CHAPTER VI

VARIATIONS IN AGRICULTURAL PRODUCTIVITY

1. INTRODUCTION

The preceding two Chapters reveal that the overall labour productivity explains most of the inter-district per capita income differences in Karnataka. To get further insight into the nature of inter-district variations in overall product per worker, the product per worker in each of the three sectors, namely, primary, secondary and tertiary is calculated for the years 1960-61 and 1970-71 at the 1960-61 prices. To know the variations in the sectoral productivities, the coefficients of variation are worked out. In addition, to know the relationship between the overall product per worker and productivity in the three sectors, the coefficients of determination (R^2) between the overall labour productivity on the one hand and explanatory variables on the other are worked out. Both the results for the years 1960-61 and 1970-71 are presented in Table 6.1.

TABLE 6.1 : Coefficients of Variation Of Sectoral Productivities And The Relationship Between The Overall Labour Productivity And Productivity In The Three Sectors, Karnataka : 1960-61 And 1970-71.

Statistic	Product Per Worker In					
	Primary Sector		Secondary Sector		Tertiary Sector	
	1960-61	1970-71	1960-61	1970-71	1960-61	1970-71
1 Coefficient of variation (%)	64.94	54.10	25.2	22.11	20.55	9.36
2 R^2 Between Overall Productivity and	(+)0.98**	(+)0.95**	(+)0.16	(+)0.38**	(-)0.10	(+)0.02

** Significant at 1% Level

Source : Calculated from Tables 2.4, 2.5 And 3.5, 3.4 .

From the table, it is evident that the highest inter-district variation is displayed by the product per worker in the Primary Sector for the years 1960-61 and 1970-71.[1] It is also found that the overall labour productivity is highly correlated with the product per worker in the primary sector for both the years of study. Thus, it can be inferred that the regional inequality in Karnataka is explained mostly by the variations in product per worker in the primary sector (to be specific, in agriculture) for the periods under examination. Therefore, the study of inter-district agricultural

1 These results are consistent with Williamson's findings. See, J.G.Williamson, op. cit., pp 44.

productivity differences becomes imperative. Section two deals with inter-district variations in product per farm worker:: and product per hectare in Karnataka. Section three studies the relative status of districts in terms of agricultural productivity and of changes in these between the years 1960-61 and 1975-76. In section four, an attempt is made to describe the factors affecting agricultural productivity. In addition, the sources of data of the present study are provided in the said section. A brief survey of earlier findings is given in section five. The factors affecting labour and land productivity in Karnataka are examined with the help of Multivariate Regression Analysis in Section Six. The conclusion is given at the end.

2. VARIATIONS IN PRODUCT PER FARM WORKERS AND PRODUCT PER HECTARE

The connotation of the word 'Agriculture' is a comprehensive one and it includes crop production together with land and water management, animal husbandry, fishery and forestry.[2] However, in the present study, fishery and forestry are excluded from the above definition. The agricultural output of each district refers to the Net District

---

2 See, Government of India, "The Report of the National Commission on Agriculture", Ministry of Agriculture and irrigation, 1976, Part I, pp. 12.

Domestic Product contributed by the Agriculture Sector (i.e. crop production, animal husbandry and allied activities) to the District Income. Agricultural Productivity of districts can be measured in terms of either agricultural output per farm worker or agricultural output per hectare of area brought under cultivation.[3]

To find out the product per farm-worker (or labour productivity in agriculture) and per hectare of net shown area (or land productivity) in each district, the Net District Domestic Product of the Agriculture Sector is divided by the respective district figures for the total workers engaged in agriculture (i.e., cultivators + Agricultural Labourers) and net sown area (NSA) respectively. Labour and land productivities thus calculated at the 1960-61 prices are given in Table 6.2 for the years 1960-61, 1970-71 and 1975-76.

---

3 The studies related to agricultural productivity variations Generally use the gross value of some selected crops by multiplying their prices and quantities. Since the present study is concerned with regional income inequalities, an attempt is made to use the Net District Domestic Product originating from Agriculture Sector . Though this measure includes the product of animal husbandry, the results are not going to be affected, as the share of animal husbandry in the income from Agriculture is negligible in the districts of Karnataka.

TABLE 6.2 : Product Per Farm Worker And Product Per Hectare Of Net Sown Area, Karnataka : 1960-61, 1970-71 and 1975-76.

(At 1960-61 Prices)

Sr. No.	Districts	Product Per Farm Worker (in Rs.)			Product Per Hectare of NSA (in Rs.)		
		1960-61	1970-71	1975-76	1960-61	1970-71	1975-76
1	Kodagu	3254 (1)	4204 (1)	4387 (1)	1914 (1)	2524 (1)	2186 (2)
2	Shimoga	1753 (2)	1469 (3)	1448 (3)	1378 (4)	1418 (5)	1600 (4)
3	U. K.	1705 (3)	1221 (4)	1246 (4)	1896 (2)	1851 (3)	2038 (3)
4	Chikmagalur	1598 (4)	2374 (2)	1893 (2)	1012 (5)	1529 (4)	1274 (6)
5	D. K.	851 (5)	970 (6)	1122 (5)	1675 (3)	2112 (2)	2715 (1)
6	Bellary	579 (10)	932 (9)	716 (12.5)	257 (14)	482 (13)	443 (15)
7	Hassan	850 (6)	999 (5)	1093 (6)	700 (6)	836 (8)	932 (8)
8	Tumkur	725 (7)	652 (14)	905 (9)	543 (9)	572 (12)	792 (11)
9	Chitradurga	444 (15.5)	757 (12)	885 (10)	315 (13)	583 (11)	731 (12)
10	Belgaum	612 (9)	620 (15)	679 (14)	350 (12)	426 (14)	521 (13)
11	Mysore	560 (11)	966 (7)	1075 (7)	511 (11)	1002 (6)	1150 (7)
12	Mandya	637 (8)	834 (10)	1065 (8)	659 (7)	961 (7)	1291 (5)
13	Dharwad	510 (12)	617 (16)	612 (17)	231 (15)	315 (17)	349 (16)
14	Bangalore	477 (13)	596 (17)	645 (15)	527 (10)	654 (10)	854 (9)
15	Kolar	438 (17)	534 (18)	628 (16)	559 (8)	760 (9)	838 (10)
16	Raichur	444 (15.5)	960 (8)	710 (12.5)	136 (17)	373 (16)	323 (17)
17	Gulbarga	461 (14)	798 (11)	596 (18)	131 (18)	286 (18)	237 (18)
18	Bijapur	362 (19)	517 (19)	550 (19)	113 (19)	183 (19)	225 (19)
19	Bidar	423 (18)	676 (13)	781 (11)	202 (16)	388 (15)	476 (14)
	Karnataka	678	854	880	386	566	646
	C.V. (%)	78.87	77.49	76.02	84.40	72.18	68.99

Note : Figures in brackets indicate the ranks from high to low value.

Source: Derived from i) Appendix Tables 2.1, 2.2, 2.3 ii) Appendix Tables 3.2, 3.4, iii) our estimates of workers for the year 1975-76, iv)Appendix Tables 6.1,6.2,& 6.3.

It is clear, from the table, that there are marked variations in the product per farm worker and product per hectare, among the districts of Karnataka in all the years, viz., 1960-61 1970-71 and 1975-76. The extent of inter - district variations in labour productivity and land productivity can be observed from the coefficients of variations given in the last row of Table 6.1 . There appears to be no reduction in regional inequalities in product per farm worker. However, a decline is observed in the case of land productivity where the coefficient of variation has gone down from 84 % in 1960-61 to 69 % in 1975-76.

