from 1968-69 to 1971-72 there was no improvement in the crop prices. From 1971-72 to 1976-77 the fertilizer consumption was more or less stagnant. The reason is that during the initial stages, with the increase in the use of HYV's, the production of crops goes up with crop

---

[12] If the fertiliser consumption curve could be divided into several phases which is described in the text later.

price remaining the same, early adopters of HYV, often large farmers benefit from this process. As the supply of the commodity increases more than proportionate to demand, price decreases. Hence, the crop prices tend to stagnate or decrease. At the same time, the diffusion of new technology percolates down from the large farmers to the small and medium farmers. However, the small and medium farmers might find it difficult to make full utilisation of the desired level of fertilizer application on account of their credit position. Hence, the consumption also tend to stagnate. The almost stagnant crop prices started increasing from 1971-72 onwards. The fertilizer prices were also on the increase till 1974-75. During 1974-75 crop prices reached a peak level and the favourable rainfall situation encouraged the farmers to avail themselves of the loan facilities for the purchase fertilizers. There had been a set back in the consumption of fertilizers in 1975-76 and 1976-77 because of the decrease in rainfall, crop prices and net area sown. At the same time the fertilizer prices were on the increase. The prices of major food crops including paddy, wheat and bajra showed a decline. By 1976-77 effect of green revolution had subsided. Though the area under HYV's was increasing, the composition was not changing. The percentage of area under bajra and maize grew at a faster rate than paddy and wheat. But this did not reflect upon the acreage. Between 1976-77 and 1979-80, the amount of loans, rainfall and irrigation did not show much importance. One reason is that, irrigation does not have its effects directly since, it is an important complementary input. Loan amount was not found to be significant in this period till mid seventies as per the year to year fluctuations seems to be moving in opposite

directions. More over in the initial stages, the expansion of banks in the rural areas had just begun after the nationalisation in 1969. It was only later that importance was given to the agricultural sector and the subsidies to institutional credit got a boost.

During the later half of the study period i.e.,1976-77 to 1984-85 the fertilizer consumption showed a steep increase and then a decline to 1986-87. During this period the influence of loans and high yielding varieties had been quite effective. The area under irrigation had increased with coming up of new irrigation projects. From 1976-77 onwards, the fertilizer prices showed a decline. A decline in prices together with increase in irrigation have created effective demand for fertilizers.

Between 1975-76 and 1978-79, the fertilizer price indicated a declining trend and fertilizer consumption levels had increased. After 198Ø-81 the loans has been an influential factor. The co-operatives and other credit agencies issuing crop loans followed the scheme on 6Ø : 4Ø ratio basis,wherein, 6Ø per cent of the loan is issued in kind and 4Ø per cent in cash. This is a form of incentive to the farmers to use the modern inputs. Along with this the subsidies on credit were on the increase(refer table 5.18). After 1982-83 there was a decline in the crop prices, but this did not affect the use of fertilizers. This could also be due to the decline in the fertilizer prices. After 1984-85 there is decline in the fertilizer consumption. Loans seem to have had a considerable influence and to some extent rainfall too. From 1982-83 to 1985-86 there was a steep increase in the subsidies for fertilizers. In 1983-84 the subsidies increased from Rs 39.8 million to Rs 215.Ø3 million and it

further increased to Rs 847.27 million in 1984-85. This is very well reflected in the fertilizer consumption curve.

Thus, we could see that different factors influenced the consumption of fertilizer at different periods of time. A multiple regression analysis was carried out including rainfall, irrigation, crop prices, area under HYV's, credit advance, number of sale points, yield, total production and gross cropped area. In the partial analysis, the use of agricultural implements and machineries which includes pump sets, tractors, threshers,etc., was dealt. Since the data on the machineries and implements are not available over time this item is not included in the model. Regarding the prices of crops and fertilizers, the relative price of fertilizer to crops did not show a high correlation. The increase in the prices of both have been almost at the same rate(the index of crop price with base 1968-69 was 283 and the fertilizer price index with same base was 280). Fertilizer price is, moreover, a controlled one. So, crop prices has been included in the model.

The result from the model indicates that, area under high yielding varieties, crop prices and gross cropped area had influenced the use of fertilizers. Due to the presence of multicollinearity, different relevant variables were tested. and it was found that fertilizer consumption, crop prices and gross cropped area influenced the use of high yielding varieties. The yield was mainly dependent on the use of HYV's and therefore, the influence of HYV's on the use of fertilizers is established.

The model explains the level of fertilizer consumption as a function of changes in availability of water through rainfall or/and

irrigation, extent of high yielding variety used, accessibility of fertilizer, area under superior cereals and commercial crops, and the

Table 6.1 Results of Time series Analysis

Variable	Coefficient	T- STAT.	2-Tail Sig.	Correlation Coefficient
Rainfall	-Ø.7Ø68	-2.2Ø7	Ø.Ø52*	-Ø.5416
Irrigation	-1.7684	-2.469	Ø.Ø33**	Ø.677Ø
Loans	1.13Ø3	3.442	Ø.ØØ6***	Ø.9551
Fertilizer prices	-Ø.74Ø3	-2.281	Ø.Ø46**	Ø.8721
Crop prices	1.1521	2.496	Ø.Ø32**	Ø.8784
HYV's	Ø.7271	-1.816	Ø.Ø99*	Ø.9181
Sale points	Ø.8367	1.552	Ø.152	Ø.92Ø3

* - Significant at 1Ø % level; ** - Significant at Ø5 % level and *** - Significant at Ø1 % level.

total cropped area. The results are presented in table 6.1. Almost all the explanatory variables were found to be statistically significant. For instance, the fertilizer consumption is found to have a negative relationship with rainfall. This tallies with our original hypotheses. As mentioned in chapter five, irrigation has a significant positive relationship with fertilizer consumption. But when it is considered in the multi variable model, it does not show the required result. One reason could be that the growth rate was very low compared to other variables which were more significant such as the loans which shows a high positive correlation coefficient. The correlation coefficient for irrigation is Ø.677Ø compared to Ø.9551 for loans. The relative price of fertilizer and crops did not show a show a significant relationship with fertilizer consumption. This is also well observed in the figure 6.2. Crop prices and fertilizer prices when taken separately in the model, showed significant relationship, i.e., fertilizer prices were negatively related and crop prices were positively

related. These two results tally with the original proposition. This shows that the relative price was not a major factor influencing the use of fertilizer mainly because of the some what similar movements in both the prices. Thus it appears that the farmers were influenced by, profit maximisation rather than cost minimisation. The farmers had gone in for extensive use of HYV's. Between HYV's and crop price the correlation is very high, the coefficient being Ø.9356. The effect of HYV's on irrigation has not been shown very well in the correlation matrix. Here the government's role in the price fixation had given a boost to the farmers. The sale points which has had a positive correlation with fertilizer consumption was not a significant variable.

A correlation matrix of the variables show very high correlation among variables. There exists a very high correlation between HYV's and crop price but with irrigation it has not been very significant. The effects of other explanatory variables on yield and production show that fertilizer and the response in terms of yield are important factors influencing the use of high yielding varieties. The loan amount are also seem to have an influence to a certain extent. Productivity is mainly dependent on the use of fertilizers.

The relationship among fertilizer consumption and other explanatory variables was specified as

$$Ln(F) = C + \Sigma C_i * \log(V_i) \quad (i = 1,2,...7)$$

where,
V_1 = Rainfall
V_2 = Irrigation
V_3 = Loans
V_4 = Fertilizer prices
V_5 = Crop prices
V_6 = HYV's
V_7 = Sale points

The estimated equation was

$$\ln(F) = 11.1524 + -Ø.366\ln(V_1) + -Ø.716\ln(V_2) + Ø.978\ln(V3) + -Ø.433\ln(V_4) + Ø.Ø87\ln(V_5) + Ø.156\ln(V_6) + Ø.193\ln(V_7)$$

$R^2 = Ø.963947$ Adjusted $R^2 = Ø.938ØØ9$

D-W Statistics =2.362247

Apart from the points explained in the above paragraphs there are certain Institutional factors influencing fertilizer consumption. In 198Ø, an organisation was formed to cater to the services of the farmers in the rural areas known as the **Farmer's Service Society** (FSS). During the same year 346 societies were opened all over the country of which 1Ø5 were located in Karnataka itself[13]. FSS is a new credit institution works on co-operative lines for the benefit of weaker section in the rural areas. The services rendered by the FSS include, (a) credit advancement (b) agricultural extension (c) custom service (d) supply service and (e) consumer service. The credit advancement includes short and medium term loans at a very low interest rate. The custom service refers to hiring of agricultural implements to small farmers at a cheap rate. For example, the hiring charges for tractors is Rs 3Ø/- per day and sprayers at Rs 4/- per day. Fifty per cent discount is given to the members of the society. Supply service includes supply of all the necessary inputs including fertilizers, seeds, plant protection chemicals, farm implements, etc,. For the members fifty per cent of the short-term crop loans are issued in kind, i.e., inputs and the rest of the fifty per cent in terms of cash. The non-members can purchase them with ready cash. The consumer service refers to the supply of house hold articles including rice, wheat, sugar, kerosene, clothes,

---

[13] refer to appendix.6 for district wise distribution of societie in the state.

etc,. So, the existence of such a system gives a boost to the farmers to use of all the agricultural inputs. As explained about the extension service by the department of agriculture, Karnataka government(refer chapter 4), the agricultural extension which includes the T & V system gives training to the staff known as 'Agricultural Assistants' on the latest technology development in the field of agriculture by the local agricultural university staff. These Agricultural Assistants in turn go over to the villages and diffuse the information to the progressive farmers. Each Agricultural Assistant has to cover 800 farm families in un-irrigated regions, 400 farm families in the irrigated regions and 250 farm families in the hilly regions, per month respectively. There is an Agricultural officer for each taluk and are located in the taluk head quarters. The Agricultural Assistants generally have their establishments in the villages itself for convenience. Thus we find that the Agricultural Extension Department has a well established network in the state and therefore the diffusion of knowledge on matters related to agricultural practices can be effectively organised. The other institutional factor is the existence of organised agricultural markets where all the agricultural commodities can be sold by the farmers generally above the farm gate prices. Karnataka has a very well established regulated markets for the sale of agricultural commodities including food crops, non-food crops, fruits and vegetables. These markets are situated in the taluk head quarters and the sub-markets in the villages and village head-quarters. Data regarding the distribution of regulated main and sub-markets among the districts for the year 1986-87 is avalable in appendix7.

To sum up the Institutional factors such as the agricultural extension, marketing facilities and existence of other agencies such as the FSS would directly or indirectly help in the growth of fertilizer use.

District wise cross-section data analysis

In order to verify the validity of the results obtained from the analysis of cross-section the time series data, cross-section data for four time periods i.e., 1970-71, 1975-76, 1980-81 and 1985-86 were used. Six independent variables, namely, rainfall, irrigation, farm machineries, area under high yielding varieties, number of sale points and average farm size were analysed against fertilizer consumption. The crop prices and fertilizer prices are assumed to be the same in all the districts.

Table 6.2 gives the district wise data on the fertilizer consumption and other related variables describing the variations in the fertilizer consumption and other variables among the various districts[14]. The data on fertilizer consumption refers to consumption per hectare of cropped area. From the above table we notice that the district of Mandya has the highest per hectare consumption of fertilizer followed by Kodagu. There are eight districts which have consumption levels above the state average. High consumption of fertilizer use in Mandya district can be explained with the fact that it has 39.41 per cent of its cropped area irrigated and 55 per cent under HYV's. The major crops (Paddy and Sugarcane), both are fertilizer intensive crops. The sale points also seem to be an influential factor as we can notice that

[14]The figures in Table 6.2 are calculated based on data from "Karnataka at a glance", statistical abstract of Karnataka for the year 1986-87.

the area covered by each sale point is least among the districts with 378.68 hectares compared to the state average of 1193.42 hectares. In Kodagu district due to its geographical conditions favours the cultivation of plantation crops in addition to food crops.

Table 6.2 Inter-district variations of fertilizer consumption and other explanatory variables 1985-86

District	Frtslr Consmn (kgs/ha)	Rainfall (in mms)	Irgn (% gca)	Loans (Rs/gca)	Hyv (% gca)	Sale Points (Ha/Slpt)	Farm Size (ha)
Bangalore	73.22	923.5	15.50	132.79	49.17	719.30	1.611
Belgaum	60.50	596.5	24.59	229.01	20.47	1066.31	2.601
Bellary	96.00	665.2	25.50	1592.07	37.47	1006.61	2.949
Bidar	16.95	702.2	07.80	207.03	10.54	1322.95	3.386
Bijapur	17.77	518.1	12.99	69.78	12.09	3711.36	4.254
Chikmaglur	79.99	1833.5	10.39	147.84	31.50	707.82	2.211
Ch.durga	53.27	657.9	20.60	59.64	41.71	1187.39	2.891
Dak.Kanara	54.42	3367.7	39.63	1525.97	37.00	367.27	1.201
Dharwad	36.67	735.7	09.94	114.45	19.30	1014.77	3.144
Gulbarga	10.93	783.9	03.35	16.40	04.13	3715.26	3.874
Hassan	86.26	979.0	13.66	30.96	38.89	1040.74	1.544
Kodagu	109.13	2294.4	02.57	625.36	19.95	820.11	3.253
Kolar	53.97	696.9	21.99	64.98	33.18	859.66	1.607
Mandya	134.67	850.9	39.41	271.49	55.83	378.69	0.964
Mysore	71.74	786.7	20.70	85.84	33.07	667.31	1.489
Raichur	58.34	600.2	15.40	66.95	25.24	1821.04	3.465
Shimoga	96.50	1270.5	45.72	117.92	62.54	691.60	1.894
Tumkur	31.67	773.8	13.30	96.95	22.23	1063.89	1.820
Utr.Kanara	35.41	2089.1	18.07	641.64	42.85	512.84	1.161
State	61.45	1108.5	18.97	320.37	31.43	1193.42	2.390

Source : Bureau of Economics and Statistics,Karnataka.