Another striking observation emerging from the data shown in the table is that, although the product per farm worker and the product per hectare of NSA have changed, from the year 1960-61 to 1975-76, viz., from Rs. 678 to Rs.880 in the case of labour productivity and from Rs. 386 to Rs.646 in the case of land productivity , there is a remarkable stability in the rank order of districts with respect to labour and land productivities over the years. The ranks given in the table indicate that there have been a few changes in the ranking order of the districts over various periods of time. The highest and the lowest positions are, in all the periods, those of Kodagu and Bijapur respectively, with the only exception in 1975 in respect of land productivity. The high ranks are, consistently, maintained by Shimoga,

Uttar Kannada, Chikmagalur, Dakshina Kannada, while the reverse is true, in itotality, in the case of Gulbarga, Raichur, Bidar and Dharwad. This is further supported by calculating the correlation coefficients of Ranks over the periods of time. The correlation coefficients of the Ranks of product per farm worker are worked at 0.78 and 0.82 between the ranks for the years 1960-61 and 1970-71 and between 1960-61 and 1975-76 year ranks respectively. The correlation coefficients of Ranks of Land Productivity turned out to be at 0.95 between 1960-61 and 1970-71 year ranks and 0.96 between the ranks for the years 1960-61 and 1970-71. All the coefficients are positive and significant. It can be inferred, from the above, that the districts which are agriculturally backward in 1960-61 continue to remain in the same position even after more than one and a half decade of planning. However, when the product per farm worker and product per hectare are together considered as indicators of Agricultural Development, it is found that the number of such districts has increased from six in 1960-61 to nine in 1970-71.

3. AGRICULTURAL PRODUCTIVITY RELATIVES : LABOUR AND LAND

To know the definite indications either of convergence or of divergence in inter-district agricultural productivity inequalities in Karnataka, the district agricultural

productivity relatives (both labour and land) as compared to the Karnataka State average productivity and their changes between the initial period and the terminal periods are worked out. By expressing each of the district agricultural productivities as a ratio of the state agricultural productivity for the same year, district agricultural productivity relatives are obtained. The labour and land productivity relatives and their changes between the initial and the terminal periods, namely, 1960-61 and 1975-76 respectively, are calculated at the 1960-61 prices and are presented in Table 6. 3 .

The table shows the existence of pronounced inter - district agricultural productivity disparities in Karnataka in both the initial and terminal periods. It is also observed that the agricultural productivity relative in terms of product per farm worker has moved up by more than 20 % in four districts, viz., Chitradurga, Mysore, Mandya and Bidar, while it has fallen by more than 20 % in three districts, viz., Shimoga, Uttar Kannada, Chikmagalur, between the years 1960-61 and 1975-76. However, there are no conclusive evidences either of convergence or of divergence in the labour productivity over the period, since the coefficient of determination (R^2) between the Labour Productivity Relative (P_{RW}) in 1960-61 and the change of it,

TABLE 6.3 : District Agricultural Productivity (Labour And Land)Relatives Amd Their Changes In Karnataka : 1960-61 and 1975-76.

Sr. No.	Districts	Labour Productivity Relative (P_{RW})			Land Productivity Relative (P_{RL})		
		1960-61	1975-76	Change between 1960-61 & 1975-76	1960-61	1975-76	Change between 1960-61 & 1975-76
1	Kodagu	4.79	4.98	+0.19	4.95	3.38	-1.57
2	Shimoga	2.58	1.64	-0.94	3.56	2.47	-1.09
3	U. K.	2.51	1.41	-1.10	4.91	3.15	-1.76
4	Chikmagalur	2.35	2.15	-0.20	2.62	1.97	-0.65
5	D. K.	1.25	1.27	+0.02	4.33	4.20	-0.13
6	Bellary	0.85	0.81	-0.04	0.66	0.68	+0.02
7	Hassan	1.25	1.24	-0.01	1.81	1.44	-0.37
8	Tumkur	1.06	1.02	-0.04	1.40	1.22	-0.18
9	Chitradurga	0.65	1.01	+0.36	0.81	1.13	+0.32
10	Belgaum	0.90	0.77	-0.13	0.90	0.80	-0.10
11	Mysore	0.82	1.22	+0.40	1.32	1.78	+0.46
12	Mandya	0.93	1.21	+0.28	1.70	1.99	+0.29
13	Dharwad	0.75	0.69	-0.06	0.59	0.54	-0.05
14	Bangalore	0.70	0.73	+0.03	1.36	1.32	-0.04
15	Kolar	0.64	0.71	+0.07	1.44	1.29	-0.15
16	Raichur	0.65	0.80	+0.15	0.35	0.50	+0.15
17	Gulbarga	0.67	0.67	0.00	0.33	0.36	+0.03
18	Bijapur	0.53	0.62	+0.09	0.29	0.34	+0.05
19	Bidar	0.62	0.88	+0.26	0.52	0.73	+0.21
	Karnataka	1.00	1.00	-	1.00	1.00	-

Source : Calculated from Table 6.2.

between 1960-61 and 1975-76, has turned out to be (-)0.156, which is not at all significant at 5 % level. When the land productivity relatives are studied, it is observed that the relative position has improved by more than 20 % in Chitradurga, Mysore, Mandya and Bidar, while the position has worsened in the case of Kodagu, Shimoga, Uttar Kannada, Chikmagalur and Hassan between the years 1960-61 and 1975-76. The calculated coefficient of determination (R^2) between the Land Productivity Relative (P_{RL}) in the initial period and its change over a period of time has turned out to be (-)0.684 (significant at 1 % level). Thus, it can be inferred that the land productivity disparities are, for the period, converging in Karnataka. However, a major upsurge in agricultural producitivity in Chitradurga, Mysore, Mandya and Bidar has been observed between the years 1960-61 and 1970-71. The more marked fall in the agricultural productivity relatives over the periods in Kodagu, Shimoga, Uttar Kannada, Chikmagalur and Hassan, perhaps indicates that agricultural productivity increased at some what lower rates in these districts than that, statewide.

4. FACTORS AFFECTING AGRICULTURAL PRODUCTIVITY

The present section not only describes the specification of the variables to be used in the Regression Analysis but also

attempts to justify, on the theoretical ground, the inclusion of such variables in the study. It also presents the sources of data.

A. Dependent Variables :

Two separate regressions are run-one, with labour productivity as dependent variable and another, with land productivity as dependent variable.

Labour productivity or product per farm worker(Y_W) is defined as the product per worker engaged in agriculture. District-wise product per farm worker is worked out on the basis of the total of agricultural workers (Cultivators + Agricultural Labourers) and the Net District Domestic Product originating from the agriculture sector at constant prices for the periods 1960-61, 1970-71 and 1975-76.

Land productivity (Y_L) as dependent variable in another equation is defined as the product per hectare of Net Sown Area (NSA). This is obtained on the basis of NSA and Net District Income originating from the agriculture sector for the three periods under examination at the 1960-61 prices.

B. Independent Variables :

The study considers fifteen factors affecting agricultural productivity (product per farm worker and product per

hectare of NSA).

i) Ratio of Gross Cropped Area to Net Sown Area (X_1).

This gives the measure of cropping intensity. Through sowing of land more than once, the agricultural productivity, measured either in terms of labour productivity or land productivity, is expected to increase, though the net area brought under cultivation may be small. However, cropping intensity depends upon the nature of soil and crops to be grown and the climatic conditions.

ii) Ratio of Area Under Cash Crops to Gross Cropped Area(X_2).

It is considered as a proxy for cropping pattern. The gross agricultural income of a region is influenced by the types of crops grown, their acreage, per acre yield of each crop and price per unit of each crop. In other words, the cropping pattern affects the region's net agricultural income. It is generally argued that the higher the proportion of the region's area under high valued crops, the higher is its agricultural productivity.

iii) Number of Tractors Per Lakh Hectare of Net Sown Area(X_3).