Thus the consumption level is comparatively higher. However, the cropped area is comparatively small, the area of the districts itself being small, In the case of Gulbarga district, which has a fertilizer use of 10.93 kgs/ha (least in the state) several constraints affect the use of fertilizers. Only 3.35 per cent of its cropped area is irrigated and the annual rainfall is 783.9 mms. As a consequence of this only 4.13 per cent of its cropped

area is under HYV's. One sale point covers 3715.25 hectares of cropped area which is very much higher than the state average value. So, here we find that irrigation is the major constraint for the use of fertilizers. Rainfall is equally unfavourable. Similarly Bidar and Bijapur come under the same category of Gulbarga. The districts of Hassan and Shimoga have high percentage of area under HYV's. In Shimoga district, irrigation plays a major role but the average fertilizer consumption tends to be less than in Mandya because of the very high rainfall which would wash away the nutrients from the soil.

The cross-section analysis has been done for four points of time i.e., 1970-71, 1975-76, 1980-81 and 1985-86. For the year 1970-71, irrigation alone happens to be the major factor influencing the fertilizer consumption. As per the correlation matrix, farm size has had a negative correlation with fertilizer consumption. The analysis of the 1975-76 data also indicates irrigation to be a lone significant factor influencing the use of fertilizers.. Rainfall and farm size, though not significant factors, did not have negative relationship. Where as in the second period, it had a negative correlation with fertilizer consumption. In 1980-81, sale points alone was the major factor determining the fertilizer consumption. Farm size and rainfall were found to have a negative relationship. The negative relationship between farm size and fertilizer consumption implies that small farmers have a higher level of application per hectare of cropped area than large farmers. This is also noticed in the NCAER(1974) study on demand for fertilizers(refer table 5.13). With 1985-86 data, farm size and sale points were found to be

significant and rainfall had a negative relationship with fertilizer consumption. The results of the cross section analysis is given in the table 6.3. Comparing the cross section and time series data we notice that irrigation had been a significant factor influencing the use of fertilizers in the first half of the study period inspite of the fact that the irrigation increased only during 1980's. Sale points had indicated an influence on the fertilizer consumption during the years 1980-81 and 1985-86.

Table 6.3 Results of the analysis based on district wise data

(a) 1970-71 data

Variable	Coefficient	T-Stat	2-Tail Sig	Corr.Coefficient
Irrigation	1.3044833	3.5601	0.004	0.7355187
HYV's	-0.3188364	-1.2688	0.229	0.5241820
Farm Machineries	-0.0862509	-0.4599	0.654	0.3105671
Rainfall	0.0325077	0.1394	0.890	0.3408755
Sale Point	-0.4083495	-1.7043	0.114	0.0259953
Farm Size	0.3667133	1.0582	0.311	-0.1801952

(b) 1975-76 data

Variable	Coefficient	T-Stat	2-Tail Sig	Corr.Coefficient
Irrigation	1.2238263	3.8512	0.002	0.8914400
HYV's	0.0356232	0.1137	0.911	0.6780277
Farm Machineries	-0.1102329	-0.6606	0.521	0.4369922
Rainfall	-0.4087555	-1.6454	0.126	-0.6288824
Sale Point	-0.1424363	-0.5227	0.611	0.5292885
Farm Size	-0.2426748	-0.9797	0.347	-0.1620633

(c) 1980-81 data

Variable	Coefficient	T-Stat	2-Tail Sig	Corr.Coefficient
Irrigation	Ø.1298460	Ø.3639	Ø.722	Ø.6741639
HYV's	Ø.1185602	Ø.5996	Ø.560	Ø.6441128
Farm Machineries	-Ø.2192568	-1.Ø740	Ø.3Ø4	Ø.24Ø3658
Rainfall	-Ø.1686479	-Ø.5457	Ø.595	-Ø.3852320
Sale Point	1.Ø849733	2.4115	Ø.Ø33	Ø.7855170
Farm Size	Ø.1911522	Ø.6299	Ø.541	-Ø.Ø923813

(d) 1985-86 data

Variable	Coefficient	T-Stat	2-Tail Sig	Corr.Coefficient
Irrigation	-Ø.Ø757504	-Ø.3475	Ø.734	Ø.6618563
HYV's	Ø.5922798	1.9Ø51	Ø.Ø81	Ø.8161694
Farm Machineries	-Ø.2651977	-1.9421	Ø.Ø76	Ø.2373470
Rainfall	-Ø.1385487	-Ø.7173	Ø.487	-Ø.6107146
Sale Point	1.Ø747223	3.4685	Ø.ØØ5	Ø.7523712
Farm Size	Ø.4429785	2.197Ø	Ø.Ø48	Ø.1953696

Comparing the cross section and time series data we notice that irrigation had been a significant factor influencing the use of fertilizers in the first half of the study period inspite of the fact that the irrigation increased only during 1980's. Sale points had indicated an influence on the fertilizer consumption during the years 1980-81 and 1985-86. This could be due to the fact that branches of institutional agencies like FSS and Co-operatives were opened in the rural areas during this period. Loan amount was found to be significant across the

districts, for example, Bellary, the highest loans obtained per hectare of cropped area of Rs 1592 and had a fertilizer consumption of 96.Ø8 kg/ha, being the second highest in the state. Rainfall had a low degree of correlation with fertilizer consumption except for the year 1985-86 where we find a significant relationship.

Chapter Seven

SUMMARY AND CONCLUSIONS

Agriculture is the largest sector in the Indian economy in terms of its contribution to the national income. The objective of increased agricultural production could be achieved by emphasising on an extensive approach depending on area expansion or intensive approach depending on yield increases. However, the scope for bringing more area under cultivation is limited and therefore emphasis on intensive methods of cultivation emphasising on changes in cultural practices achieve a great significance. Since fertilizer is a major input in the cultural practices, it has a special role. The level of fertilizer consumption would depend on three issues; whether to apply the fertilizers, which crops to be fertilized and the level of application for each crop fertilised. Given these three factors, the actual level of consumption would depend on the degree of accessibility - geographically and institutionally.

The agricultural development in Karnataka has taken place in a phased manner over a period of time catalysed by the technological development in agriculture. The growth in the use of "modern" agricultural inputs was quite spectacular, especially the use of HYV's and chemical fertilizers and agricultural implements and equipments.

The fertilizer consumption during the period 1968-87, experienced a high growth rate of about 1Ø per cent per annum compared to all-India average of 9 per cent per annum. In the pre-green revolution period, the fertilizer consumption experienced a slow growth and picked up from late sixties and early seventies onwards. Eight districts experienced a growth rate higher than the state average, six districts experienced a growth rate less than the state average and the remaining five districts experienced almost the same growth rate. Among the three different types of fertilizers,(N, P and K) the K type of fertilizer experienced a higher growth rate than N type and P type. In absolute terms, the consumption of N type fertilizer was the highest which was almost twice that of P type and K type.

The factors influencing the use of fertilizers has been grouped into four categories : (1) Physical factors (2) Technological factors (3) Economic factors and (4) Institutional factors. Each of these factors include a number of sub factors. The physical factors consists of mainly rainfall, irrigation and cropping pattern. While analysing the effect of rainfall on fertilizer consumption, a negative relationship was observed which is statistically significant. Across the districts, the correlation between rainfall and fertilizer consumption was significant in only five districts of which two were positive and three were negative. Though rainfall does not have a direct effect on the fertilizer consumption, indirectly it is affected through crops and seed varieties. In extreme cases of drought or high rainfall a significant change is seen in the consumption levels of fertilizer. With regard to irrigation, it

was found to have a statistically significant positive correlation with fertilizer consumption. However, high irrigated areas experienced slow growth rate of fertilizer consumption. Over a period of time no major changes in the cropping pattern was noticed across the districts, except in the case of Bellary and Raichur districts, where there was a shift in the cropping pattern towards cotton as a result of the Tunga Bhadra canal project. Paddy and Sugarcane were grown only in those areas such as Shimoga and Mandya, with high and assured irrigation or rainfall. Inspite of assured water supply the area under sugarcane is not significant, the highest being in Mandya district with 9 per cent of the total cropped area. In most of the districts ragi and jowar are mostly grown as they are basically rainfed crops.Thus changes in the cropping pattern in favour of superior cereals, pulses and cash crops such as sugarcane could have an impact on increasing the fertilizer consumption.

With regard to the sources of irrigation there had been a decline in the area under tank irrigation over time. The irrigation through canal had been increasing and nearly 35 per cent of the irrigation was through canals. Over the twenty year period from 1968-69 onwards, the share of tank irrigation declined from 28.41 per cent to 14.44 per cent. Where as the share of canal irrigation increased from 25. 73 per cent to 43.88 per cent during the same period(refer appendix 8).

Technological factors especially the use of HYV's and agricultural machineries also influnce the use of fertilizer

consumption. While the physical factors (especially rainfall and irrigation) create the potential for the use of HYV's an assured supply of these items creates further incentive in the use of HYV's. The use of HYV's was found to have a significant positive correlation with fertilizer consumption and therefore the hypothesis that fertilizer consumption increases with increase in the area under HYV's was validated. The area under HYV's increased more than six times during 1968-86 period of which superior cereals such as paddy, jowar and wheat accounted for most of the HYV coverage. Area under HYV-paddy increased from 25.6 million ha in 1965-66 to 434.6 million ha in 1975-76(about 17 times) and area under HYV-Jowar increased from 22 million ha to 510.8 million ha(about23 times) during the same period. Though the acreage under these crops had decreased, the production had increased due to to the use use of HYV's. The use of agricultural machineries has indicated an increased degree of mechanisation. The correlation matrix showed a high correlation between the use of HYV's and crop prices, indicating that crop prices gave an incentive to produce more and as a consequence the intensive crop production practices are used.

The most important economic factors mainly deals with prices of fertilizer and harvest prices of crops. The analysis indicated a negative relationship between the fertilizer prices and consumption. There was a positive correlation between crop prices and fertilizer consumption. The coefficients of both variables were found to be statistically significant.

The institutional factors that influence fertilizer consumption include the institutional crop loans, sale points, extension programmes and agricultural markets. The crop loans had been a dominating factor among the other variables influencing the use of fertilizers. Even though the growth in the advancement of loans was very high, in absolute terms the amount of loans advanced was much below the farmer's requirement. The average loan per hectare of cropped area was Rs 124 compared to a minimum requirement varying between Rs 925 to Rs 1650. The sale points had a positive correlation but it was not a significant one when analysed in the complete model. The number of sale points did not increase substantially over time, infact, the number of co-operatives had been declining over time. The agricultural extension programme is well structured in Karnataka to diffuse the information on latest agricultural practices. The T & V system has been functioning quite efficiently. The diffussion of market information to the farmers(which includes the prevailing prices of specific crops, the supply of those crops in terms of quantity that was made available in the market,etc.,) is yet to be developed. The agricultural marketing is done through the regulated markets(main markets in the cities and big towns and sub market in the villages and small towns) which are spatially spread into the rural areas.

The government policies includes the agricultural commodity's price fixation, fixation of prices for fertilizers, subsidies, etc,. For the purpose of the study, the role of subsidies towards agricultural sector in general and inputs in particular was considered. The share of subsidies towards

agriculture in the total subsidies decreased over time but in absolute terms there was an increase at all-India level. In Karnataka the subsidies on fertilizers increased nearly eleven times between 197Ø-73 and 198Ø-83 at constant prices. Between 198Ø-81 and 1986-87, the subsidies declined from Rs 38Ø million in 198Ø-81 to Rs 39.8 million in 1982-83 increased to Rs 9Ø5 million in 1986-87. Subsidy on credit and electricity were consistently increasing. Subsidy on irrigation increased from Rs 453 million in 198Ø-81 to Rs 1576 million in 1986-87. The highest growth experienced was for electricity, nearly 61 times from Rs 11.25 million in 198Ø-81 to 691.24 million in 1986-87. This must have been provided as an incentive for the farmers to use irrigation pumpsets and other power driven equipments which inturn might have provided an incentive to use fertilizers.

SOME POLICY IMPLICATIONS

To increase the demand for fertilizer and its consumption, it is important to create potential demand and to translate the potential into effective demand. Based on the analysis of different variables and their effects on the fertilizer consumption certain policy implications can be derived. Since the main objective of the state plans is to increase the agricultural production initially the focus should be on evolving an appropriate cropping pattern and then to identify crop varieties which are fertilizer responsive. It is also important to provide adequate support facilities especially through price incentives and assured marketing. In the study it was noticed that the cropping pattern had not changed much over time(refer appendix 9). For instance, the area under paddy had

been about 11 per cent and area under pulses has also more or less remained the same at 4 per cent. It has also been found that in recent years the per capita availability of pulses has been either stagnant or decreasing. In regions with assured rainfall and irrigation it is necessary that crops such as sugarcane, cotton, pulses, and other important cereals (wheat and maize) should be given a high priority. In regions such as Uttara Kannada and Shimoga districts (1939 hectares and 5772 hectares under sugarcane respectively) despite high level of irrigation the area cropped under sugarcane is less than 2 per cent which is substantially less compared to Mandya district with 23411 hectares which accounts for 7 per cent of the total cropped area. Secondly the sources of irrigation mainly wells and tanks should be improved. It may be recalled that the share of area under tank irrigation has decreased by nearly 50 per cent, and area under well irrigation may not be completely realized since the chances of wells going dry during summer season is high. Since about 85 per cent of the cropped area is still rainfed increased fertilizer consumption would require that the technology for dry land farming has to be further developed and disseminated among the farmers. The irrigation potential in these areas should be fully utilised through various means such as drip irrigation, etc., and other similar system of irrigation.

With regard to institutional factors, the strategies for creating potential for fertilizers in rainfed areas and irrigated areas has to be different. As found in a study by M.Von Oppen(et.al,1983) that larger the distance from the market

center, the productivity decreased[15]. The rural markets (regulated markets) should be made more approachable institutionally. A good marketing environment should be created to the farmers, so that all the agricultural produce are sold in those regulated markets. Agricultural marketing process does not end with the marketing of the produce to the wholesalers alone but it is a long chain from the farmers to the final consumer. During this process, the involvement of large number of middlemen including the commission agents, traders, wholesalers and retailers increases the cost of the commodity. Thus the marketing channel should be made more efficient so that margin between the harvest price and the retail price is as small as possible. The marketing strategies in rainfed regions is an important aspect to be dealt with, since, it is likely that it may have an impact on small and medium farmers. In the regions with assured rainfall and irrigation demand from farmers would create opportunity for the opening of new outlets. In the rainfed regions the out let density needs to increased not only in terms of number but also geographically well dispersed. As with any input that is scarce in supply, large farmers are the first to take advantage of access to markets, where such access is limited. But as availability increases, small farmers also gain access. Thus, apart from its efficiency effect better market access above a minimum level also has a desirable equity effect. The farmers must be aware of the current market information. The major aspect of institutional factor being the credit facilities, it

---

[15] Von Oppen, M., Parthasarathy, P. and Rao, Subba, K.V., "Impact of Market access on Agricultural Productivity in India", in Agricultural Markets in the Semi-Arid Tropics, proceedings of the International Workshop held at ICRISAT Center, 24-28 October 1983.