Tractor is the recent source of farm power to carry out various agricultural operations. The quantum of farm power per hectare to obtain the maximum output depends on factors like climate, soil and other endowments and therefore can vary considerably not only from region to region but within

the region also. The available evidences show that there is a definite and positive relation between the availability of farm power and farm productivity. In the absence of availability of data on hours of tractor power used for farm operations, density of tractor is considered as a proxy for tractor power. Therefore the areas with high density of tractors are expected to show high agricultural productivity than that of the areas with low density of tractors. Here, it is to be noted that the differences in the quality of tractors, viz., H.P. are to be taken care of. It is further argued that the introduction of tractor may displace labour and bullock power used for agricultural operations.

iv) Ratio of Area Under HYV Crops to Total Area Under Food Crops (X_4). High yielding variety seeds are recent land-augmenting innovations. Application of these seeds along with their complementary factors such as fertilizer and irrigation help to increase the marginal yield of cultivated area. HYV seeds, so far used in the state, are mostly of food crops. Ratio of area under HYV crops to total area under food crops provides the measure of use of HYV seeds in different areas. Therefore, higher the region's area under HYV seeds as the proportion to total food crops, the higher is its agricultural productivity expected.

v) Infrastructure for Agriculture (X_5). Since there is no consensus in the literature on the meaning of infrastructure, it is difficult to define and conceptualise 'infrastructure' specially for agricultural economy. However, R. Wharton, Jr defines agriculture infrastructure as, "the physical capital and the institutions or organisations, both public and private, which provide economic services to and which have a significant effect, directly or indirectly, upon the economic functioning of the individual farm firm, but which are external to the separate individual farm firm".[4] According to him facilities, like irrigation and public water, transport, storage, processing, electricity, education, agricultural research, grading, credit and finance, etcetra, constitute the major components of agricultural infrastructural facilities. The presence of these infrastructural facilities will definitely help promote agricultural development and therefore account for productivity differentials, viz., higher the level of infrastructure higher is the agricultural productivity expected.

The level of infrastructure in the districts of Karnataka is measured by preparing the composite index of

---

4 Flifton.R. Wharton, Jr , "The infrastructure for agricultural growth," in H.M. Southworth and B.F. Johnston(Eds.) "Agricultural Development and Economic Growth," Cronell University Press, London, 1967, pp 109.

infrastructure. The composite index of intrastructure for agriculture, in the present study, includes seven items, viz., road length per 100 sq.K.M. area, percent of villages electrified, number of financial institutions per lakh of population, number of veterinary institutes per lakh live stock population, number of regulated markets per lakh hectare of net sown area and degree of urbanisation. The high agricultural productivity, measured either per farm worker or per hectare of land, is expected to be positively associated with high index of infrastructure for agriculture.

vi) Draught animals per 100 hectare of Net Sown Area (X_6).

India has been dependent mainly on bullock-power for farm operations. According to the National Commission on Agriculture, "average farm power availability in the country from all sources was 0.36 H.P. per hectare in 1971. Over 62 % of it was contributed by human labour and draught animals and the remaining 38 % by machinery. The share of tractors in the latter was just 4 % while pumpsets had a much larger share of 32 %".[5] In the absence of availability of data

---

5 Government of India, "Report of the National Commission On Agriculture", Ministry of Agriculture and Irrigation, 1976, Part X, pp 344.

on the actual use of hours of bullock power for farm operations, density of livestock is considered as a proxy for bullock power. Therefore, the density of draught animals (livestock) and agricultural productivity are expected to be positively associated.

vii) Number of Pumpsets (Oil + Electric) Per 100 Hectare of Gross Irrigated Area (X_7). Pumpsets is a major source of farm power, specially for irrigating the land. The data on the actual use of power from pumpsets to irrigate the land are difficult to obtain. Therefore, the density of pumpsets (oil + electric) is taken as a proxy for the power from pumpsets used for irrigation, which in turn is expected to enhance the agricultural productivity. Therefore, the areas with high density of pumpsets are expected to show high productivity in agriculture.

viii) Fertilizer Consumption Per Hectare in Kg (X_8)

When the total fertilizer consumption (i.e. sum of the three nutrients of N.P and K) is divided by Gross Cropped Area, the fertilizer consumption on per hectare basis is obtained. Fertilizer use, along with its complementary factors, is expected to increase the agricultural productivity, i.e. product per farm worker or product per hectare. But the disproportionate use of fertilizer may

pull down the agricultural productivity rather than pushing it up. In addition, the timing of supply of fertilizer to crops also influences its affect on productivity. However, one can expect a positive association between the fertilizer consumption and agricultural productivity.

ix) Ratio of Rural Literates to Rural Population (X_9).

It is argued that the levels of skills and amount of schooling of farm people have a remarkable impact on farm productivity. It is also true, to quote Mellor, that " although education is not in itself a sufficient condition for development of agriculture it is certainly a necessary condition."[6] Often the low level of agricultural productivity in the developing countries is attributed to the low level of skill and the general illiteracy of farm people in such countries. According to Professor T.W. Schultz, "... the differences in capabilities of farm people are most important in explaining the differences in the amount and rate of increasing agricultural production".[7]

---

6 J.W. Mellor, "The Economics of Agricultural Development", Cornell University Press, Ithaca, U. S. A., 1966, pp 345.

7 T.W.Schultz, "Transforming Traditional Agriculture", Yale University Press, London, 1964, pp 16.

Schultz, further points out that the agricultural production per acre in Japan has been fully eight times that of India. Such difference, according to him, is due to high level of farming skills and the amount of schooling that the farm people of Japan have acquired compared to the low level of skills and general illiteracy that still prevail in India. However, the rural literacy rate is taken as the proxy for education status of farm people in the present study. Therefore, product per farm worker and product per hectare of net sown area are expected to be positively associated with rural literacy rate.

x) Average Annual Rainfall in MM (X_{10}). Water and land are the most important natural resources of a region and are basic to agriculture. Timely and adequate rainfall helps, definitely, to augment the agricultural productivity of a region. Therefore, variations in rainfall accounts for variations in Agricultural productivity among the regions. In other words.a high and positive correlation between the rainfall and agricultural productivity is expected.

xi) Average size of land holding (X_{11}). The operational size of holdings has a bearing on agricultural productivity. Owing to economies of scale, productivity of land is expected to be higher on large size holdings than on small-size holdings. Therefore, a positive association between

the size of the holding and the productivity per hectare of holding is expected. However, at this stage, it is of interest to know some important findings of farm management studies and similar investigations on the above hypothesis. The findings reveal that the small farms as a class are more efficient production units compared to large farms, when looked at from the point of view of productivity. These farms are generally better endowed with irrigation facilities which in turn facilitate for intensive use of land. Family labour being abundant on these farms, they generally apply more labour to produce higher yields per hectare cultivated. In contrast, the man-land ratio is much lower on large farms and the per hectare output also is comparatively low. This inverse relationship between the size of holdings and the gross output per hectare, the latter decreasing with increase in the farmer has been recognised by Long,[8] A. M. Khusro,[9] Muzumdar,[10] Sen,[11]

---

8 Long, Erven, J. "The economic basis of land reform in under-developed economies", Land Economics, Vol.37(2), March 1961, pp 113-123.

9 A.M.Khusro, "Returns to scale in Indian Agriculture", Indian J.of Agricultural Economics, Vol. 19, Oct.-Dec. 1964, pp 51-88.

10 Muzumdar, "On the Economies of Relative Efficiency of Small Farmers", The Economic Weekly, Vol. 15, July 1963, pp 1259-63.