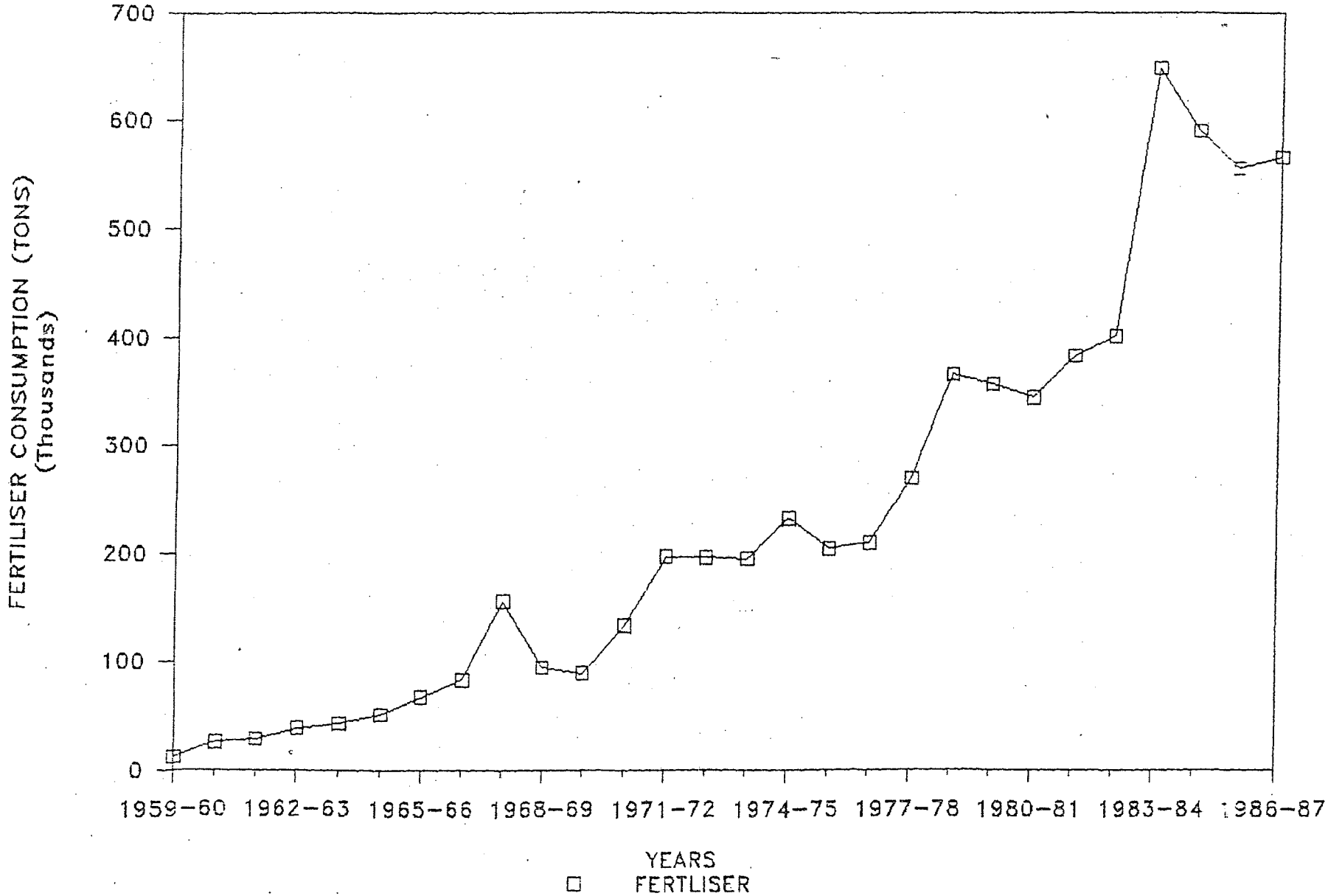
should be strengthened through the banks and co-operative agencies. The aggregate loan amount per hectare of cropped area has to be increased from the present level of Rs 124 to a minimum of Rs.1000/-per hectare of cropped area depending on the type of crop to be cultivated. The sale points which presently cover approximately three to four villages, i.e., approximately 23 sq.kms is to be reduced in terms of area coverage. In order to reach fertilizers to reach the interior villages accessibility through the road and railway network has to be improved. It was noticed from the study that the use of HYV's has increased over time, but there exists further potential for increasing the use of fertilizers. Proper control on seed distribution to ensure the varietal characteristics could improve the fertilizer use and consequently agricultural production in the state.

The fertilizer consumption is somewhat sensitive to economic factors especially the prices of fertilizers, and therefore stability in fertilizer prices should be aimed as a policy objective. The prior knowledge on the prices of fertilizer and crops would help farmers to reduce the uncertainities in crop planning.

APPENDIX GRAPH 1

INDEXED VALUES OF FERTILISER

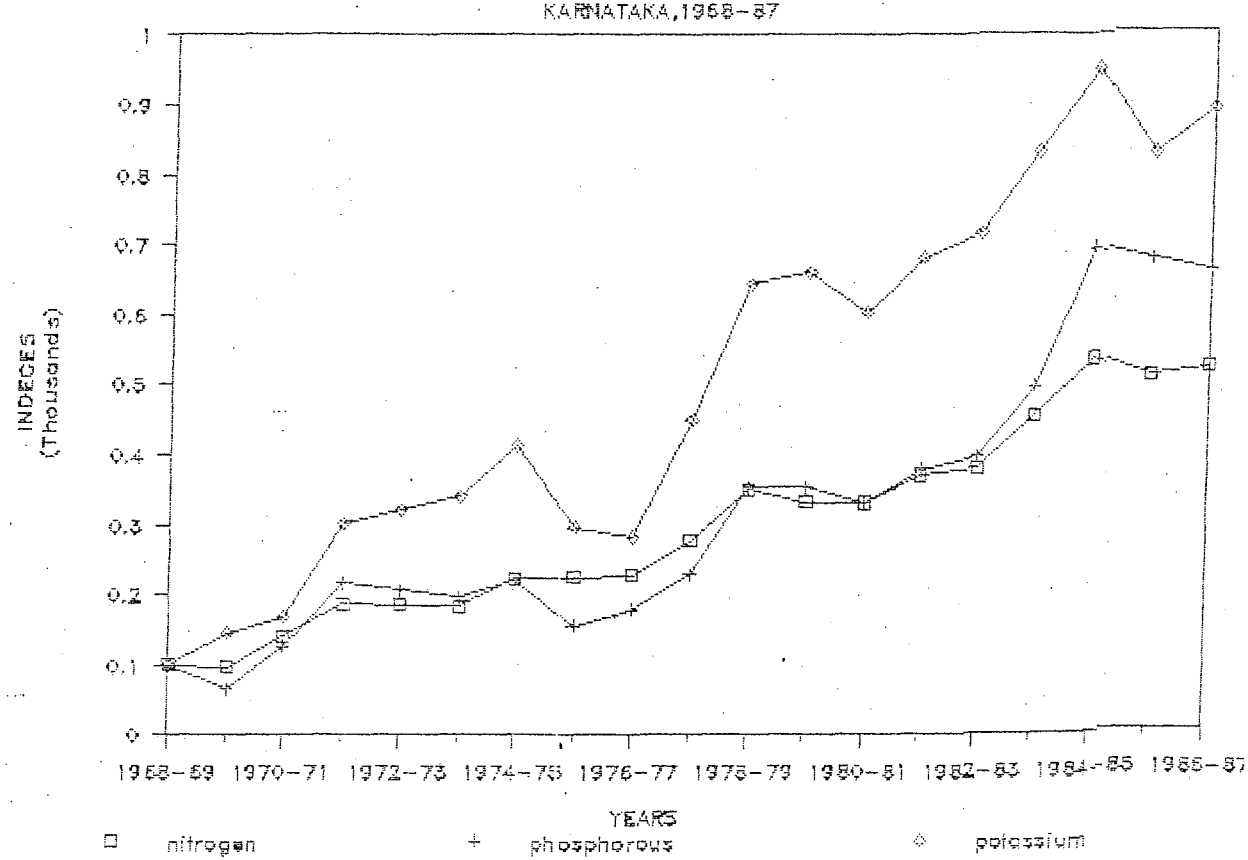
CONSUMPTION 1959 - 60 TO 1986 - 87



APPENDIX GRAPH 2

growth of N P K types of fertilisers

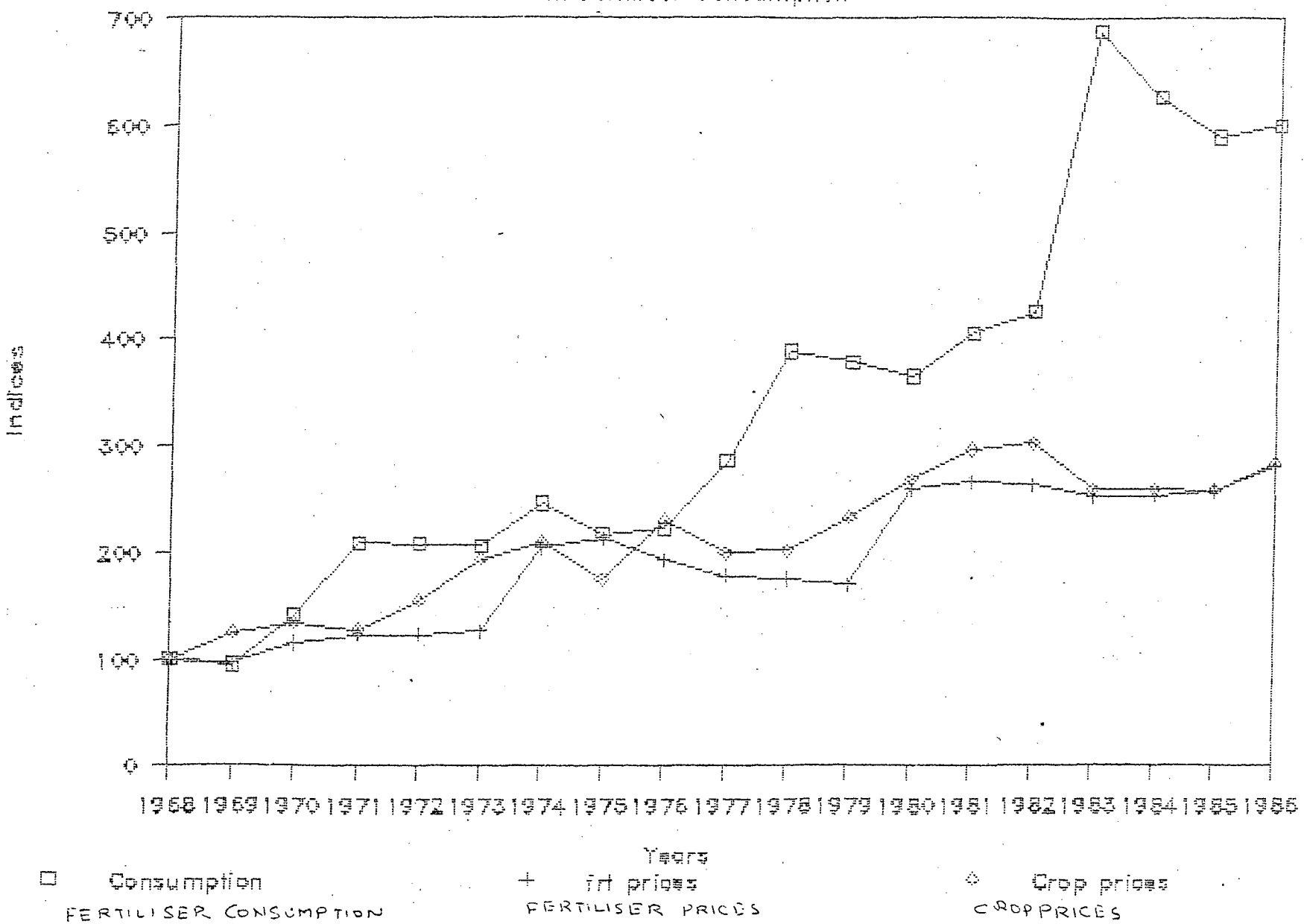
KARNATAKA, 1958-87



APPENDIX GRAPH 3

Effect of Economic Factors

on Fertiliser Consumption



Appendix.I(a)

DISTRICT WISE DATA ON NUMBER OF LAND HOLDINGS AND OPERATED

(area in hectares)

DISTRICTS	1970 - 71		1976 - 77		1980 -81		1985 - 86	
	No. of holdings	Total Area	No. of holdings	Total Area	No. of holdings	Total Area	No. of holdings	Total Area
BANGALORE	240708	448679	245781	429304	256816	467948	282100	454500
BELGAUM	298345	971532	323032	979679	351336	1011959	356900	928300
BELLARY	127834	553151	174490	587426	193342	607857	214600	633000
BIDAR	87644	479356	102025	469821	118596	462643	133200	451000
BIJAPUR	247440	1454578	277446	1461431	302566	1458865	346600	1474600
CHIKMAGALUR	91967	248781	103454	263188	106518	264006	131700	291200
CHITRADURGA	177348	705888	190622	694700	206943	709770	254700	736500
DAK.KANNADA	129881	285915	151547	281413	161278	243263	209100	268000
DHARWAD	268577	1128661	276476	1090288	291765	1051258	353300	1110700
GULBARGA	212682	1263243	243265	1319885	282680	1355215	341600	1323300
HASSAN	166658	359933	184114	366899	222924	398211	253900	392000
KODAGU	36786	136258	40467	146683	42864	173982	55300	179900
KOLAR	289342	394044	212543	385395	230696	397701	257900	414400
MANDYA	215805	294636	223979	275867	289159	312431	322100	310600
MYSORE	271912	513801	272960	495319	345282	551533	379300	564000
RAICHUR	229520	1121528	234226	1086930	276010	1132924	331600	1149200
SHIMOGA	147234	326614	151587	335794	171275	362320	195000	369400
TUMKUR	285330	613522	286177	614310	337800	633037	369900	676200
UTR.KANNADA	106217	147785	116529	152503	121434	150742	130000	150900
TOTAL	3551230	11367825	3810720	11356835	4309284	11745665	4910800	11878500

Source: Bureau of Economics and Statistics, Karnataka.