11 A.K.Sen, "Size Holdings and Productivity", The Economic Weekly, Vol. 16, Feb. 1964, pp 323-326.

C. H. H. Rao,[12] P. K. Bardhan,[13] P. S. Sharma[14] and G. R. Saini[15] in their studies. However, as a result of recent advances in crop production, particularly following the introduction of HYV crops in the mid sixties, some material change in the trend is expected. However, only few studies[16] controvert the inverse relationship between the farm size and productivity. Even then the inverse relationship between the size of holdings and the output per hectare prevails in most areas.

However, in the present study, because of the non-availability of data on the size of operational holdings

---

12 C. H. H. Rao, "Alternative explanations of the inverse relationship between farm size and output per hectare in India", The Indian Economic Review, Vol. Oct. 1960, pp 1-12.

13 P. K. Bardhan, "Size, Productivity and Returns to Scale- An Analysis of Farm - Level Data in Indian Agriculture", Journal of Political Economy, Vol.81(6), Nov.-Dec. 1973, pp 1370-1386.

14 P.S.Sharma, "Impact of Farm Size on Agricultural Productivity in India - A Cross-Sectional Analysis", Agricultural Situation in India, Nov. 1971, pp 543-551.

15 G. R. Saini, "Holding Size, Productivity and Some Related Aspect of Indian Agriculture", Economic and Political Weekly, Vol. VI(26), Jan. 26, 1971, pp A79-A84.

16 See,(i) A.P.Rao, "Size of holding and Productivity", Economic and Political Weekly, Nov. 1967, pp 1898-91, (ii)Rajvir Singh and R.K.Patel, "Returns to Scale, Farm Size and Productivity in Meerut District", Indian J. of Agricultural Economics, Vol. 23(2), April-June 1973, pp 43-47.(iii) K.Munidoraswamy and Others, "A note on Farm Size, Cropping Intensity and Labour in the Indian Agriculture", Indian J. of Agricultural Economics, Vol. 36(2), April-June 1981, pp 54-58.

and size-wise output, the average size of land holding is obtained by dividing the total area under all sizes by the number of holdings and its influence on average output is exmined. The expectation, on the theoretical ground, is that average size of land holding and agricultural productivity, measured either by product per farm worker or per hectare, are positively correlated .

xii) Concentration Ratio of Land Holding (X_{12}). The distribution pattern of land ownership indicates the nature of agrarian structure in a particular area. The distribution pattern of land ownership may be equal or unequal. It is, generally, argued that the unequal distribution of means of production (i.e. land in the present context) also affects productivity positively. One of the indicators to describe the ownership pattern of land is Gini Concentration Ratio. The high (i.e. nearer to 1) concentration ratio would show more unequal distribution of holdings by ownership and vice versa. Hence, one can expect a positive association between the agricultural productivity and concentration ratio of land holdings. In the present study the Concentration Ratio(C.R.) is calculated by :

$$C.R. = \frac{5000 - \frac{1}{2}\sum_{i=1}^{n}(q_i + q_{i-1})r_i}{5000}$$

where; q_i = Cumulative Percentage of area under size group i ;

r_i = Percentage of holdings in size group i .

xiii) Man-Land Ratio (X_{13}). It is the ratio of total agricultural workers (Cultivators + Agricultural Labourers) to Net Sown Area. The quantity and quality of the land under plough have an effect on the region's agricultural productivity. It has frequently been observed that regions, with a high density of population, and, consequently, with a high agricultural worker-land ratio, will have a high yield per hectare of net sown area. The causation underlying this phenomenon is open to alternative interpretations. However, Y. K. Alagh and others have maintained that such a phenomenon may be due to a more intensive cultivation of land through greater utilization resulting from greater availability of labour unit of land.[17] But, this man-land ratio has a dampening effect on worker productivity. Therefore, one can hypothesise that the product per farm worker is negatively associated with the man-land ratio, while the land productivity is positively associated with man-land ratio.

---

17 Y. K. Alagh, G. S. Bhalla, Amit Bhaduri, "Agricultural Growth and Man-Power Absorption in India", in ILO - ARTEP Publication, Nov. 1978, pp 119.

xiv) Ratio of Net Irrigated Area to Net Sown Area (X_{14}).

Since the rains are highly uncertain and irregular, an artificial means of watering through irrigation becomes necessary in the Indian Conditions. Through Multiple Cropping, through increase in the Yield Per Unit Cost and through Production of More Lucrative Crops, irrigation can raise productivity of labour and land. Therefore the regions with good irrigation facilities are expected to have a high agricultural productivity. In the present work, irrigation facility is measured as a ratio of net irrigated area to net sown area. Hence, a positive association between the agricultural productivity and area irrigated as a proportion to net cultivated area is expected.

xv) Number of Agricultural Implements(Ploughs of All Types + Carts) per 100 Hectare of Net Sown Area (X_{15}).

Power can be utilized for carrying out various farm operations through various tools, implements and machinery i.e. sickle, spade, pickaxe, plough, cart, thrashing machines, among other things. It is also known that no single appliance can meet all farming requirements. However, the plough is the basic implement that is available with almost every farmer in the country and ploughing is the operation that consumes the greater proportion of

energy. The bullock-cart played and would continue to play a predominant role in the transportation of agricultural commodities in rural India. Therefore, areas of high density of agricultural implements are expected to have high levels of productivity, measured either product per farm worker or product per hectare.

All the above variables are worked out for the Districts of Karnataka with reference to three periods, viz., 1960-61, 1970-71, and 1975-76. The required data are obtained from several published and unpublished reports. In some cases, the researcher has made estimates. However, by and large, the data are obtained from Bureau of Economics and Statistics, Population Census Reports, Quinquennial Live-Stock Census Reports, Census of Land Holdings, Annual Season And Crop Reports, Department of Agriculture, Statistical Abstracts of Karnataka and Karnataka At a Glance for the different years. For 1960-61, the figures for agricultural workers are not taken directly from the 1961 Census as they are not comparable with those of the 1971 Census. Hence, the figures from the adjusted workforce, which are comparable to the 1971 Census data, are used. For 1975-76, agricultural worker figures are estimated by the researcher on the basis of provisional population figures of the 1981 Census and 1971 Census worker and Population figures. The 1955-56 Census of Land Holding data is used for the

year 1960-61 in the study.

The district-wise data on the variables of the study for the years 1960-61, 1970-71 and 1975-76 are presented in Table 6.4, 6.5 and 6.6 respectively. The original data for preparing the above three tables are given in Appendix Tables 6.1, 6.2 and 6.3 respectively. Further, to get an idea about the magnitude of variations in the explanatory variables, the coefficients of variation are calculated and are given at the bottom of Tables 6.4, 6.5 and 6.6 . The significant variation in some of the factors may account for the different levels of agricultural development in the districts of Karnataka.

On comparing the data given in Tables 6.4, 6.5 and 6.6, an improvement can be observed in most of the districts, in respect of cropping intensity, pumpsets, literacy rate, man-land ratio, irrigated area for the year 1975-76 over that in 1960-61. Though there has been an improvement in almost at the districts in respect of tractor density and area under HYV crops, the fertilizer consumption has fallen in most of the developed districts in 1975-76 over that in 1970-71. It is also noticed that there is an appreciable improvement in the cropping pattern in favour of high valued crops of backward districts over a period of 15 years. With the exception of Kolar, Mandya, Mysore

TABLE 6.4 : Factors Affecting Variations In Agricultural Productivity (Per Worker And Per Hectare), In Karnataka : 1960-61.

Sr. No.	Districts	Cropping Intensity (GCA/ NSA)	Area under cash crops (as % of GCA)	Composite Index of Infrastructure	Draught Animals (per/100 hectare NSA).	No. of pump sets (per/ 100 hect.GIA)	Rural literacy rate(1961) (in %)
1		2	3	4	5	6	7
1	Kodagu	1.0076	51.45	128	215	1.00	39.84
2	Shimoga	1.0414	17.58	108	290	0.36	28.69
3	U. K.	1.0772	31.89	145	311	0.70	35.57
4	Chikmagalur	1.0308	45.03	109	236	0.12	28.96
5	D. K.	1.4169	91.74	116	396	1.33	33.32
6	Bellary	1.0226	37.87	107	87	2.58	19.81
7	Hassan	1.0373	68.44	78	263	0.32	24.88
8	Tumkur	1.0208	18.69	92	163	3.93	22.90
9	Chitradurga	1.0228	25.67	88	139	6.41	24.55
10	Belgaum	1.0210	34.44	100	92	6.47	25.44
11	Mysore	1.1393	18.99	103	229	0.69	15.50
12	Mandya	1.0597	20.96	106	210	0.15	16.91
13	Dharwad	1.0423	42.28	121	78	1.29	34.82
14	Bangalore	1.0289	10.04	147	250	0.42	20.31
15	Kolar	1.0219	21.40	98	244	7.41	18.30
16	Raichur	1.0001	41.90	51	57	0.36	15.50
17	Gulbarga	1.0017	19.36	54	34	3.17	13.18
18	Bijapur	1.0167	23.60	79	48	5.13	24.93
19	Bidar	1.0632	19.23	54	121	7.43	13.95
	Karnataka	1.0351	28.41	100	124	2.30	23.52
Coefficient of Variation(%)		8.80	59.88	27.83	55.69	103.52	37.72

Contd...

TABLE 6.4 : (contd..)

Sr. No.	Districts	Rainfall (Annual average) in mm	Average size of holding (1955-56) in hects.	Concentration ratio (Gini)	Man/land ratio (per/100 hectare NSA)	Net irrigated area (as % of NSA)	No.of Agricultural implements (per/100 hect.NSA)
1		8	9	10	11	12	13
1	Kodagu	2792.0	2.47	0.4673	59	6.49	44
2	Shimoga	1402.0	3.79	0.5141	79	47.67	62
3	U. K.	2695.0	1.53	0.5519	111	17.41	78
4	Chikmagalur	1955.0	4.98	0.5803	63	23.01	51
5	D. K.	4489.9	6.61	0.7216	197	42.66	135
6	Bellary	585.7	4.69	0.4769	44	4.73	22
7	Hassan	957.2	2.81	0.4956	82	12.71	66
8	Tumkur	667.5	3.13	0.5288	75	11.74	49
9	Chitradurga	504.9	5.98	0.5248	59	6.32	31
10	Belaum	833.9	3.73	0.5769	57	6.28	23
11	Mysore	682.8	2.56	0.4549	91	12.77	62
12	Mandya	725.4	1.79	0.4003	103	28.87	87
13	Dharwad	696.1	4.34	0.5493	45	5.19	22
14	Bangalore	763.7	2.48	0.4934	111	12.04	63
15	Kolar	638.5	2.03	0.4459	128	16.95	71
16	Raichur	738.0	6.27	0.4800	31	3.23	13
17	Gulbarga	724.4	6.75	0.5071	28	1.24	8
18	Bijapur	639.4	6.67	0.5357	31	2.08	12
19	Bidar	787.9	6.22	0.5212	48	2.30	11
	Karnataka	1225.9	4.86	0.5897	56	8.39	31
	C.V.(%)	85.39	44.19	13.00	54.59	95.86	68.26

Note : For computational procedure, see the Text.

Source : Computed from i) Appendix Table 6.1, ii)Mysore at a glance, 1960-61, Bureau of Economics & Statistics, Govt. of Mysore, Bangalore, iii) Census of Land Holdings, 1955-56, Bureau of Economics & Statistics, Govt. of Mysore, Bangalore.

TABLE 6.5 : Factors Affecting Variations In Agricultural Productivity (Per worker and Per hectare), Karnataka : 1970-71

Sr. No.	Districts	Cropping intensity (GCA/NSA)	Area under cash crops (as % of GCA)	No.of Tractors (per lakh hectares of NSA)	Area under HYV (as % of area under food crops)	Composite index of infrastructure.	Draught animals (per/100 hectare NSA)	No. of pumpsets (per/100 hectare GIA)	Fertilizer consumption per hectare GCA (in kg)
1		2	3	4	5	6	7	8	9
1	Kodagu	1.1134	58.00	225	3.26	124	202	12	38
2	Shimoga	1.1207	15.54	298	13.69	120	322	2	29
3	U. K.	1.1202	20.97	82	8.78	175	454	10	15
4	Chikmagalur	1.0771	39.77	144	4.83	102	236	6	20
5	D. K.	1.4451	28.69	119	16.33	120	441	16	35
6.	Bellary	1.0369	41.35	64	15.59	96	88	10	22
7	Hassan	1.1006	27.65	81	2.15	104	224	5	25
8	Tumkur	1.0258	21.32	37	8.06	89	151	21	20
9	Chitradurga	1.1172	24.28	98	7.48	95	147	8	30
10	Belgaum	1.0158	34.62	62	8.59	99	103	19	14
11	Mysore	1.1886	24.59	56	7.27	107	213	10	16
12	Mandya	1.1084	19.10	34	9.57	118	193	5	48
13	Dharwad	1.0265	44.55	44	14.13	126	84	12	43
14	Bangalore	1.0428	14.72	261	6.03	125	236	21	25
15	Kolar	1.0833	19.30	118	11.49	95	240	22	27
16	Raichur	1.0187	43.60	88	13.99	68	64	3	13
17	Gulbarga	1.0366	35.56	14	2.93	64	64	19	1
18	Bijapur	1.0110	29.07	39	4.22	82	52	26	3
19	Bidar	1.2220	23.19	19	2.55	77	114	55	7
	Karnataka	1.0623	31.88	74	8.25	100	129	13	15
	C.V. (%)	9.27	38.81	81.69	87.92	23.39	61.45	81.13	56.48

Contd...

TABLE 6.5 : (contd..)

Sr. No.	Districts	Rural literacy rate(1971) in %	Rainfall (annual average) in mm	Average size of holding (in hectares)	Concentration ratio (Gini)	Man/land ratio (per/100 hect.NSA)	NIA of (as % of NSA)	No. of Agricultural implements (per/100 hect.NSA)
1		10	11	12	13	14	15	16
1	Kodagu	48.25	2914.5	3.70	0.5773	60	7.72	42
2	Shimoga	37.24	1894.9	2.22	0.4780	96	44.53	66
3	U. K.	43.36	3615.5	1.39	0.6190	152	26.50	89
4	Chikmagalur	36.85	1972.4	2.71	0.5309	64	13.96	51
5	D. K.	45.49	5044.8	1.59	0.5152	218	60.09	116
6	Bellary	23.14	644.6	4.33	0.5002	52	7.99	20
7	Hassan	31.47	1033.3	2.16	0.4988	84	12.01	59
8	Tumkur	30.20	738.5	2.15	0.5495	88	15.84	45
9	Chitradurga	30.76	590.6	3.98	0.5111	77	16.91	33
10	Belgaum	29.96	744.7	3.26	0.5487	69	13.07	27
11	Mysore	19.55	849.5	1.89	0.4600	104	17.58	49
12	Mandya	22.71	424.9	1.37	0.5132	115	32.46	76
13	Dharwad	39.18	768.5	4.20	0.4648	51	6.45	22
14	Bangalore	28.74	975.6	1.86	0.5188	110	23.08	56
15	Kolar	23.76	627.3	1.88	0.5094	142	37.11	63
16	Raichur	20.78	523.3	4.89	0.4269	39	13.43	12
17	Gulbarga	16.88	745.9	5.94	0.4831	36	2.41	13
18	Bijapur	27.12	712.1	5.88	0.4742	35	4.64	13
19	Bidar	20.04	872.6	5.47	0.4935	57	4.99	14
	Karnataka	29.48	1352.3	3.20	0.5556	66	13.32	31
	C.V.(%)	30.64	91.59	48.63	8.64	53.42	80.08	62.89

Note : For computational procedure, see the Text.