Appendix.1(b)

AGRICULTURAL CENSUS 1980 - 81

NUMBER AND AREA OF OPERATIONAL HOLDINGS
(Units : 'hectares)

CATEGORY	No. of holdings 1970-71	Total Area	No. of holdings 1976-77	Total Area	No. of holdings 1980-81	Total Area	No. of holdings 1985-86	Total Area
MARGINAL)	527015	136753	648078	174336	775878	203164	954400	243000
	554174	412085	626096	463622	713072	529953	837700	623300
SMALL &	839581	1220807	888023	1319978	1057091	1542648	1292900	1888500
SEMI	491047	1185961	509893	1238820	577235	1399218	669400	1619400
MEDIUM	297423	1019344	308177	1048676	340454	1173082	365300	1258700
	281998	892978	210971	938607	222341	988985	228300	1015000
MEDIUM	420867	2899084	420459	2919633	339619	3028923	417700	2866200
	175641	2343999	165881	2248030	156801	2077327	132900	1748200
	30776	725681	25030	581984	20324	475218	15200	356400
LARGE	8264	279658	5275	177150	3828	129719	2800	96300
	2426	106007	1745	76742	1209	52892	1000	41800
	2618	145476	1803	170257	1432	144616	1200	121700
TOTAL	3551230	11367825	3811351	11356835	4209284	11745665	4910800	11878500

Source: Bureau of Economics and Statistics,Karnataka.

Appendix 2

	SOWING SEASONS OF VARIOUS CROPS	
1	Autumn Rice	May - August
2	Winter Rice	June - October
3	Summer Rice	December - February
4	Kharif Jowar	May - July
5	Rabi Jowar	September - November
6	Bajra	June - August
7	Kharif Maize	April - July
8	Wheat	September - November
9	Gram	September - December
1Ø	Sugarcane	December - March
11	Tobacco	April - September
12	Groundnut	June - August
13	Cotton	May - September
14	Kharif Ragi	May - August
15	Rabi Ragi	January

Source: Department of Agriculture, Bangalore.

Appendix. 3

DISTRICTS	Number of Sale Points			
	1970-71	1975-76	1980-81	1985-86
BANGALORE	560	704	382	526
BELGAUM	777	840	772	835
BELLARY	167	318	377	528
BIDAR	77	96	115	271
BIJAPUR	462	479	323	340
CHIKMAGALUR	74	233	232	391
CHITRADURGA	125	283	296	454
DAK.KANNADA	304	147	434	591
DHARWAD	298	632	600	934
GULBARGA	487	207	127	338
HASSAN	191	263	254	326
KODAGU	200	234	146	180
KOLAR	369	530	250	411
MANDYA	194	356	504	666
MYSORE	99	319	552	772
RAICHUR	233	379	391	537
SHIMOGA	290	402	345	457
TUMKUR	383	507	350	474
UTR.KANNADA	316	322	207	213

Appendix.4(a)

SUBSIDY ON AGRICULTURE (ALL - INDIA)

Year	Share of agricultural subsidy in total (percentage)	Direct subsidies to agriculture (in Million Rupees)
1974	94	7203
1975	86	6772
1976	78	5148
1977	74	5917
1978	71	10435
1979	65	14638
1980	62	15838

Source : " State Policies and Regional disparities in Indian Agriculture" K.Subba Rao in Development and Change, 198

Appendix. 3

DISTRICTS	Number of Sale Points			
	1970-71	1975-76	1980-81	1985-86
BANGALORE	560	704	382	526
BELGAUM	777	840	772	835
BELLARY	167	318	377	528
BIDAR	77	96	115	271
BIJAPUR	462	479	323	340
CHIKMAGALUR	74	233	232	391
CHITRADURGA	125	283	296	454
DAK.KANNADA	304	147	434	591
DHARWAD	298	632	600	934
GULBARGA	487	207	127	338
HASSAN	191	263	254	326
KODAGU	200	234	146	180
KOLAR	369	530	250	411
MANDYA	194	356	504	666
MYSORE	99	319	552	772
RAICHUR	233	379	391	537
SHIMOGA	290	402	345	457
TUMKUR	383	507	350	474
UTR.KANNADA	316	322	207	213

Appendix.4(a)

SUBSIDY ON AGRICULTURE (ALL - INDIA)

Year	Share of agricultural subsidy in total (percentage)	Direct subsidies to agriculture (in Million Rupees)
1974	94	7203
1975	86	6772
1976	78	5148
1977	74	5917
1978	71	10435
1979	65	14638
1980	62	15838

Source : " State Policies and Regional disparities in Indian Agriculture" K.Subba Rao in Development and Change, 19

Appendix.4(b)

SUBSIDIES ON FERTILIZERS IN KARNATAKA

Year	Current Prices	Constant Prices
197Ø - 73	1.25	1.16
1975 - 78	13.67	8.36
198Ø - 83	3Ø.58	12.59

Source: Same as in appendix 4(a).

Appendix. 5

SUBSIDY ON AGRICULTURAL INPUTS IN KARNATAKA

Year	NPK	Irgn	Elec.	Credit	Total
198Ø-81	38Ø.43	242.41	11.25	453.Ø7	3268.85
1981-82	389.86	251.22	52.48	59Ø.95	3545.49
1982-83	39.8	267.2Ø	69.75	648.12	3429.67
1983-84	215.Ø3	283.5Ø	98.11	815.38	3963.52
1984-85	849.27	249.19	152.3	1Ø34.45	4527.92
1985-86	9Ø5.97	263.16	3Ø9.43	1227.Ø5	5124.Ø5
1986-87	194.62	277.45	691.24	1576.54	5236.91

Source: "Input subsidies in Indian Agriculture:A State-wise analysis", Ashok Gulati, E P W, June 1989.

Appendix.6

District wise distribution of Farmer's Service Societies

	District	Number of Societies
	Bangalore	1Ø
	Belgaum	7
	Bellary	12
	Bidar	3
	Bijapur	1Ø
	Chikamaglur	2
	Chitradurga	8
	Dakshina Kannada	9
	Dharwad	3
	Gulbarga	4
	Hassan	4
	Kodagu	1
	Kolar	1
	Mandya	Ø
	Mysore	4
	Raichur	13
	Shimoga	3
	Tumkur	8
	Uttar Kannada	3
	State Total	1Ø5
	All-India Total	345

Source : Arun.K.Mukhopadhyay," Farmer's Service Societies: A study on Karnataka", Monograph series-1, NIRD, Hyderabad.

Appendix. 7

REGULATED MAIN AND SUB MARKETS-DISTRICT WISE

DISTRICTS	MAIN MARKETS	SUB MARKETS
BANGALORE	3	6
BELGAUM	10	29
BELLARY	5	12
BIDAR	5	9
BIJAPUR	6	20
CHIKAMAGLUR	2	8
CHITRADURGA	6	12
DAK.KANNADA	1	3
DHARWAD	15	31
GULBARGA	9	14
HASSAN	5	9
KODAGU	3	1
KOLAR	8	6
MANDYA	1	7
MYSORE	6	12
RAICHUR	7	20
SHIMOGA	6	11
TUMKUR	10	9
UTR.KANNADA	7	14
TOTAL	115	233

Source: Bureau of Economics and Statistics, Karnataka, 1987.