Source: Computed from i) Appendix Table 6.2, ii) Mysore at a glance, 1970-71, Bureau of Economics & Statistics, Govt. of Mysore, Bangalore, iii) Census of Agricultural Holdings in Karnataka, 1970-71, State Agricultural Census Commissioner, Bangalore, 1974.

TABLE 6.6 : Factors Affecting Variations In Agricultural Productivity (Per Worker and Per Hectare), Karnataka : 1975-76.

Sr. No.	Districts	Cropping intensity (GCA/NSA)	Area under cash crops (as % of GCA)	No. of Tractors (Per lakh hectares of NSA)	Area under HYV crops (as % of area under food crops)	Composite index of infrastru-cture	Draught animals (per/100 hectare NSA)	No. of pumpsets (per/100 hectare GIA)	Fertilizer consumption per hectare GCA (in Kg)
1		2	3	4	5	6	7	8	9
1	Kodagu	1.0384	60.48	206	9.92	114	168	7	12
2	Shimoga	1.1190	18.99	246	49.92	119	315	3	45
3	U. K.	1.1092	21.21	137	30.36	187	454	17	10
4	Chikmagalur	1.0840	43.79	223	17.20	93	235	8	13
5	D. K.	1.4284	30.79	400	39.72	117	442	37	31
6	Bellary	1.0644	32.61	93	41.10	93	85	7	36
7	Hassan	1.1332	30.28	95	12.88	99	215	5	19
8	Tumkur	1.0612	25.15	138	15.89	86	152	22	16
9	Chitradurga	1.1168	23.30	235	33.66	91	146	13	34
10	Belgaum	1.0272	35.76	142	17.63	97	110	20	19
11	Mysore	1.2075	26.87	55	18.87	104	196	12	20
12	Mandya	1.1969	21.21	112	13.04	114	190	7	63
13	Dharwad	1.0289	46.57	234	26.17	117	90	14	11
14	Bangalore	1.0362	19.09	270	13.47	130	234	35	40
15	Kolar	1.0974	33.38	209	24.60	102	209	33	24
16	Raichur	1.0537	43.56	91	22.99	68	67	5	18
17	Gulbarga	1.0566	33.20	34	7.04	65	60	31	1
18	Bijapur	1.0166	29.36	72	16.16	83	58	23	5
19	Bidar	1.1913	27.26	34	21.36	92	99	49	5
	Karnataka	1.0771	32.80	135	21.27	100	130	16	18
	C.V. (%)	8.75	33.74	59.99	50.87	25.44	62.55	70.20	71.16

Contd..

TABLE 6.6 :(contd..)

Sr. No.	Districts	Rural literacy rate(1971) in %	Rainfall (annual average) in mm	Average size of holding (in hectare)	Concentration ratio (Gini)	Man/land ratio (per/100 hect.NSA)	Net irrigated area (as % of NSA)	No. of Agricultural implements (per/100 hectare NSA)
1		10	11	12	13	14	15	16
1	Kodagu	48.25	3164.5	3.61	0.6217	50	11.22	44
2	Shimoga	37.24	1687.5	2.22	0.4903	111	42.41	68
3	U. K.	43.36	3630.8	1.31	0.5832	164	20.45	95
4	Chikmagalur	36.85	2221.7	2.54	0.5631	67	11.71	55
5	D. K.	45.49	5495.7	1.33	0.5051	242	40.65	129
6	Bellary	23.14	915.9	3.37	0.5384	62	15.16	20
7	Hassan	31.47	1166.8	1.99	0.5208	85	17.13	70
8	Tumkur	30.20	1043.4	2.15	0.5366	88	15.77	50
9	Chitradurga	30.76	789.5	3.64	0.5157	83	14.74	34
10	Belgaum	29.96	1064.0	3.03	0.5497	77	14.80	27
11	Mysore	19.55	882.1	1.81	0.4860	107	17.05	59
12	Mandya	22.71	853.4	1.23	0.5194	121	32.55	87
13	Dharwad	39.88	901.7	3.94	0.4803	57	6.96	21
14	Bangalore	28.74	1375.1	1.75	0.5204	132	17.48	64
15	Kolar	23.76	972.5	1.81	0.5080	133	20.98	67
16	Raichur	20.78	1245.3	6.64	0.4866	46	12.19	15
17	Gulbarga	16.88	1101.8	5.43	0.4817	40	2.46	12
18	Bijapur	27.12	712.9	5.27	0.4616	41	6.74	13
19	Bidar	20.04	1341.2	4.60	0.4838	61	5.72	13
	Karnataka	29.48	1745.6	2.98	0.5564	73	13.17	34
	C.V.(%)	30.73	76.53	51.73	7.73	54.23	63.19	65.31

Note : For computational procedure, see the Text.

Source : Computed from i) Appendix Table 6.3 , ii) Karanataka at a glance, 1975-76, Bureau of Economics and Statistics, iii) Agricultural Census - 1976-77, State Agricultural Census Commissioner, Govt. of Karnataka, Bangalore, 1978.

and Dakshina Kannada, the use of agricultural implements has increased in most of the districts. Another observation which emerges from the tables is that the infrastructural facilities are not developed commensurate with the requirements of developed districts, whereas there is a marginal improvement in this regard in the case of backward districts. Further, it can be seen that the average size of holding is falling, in almost all the districts. But the concentration ratio of land holdings has increased in Kodagu, Shimoga, Chikmagalure, Bellary, Hassan, Mysore, Mandya, Bangalore, Kolar, Dharwad and Raichur in 1975-76 over that of in 1970-71. However, there is not much change in the concentration ratio of land holdings for the state as a whole between 1970-71 and 1975-76.

5. EARLIER FINDINGS : A BRIEF SURVEY

In fact, several studies have been conducted to show the interregional agricultural productivity differences in terms of the above few or several factors. It may not be out of place to present at this stage, main finding of such studies. An attempt has been made by P. S. Sharma[18]

---

18 P. S. Sharma, "Impact of Selected Aspects of Labour and Land on Per Acre Productivity", Indian Journal of Agricultural Economics, Vol. 21(1), Jan.-March 1966, pp 31-41.

to study the relative association of per acre productivity with rainfall, irrigation, holding size, land concentration ratio, area under tenancy, workers per acre, area cultivated upto 5 acres, percent of area under mixed tenancy and percent of hired workers to total agricultural workers in crop-zones, state-zones and All - India (303 districts) based on cross - section data for the average of triennuium of 1959-1962. His study shows that, of the nine factors included in the Multiple Regression Analysis, Five factors, viz., average rainfall, gross area irrigated as percent of gross cropped area, average size of holding, total cultivated area upto 5 acres and hired workers as percent of total agricultural workers, were found to be the significant factors (at the 1% level) to explain inter-district agricultural productivity variations in India. Except for the average size of the holding, the coefficients of all other significant factors had positive signs before them. However, the selected variables explained 67 % of the total variations. M. M. Dadi[19] considers cropping pattern, land-man ratio, rainfall, irrigation, cropping intensity and average size of holding as the factors to explain inter-district

---

19 M. M. Dadi, "Occupational Structure and Productivity levels in the districts of Gujarat", A paper presented at the Second GEC held at Baroda on 2-3 Jan. 1971.

variations in agricultural income per worker in Gujarat. Though the selected variables explained 67 % of such variations in 1960-61, only the cropping pattern coefficient turned out to be significant in his Multiple Regression Analysis. S. R. Hashim and M. M. Dadi,[20] regressed per hectare output on selected variables to examine the factors of inter-district per hectare agricultural productivity variations in Gujarat on cross-section data for the year 1960-61. The selected variables explained 61 % of inter-district variations. However, of the various factors selected, only two factors, viz., land-man ratio and cropping intensity, were found to be significant factors to explain the variations in their Multi-variate Analysis. By employing the Technique of Factor Analysis, Baldev Singh[21] demonstrated that nearly 90 % of inter-district variation in agricultural productivity is explained by the resource structure of the agricultural sector in Gujarat State for

---

20 S. R. Hashim and M. M. Dadi, "Population pressure, size distribution of land holdings and land productivity — an analysis of inter-regional variations in Gujarat", A paper presented at the second GEC held at Baroda, on 2-3 Jan. 1971.

21 Baldev Singh, "Productivity and Resource Structure — A Case Study of Agricultural Development of Gujarat", Indian Journal of Agricultural Economics, Vol. 35(3), July-Sept. 1980, pp 34-50.

the years 1960-61 and 1970-71. A. Vaidyanathan's[22] study, based on cross-sectional data for the average of 1970-71 to 1972-73, reveals that less than 60 % of the inter-district variations in productivity per hectare are explained by physical factors in India. G. S. Bhalla and Y. K. Alagh in their work[23] have found that the areas with high productivity levels in agricultural output are significantly associated with the areas of high rainfall and assured levels of irrigation. With the help of Multiple Regression and Factor Analysis, Bhawa and P. Singh[24] have found that the most important factor responsible for inter-district variations in Agricultural productivity is infra-structure. According to them, the inter-district variations in Punjab can be narrowed down to the extent of 60 % by providing a uniform infrastructure. Their study was based on cross-section data for the year 1975-76. C. G. Ranade[25]

---

22 A.Vaidyanathan, " Labour use in Indian Agriculture — An Analysis Based on Farm-Management Study Data", in ILO - ARTEP Publication, Nov. 1978, pp 44,

23 G. S. Bhalla and Y. K. Alagh, "Performance of Indian Agriculture —A District-wise Study", Sterling Publishers, Pvt., Ltd., New Delhi - 1979, pp 196.

24 R.S.Bhava and P,Singh, "Sources of inter-district variations in Agricultural Productivity in Punjab", PSE-Econimic Analyst, Vol. II, Dec. 1980, pp 38-46.

25 C. G. Ranade, "Impact of cropping pattern on agricultural production", Indian Journal of Agricultural Economics, Vol. XXXV (2), April-June 1980, pp 85-93.

examines the effect of cropping pattern, fertilizer consumption and irrigation upon agricultural output per hectare across 54 agro-climatic regions covering sixteen states at two points of time i.e., averages of 1962-65 and 1970-73. The Multiple Regression Analysis conducted by him reveals that all the factors are significant in explaining the variations. The three factors explained 87 % to 90 % variation in the pre-green revolution period (i.e. 1962-65) and 81 % to 84 % in the post - green revolution period (i.e. 1970-73). By fitting the Cobb-Doughlas type production function to the inter-state cross-section data for the years 1973 - 74 to 1975 - 76, P. K. Joshi and T. Haque[26] demonstrate, considering an agriculturally developed state like Pubjab as the base, that the fertilizer seemed to be the most important determinent of productivity differences in as many as seven out of the fifteen states, while in Karnataka, Kerala, Maharashtra, Orissa, Rajasthan and West-Bengal, the major part of productivity difference was explained by HYV crops. However, in Tamil-Nadu and Gujarat, it was explained mainly by irrigation, HYVs and fertilizer. Their study

---

26 P. K. Joshi and T.Haque, "An Economic Enquiry into the Long-Term Prospects of Balanced Agricultural Growth in India", Indian Journal of Agricultural Economics, Vol. 35(4), Oct - Dec. 1980, pp 5.

also indicates that the credit played an insignificant part in explaining the agricultural productivity differences. Applying the Multiple Regressions to the cross-sectional data for 1975-76, M. S. Bhatia[27] showsthat 80 % of variability in yield rates of rice, wheat and food grains in different states is explained by the variables of irrigated area, fertilizer consumption (per hectare), proportion of area under HYV crops and rainfall in the states.

6. REGRESSION ANALYSIS

Before doing a Multiple Regression analysis it would be worthwhile to examine, in the present section, the association between product per farm worker on the one hand and each of the explanatory variables on the other, and the association between product per hectare of NSA and each of the explanatory variables. This has been done separately, by calculating the coefficients of correlation between the dependent and each of the explanatory variables for the periods 1960-61, 1970-71 and 1975-76. After solving the problem of Multi collinearity, the Multiple Regression Models of the study are stated. In the final part of the section, the results of Multiple Regressions are given.

27 M. S. Bhatia, "State-wise variations in growth of food production in India", Agricultural Situation In India, Aug. 1981, pp 379-384.

The calculated coefficients of correlation between product per farm worker and explanatory variables are given in the last row but one of the Tables 6.7 , 6.8 and 6.9 for the years 1960-61, 1970-71 and 1975-76 respectively. The correlation results reveal that labour productivity in Karnataka is positively and significantly associated with infrastructure for agriculture, rural literacy rate and rainfall in 1960-61 ; with area under cash crops, tractor density, rural literacy rate in 1970-71 ; and with area under cash crops, rural literacy rate and concentration ratio of land holdings in 1975-76. Since the coefficients of correlation between product per farm worker and other factors are not found to be significant at 5 % level, it is difficult to comment on their influence on labour productivity in the state.

Further, the coefficients of correlation between land productivity on the one side and each of the explanatory variables on the other are calculated and these are given in the last row of Tables 6.7, 6.8 and 6.9 for the years 1960-61, 1970-71 and 1975-76 respectively. From the results, it is evident that density of draught animals, rural literacy rate, rainfall, man-land ratio, irrigated area and density of agricultural implements bear a definite and positive correlation with land productivity in 1960-61. In 1970-71,

TABLE 6.7m : Factors Associated With Product Per Farm Worker (Y_W) and Product Per Hectare (Y_L), Karnataka, 1960-61 : COEFFICIENT OF CORRELATION MATRIX.

Variables	X_1	X_2	X_5	X_6	X_7	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1.0000											
X_2	0.5996	1.0000										
X_5	0.2252	0.0903	1.0000									
X_6	0.6102	0.3699	0.5845	1.0000								
X_7	-0.1818	-0.3066	-0.4117	-0.4027	1.0000							
X_9	0.2356	0.5222	0.6399	0.4130	-0.2914	1.0000						
X_{10}	0.7213	0.6977	0.4383	0.6811	-0.3496	0.6719	1.0000					
X_{11}	0.1709	0.2015	-0.6173	-0.4661	0.2871	-0.1828	0.0219	1.0000				
X_{12}	0.6514	0.5864	0.1350	0.2738	0.0450	0.4871	0.6479	0.4754	1.0000			
X_{13}	0.7703	0.3694	0.5120	0.8727	-0.1897	0.2343	0.6174	-0.3509	0.3467	1.0000		
X_{14}	0.5705	0.2558	0.3827	0.7883	-0.4068	0.2923	0.5437	-0.2056	0.2996	0.7009	1.0000	
X_{15}	0.7243	0.4186	0.5410	0.9239	-0.3956	0.3147	0.6502	-0.4251	0.2741	0.9543	0.7973	1.0000
Y_W	-0.0259	0.2664	0.4602	0.4219	-0.4060	0.7011	0.5917	-0.3438	0.0286	0.0721	0.2861	0.2234
Y_L	0.4275	0.4309	0.6217	0.7942	-0.4477	0.7294	0.8547	-0.3892	0.3032	0.5702	0.6175	0.6733

Note : i) The critical values of coefficients of correlation (with 17 degrees of freedom) at 1% and 5% levels of significance are 0.5741 and 0.4557 respectively.
ii) The coefficients are calculated from the figures provided in Table 6.4.