Appendix.8

AREA UNDER IRRIGATION - SOURCE WISE

1970-71			1975-76		
Source	Area (1)	Percentage (2)	Source	Area (1)	Percentage (2)
Canal	448695	32.85835	Canal	108777	37.92908
Tanks	364842	26.71772	Tanks	90514	31.56093
Wells	459564	33.65430	Wells	61828	21.55859
Others	92442	6.769614	Others	25672	8.951394
Total	1365543	100	Total	286791	100

1980-81			1985-86		
Source	Area (1)	Percentage (2)	Source	Area (1)	Percentage (2)
Canal	551450	44.17077	Canal	704598	41.61572
Tanks	343728	27.53238	Tanks	326250	19.26933
Wells	358443	28.71104	Wells	462584	27.32163
Others	135739	10.87260	Others	199673	11.79330
Total	1248450	100	Total	1693105	100

Source: Column(1)-Bureau of Economics and Statistics,Karnataka.
Column(2)- Derived from column(1).

Appendix. 9

Crops	PERCENTAGE SHARE OF MAJOR CROPS IN TOTAL CROPPED AREA		
	196Ø-65	197Ø-75	198Ø-85
Rice	1Ø.53	11.43	11.Ø4
Wheat	2.93	3.3	3.21
Jowar	28.84	23.64	19.66
Maize	Ø.14	Ø.92	1.5
Ragi	9.94	9.98	1Ø.59
Cereals	57.43	53.8	51.6
Pulses	4.11	4.36	4.92
Foodgrains	61.53	58.15	56.52
Oilseed	1Ø.Ø3	1Ø.45	1Ø.Ø8
Cotton	9.73	1Ø.28	9.57
Sugarcane	Ø.76	1.Ø7	1.7
Others	17.95	19.47	21.37

Source: Table 2:" Spatial pattern of Agricultural Development in India",G.S.Bhalla and D.S.Tyagi,E P W,June 1989.

BIBLIOGRAPHY

Ashok Gulati, "Input subsidies in Indian Agriculture: A state wise analysis"; Economic and Political Weekly, Vol XXIV No.25, June 1989.

Ashok Parikh," Consumption of nitrogenous fertilizers: a continuous cross-section study and covariance analysis",Indian Economic Journal(Econometric Annual),14(2) July-Sept 1966, pp258-274.

Bansil,P.C," Role of Irrigation and fertilizer in capital formation ", Indian Journal of Agricultural Economics,Oct-Dec1969

Bapat,S.R ; Singh,D ; Krishnan,K.S ;" Economics of fertilizer use based on experiments conducted on cultivator's field",Fertilizer News,1976,21(3),pp8-13.

Bhalla,G.S and Tyagi,D.S;"Spatial pattern of Agricultural Development in India",Economic and Political Weekly,Vol XXIV, No.25, June 1989.

Bruce,C.Cohen, "Effects of multicollinearity on regression measures",Econometric annual of the Indian Economic Journal,Vol XVII, No.6, pp69Ø-7Ø6.

Bureau of Economics and Statistics(1976), "Growth of Agriculture in Karnataka: A district wise analysis 1960-61 to 1974-75.", Government of Karnataka.

Chakraborty,R.G.D ;"Organic versus inorganic fertilizers",Capital, August 10 1981,pp 10-14.

Chotan Singh and Puran Chand ; Inequalities in the use of Agricultural input subsidies in India, Mimeo,Indian Agricultural Research Institute, New Delhi.

Das,M.N,et.al(1973); Sample Surveys for Assesment of High Yielding Variety Programme (2 Vols.),Institute of Agricultural Research Statistics, New Delhi.

Desai,G.M.and Singh,G.,(1973), Growth of fertilizer use in Districts of India: Performance and Policy Implications,C M A Monograph No.41, C M A, Indian Institute of Management,Ahmedabad.

Desai,G.M(1969); Growth of fertilizer use in Indian Agriculture: Past trends and Future demand.Ithaca,N.Y: Department of Agricultural Economics, Cornell University.

ICRISAT(1983), Agricultural Markets in the Semi-Arid Tropics,Prioceedings of the International Workshop held at ICRISAT Center, 24 - 28 October 1983.

Madhukar,H.M(1975), Demand for fertilizers: An Analysis of factors affecting demand and estimation of future demand with special reference to Gujarat,Good Companians,New Delhi.

Mallik,R.P.S(1988); Region wise - Crop wise fertilizer consumption: A case study of Punjab,1983-84, Agricultural Economics Research Centre, Unversity of Delhi.

Mamoria,C.B(1985), Agricultural Problems in India,Kitab Mahal,New Delhi.

Misra,V.N.," Farm Structure and Fertilizer use",Agricultural Situation in India, 25(1Ø),pp1Ø61-67.

Mukhopadhyay,Arun.K(1982); Farmer's Service Societies: A study in Karnataka , Monograph series - 1; National Institute of Rural Development, Hyderabad.

Nagaraj,R(198Ø),Determinants of Fertilizer Use and its Growth: An Analysis,(Unpublished M.Phil thesis), Centre for Development Studies, Trivandrum.

National Council for Applied Economic Research(1979),Projection for Fertilizer Demand, New Delhi.

National Council for Applied Economic Research(1974), Fertilizer use on Selected Crops in India, New Delhi.

National Sample Survey(1978), "Fertilizer Use in Agricultural Holdings,NSS 26th round", Sarvekshana,July 1971-September 1972.

Panchal,Mool Chand(1987), Impact of Price reduction on Fertilizer Consumption: A Farm level study of Kanpur district of Uttar Pradesh, Mimeo, Applied Economic Research Centre, New Delhi.

Pratap Narayan(1986), Fertilizer pricing in India in "Fertilizer producer pricing in developing countries - issues and approaches ";(eds) Edilberto, L. Segura, Y.T.Shetty and Mieko Nishimiza, Industry and Finance series, Vol II, The World Bank, Washington D C, U S A, 1986.

Puttaswamaiah,K(1980), Economic Development of Karnataka: A Treatise in Continuity and Change, 2 Vols.,Oxford University Press, New Delhi.

Rajeshwar Prasad ;"Efficient use of fertilizers inmodern agriculture",Farmers and Parliament, 22(10),oct 1987,p27-30.

Rao,K.Subba ; "State policies and regional disparity in Indian Agriculture",Development and Change,(Sage,London and New Dolhi) Vol.16, 1985.,pp523-546.

Ray,S.K(1987), Indian Economy, Prentice-Hall of India Pvt.Ltd, New Delhi.

Shanti Swaroop and Pandey,R.K ;"Socio-Economic characteristics affecting fertilizer use in Orissa" Artha Vikas,!8(1-2), Jan-Dec1982, pp52-57.

Reports

Fertilizer Association of India(1988), " Report of the high powered committee on fertiliser consumer prices".

Ministry of Agriculture(1976), " Report of the National Commission on Agriculture - Inputs", Vol.X.