TABLE 6.6 : Factors Associated With Product Per Farm Worker (Y_W) And Product Per Hectare (Y_L), Karnataka, 1970-71 :

COEFFICIENT OF CORRELATION MATRIX

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1.0000														
X_2	-0.1945	1.0000													
X_3	0.0886	-0.0785	1.0000												
X_4	0.0758	0.2052	0.1834	1.0000											
X_5	0.2418	-0.1631	0.3877	0.0771	1.0000										
X_6	0.6566	-0.3928	0.4591	0.1959	0.7474	1.0000									
X_7	0.1538	-0.1857	-0.3051	-0.3552	-0.3266	-0.2395	1.0000								
X_8	0.2342	0.0524	0.3359	0.1533	0.5026	0.3179	-0.1414	1.0000							
X_9	0.3177	0.2452	0.4889	0.2420	0.7036	0.6108	-0.2838	0.4855	1.0000						
X_{10}	0.7001	0.0905	0.3525	0.2112	0.5912	0.8079	-0.1173	0.2107	0.7812	1.0000					
X_{11}	-0.3348	0.1889	-0.3655	-0.1937	-0.6640	-0.7737	0.3904	-0.5247	-0.3652	-0.3794	1.0000				
X_{12}	0.0770	0.0417	0.1691	0.0060	0.6087	0.5089	0.0278	0.1386	0.5706	0.4987	-0.4308	1.0000			
X_{13}	0.7016	-0.5021	0.2282	0.0719	0.5716	0.8701	-0.0920	0.3872	0.3891	0.6558	-0.7889	0.3689	1.0000		
X_{14}	0.6316	-0.5022	0.4237	0.1986	0.4241	0.7839	-0.2453	0.4521	0.3454	0.5616	-0.7072	0.1276	0.6846	1.0000	
X_{15}	0.6391	-0.4339	0.3524	0.1823	0.6800	0.9337	-0.2995	0.913	0.5274	0.7087	-0.8648	0.4435	0.9345	0.8634	1.0000
Y_W	0.0918	0.5830	0.4938	0.2262	0.2686	0.216	-0.2755	0.2671	0.5701	0.4491	-0.0551	0.3972	-0.0974	-0.0777	0.1128
Y_L	0.5597	0.1496	0.5315	0.2424	0.6398	0.7794	-0.3154	0.4205	0.7648	0.8546	-0.5291	0.5674	0.5579	0.5064	0.7079

Note : i) The critical values of coefficients of correlation (with 17 degrees of freedom) at 1% and 5% levels of significanceare 0.5741 and 0.4557 respectively.

ii) The coefficients are calculated from the figures provided in Table 6.5.

TABLE 6.9 : Factors Associated With Product Per Farm Worker (Y_W) And Product Per Hectare (Y_L) Karnataka 1975-76

COEFFICIENT OF CORRELATION MATRIX

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1.0000														
X_2	-0.2931	1.0000													
X_3	0.3372	0.0571	1.0000												
X_4	0.3442	-0.2786	0.4364	1.0000											
X_5	0.1851	-0.2650	0.3717	0.2763	1.0000										
X_6	0.7866	-0.1748	0.5861	0.4138	0.7678	1.0000									
X_7	0.2567	-0.1853	0.0828	-0.1556	-0.0176	0.0346	1.0000								
X_8	0.3044	-0.4593	0.3604	0.3682	0.2070	0.2766	-0.2994	1.0000							
X_9	0.1382	0.3042	0.7023	0.2771	0.5964	0.6166	-0.1560	-0.0314	1.						
X_{10}	0.5844	0.1509	0.5876	0.2832	0.5062	0.7685	0.1959	-0.0487	0.	1.000					
X_{11}	-0.4447	0.4284	-0.4434	-0.1783	-0.6472	-0.7455	0.0371	-0.5163	-0.	-0.333	.0000				
X_{12}	-0.1598	0.3414	0.2063	-0.1318	0.4383	0.3307	-0.2414	0.0043	0.	0.417	.3640	1.	0		
X_{13}	0.7395	-0.4444	0.6192	0.4021	0.6122	0.8737	0.2660	0.4291	0..	0.6662	7523	0.	7	1.00	
X_{14}	0.6222	-0.4359	0.5595	0.5797	0.4235	0.7250	-0.1648	0.7875	0.1	0.4477	5658	0.	3	0.77	1.0000
X_{15}	0.6855	-0.3471	0.5750	0.2531	0.6362	0.9147	0.0074	0.4660	0.4	0.6650	9448	0.	9	0.91	.8047
Y_W	-0.0248	0.5683	0.2212	-0.1524	0.2112	0.2086	-0.2726	-0.0703	0.5	0.4468	095	0.	3	-0.07	.0574
Y_L	0.6015	0.0132	0.5923	0.2781	0.6274	0.8794	-0.0505	0.2529	0.7	0.8656	7236	0.		0.71	.6696

Note : i) The critical values of coefficients of correlation (wi 47 degree of freedom at 1% and 5% levels of significance are 0.5741 and 0.4 respectively.

ii) The coefficients are calculated from the figures provi in Table .

land productivity shows a positive and significant association with cropping intensity, tractors, infrastructure, draught animals, rural literacy rate, rainfall, concentration ratio of land holding, irrigated area and density of agricultural implements, while it shows a negative and significant association with average size of holding. For the period 1975-76 , except for area under cash crops, area under HYV, density of pumpsets and fertilizer consumption, all factors are found to be significantly associated with land productivity. However, the size of land holding and land productivity are inversely related.

To understand the relative importance of explanatory variables either on product per farm worker or product per hectare of Net Sown Area, the Multiple Regression Analysis is resorted to. Since the present study covers many explanatory variables, the problem of multicollinearity arises because of inter-correlation between the different explanatory variables. However, an attempt is made to solve the problem of Multicollinearity by eliminating the interrelated variables from the regression equations. The interrelationship between the explanatory variables is given in the Coefficient of Correlation Matrix Tables 6.7, 6.8 and 6.9 for the three years, viz., 1960-61, 1970-71 and 1975-76 separately. These correlations are based on observations relating to the

nineteen districts of Karnataka.

From the Correlation Matrix Tables, it is evident that there are interrelations among the explanatory variables. For example, cropping intensity bears a high positive correlation with draught animals, rainfall, irrigated area, man-land ratio and density of agricultural implements. Infrastructure is significantly correlated with draught animals, rural literacy rate, man-land ratio, size of holding and density of agricultural implements. Tractor density is positively associated with density of animals, man-land ratio, irrigated area and rural literacy rate in 1975-76. In fact, this interrelationship suggests that the tractoristion does not displace animal and man-power in the early stages of development. The average size of holding shows a negative and significant correlation with composite index of infrastructura, density of draught animals, man-land ratio, irrigated area and density of agricultural implements. Thus, some of the interrelated variables have to be dropped from the regression equations.

A. REGRESSION MODELS

After removing the inter-correlated variables, the regression equations finally selected are stated as follows :

PRODUCT PER FARM WORKER EQUATIONS

$$Y_W = \alpha + \beta_1 X_1 + \beta_7 X_7 + \beta_9 X_9 + \beta_{11} X_{11} + u \quad \ldots \quad \ldots \quad (1)$$

$$Y_W = \alpha + \beta_5 X_5 + \beta_7 X_7 + \beta_{10} X_{10} + u \quad \ldots \quad \ldots \quad (2)$$

$$Y_W = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + u \quad \ldots \quad \ldots \quad (3)$$

$$Y_W = \alpha + \beta_2 X_2 + \beta_4 X_4 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + u \quad \ldots \quad \ldots \quad (4)$$

$$Y_W = \alpha + \beta_2 X_2 + \beta_4 X_4 + \beta_7 X_7 + \beta_9 X_9 + u \quad \ldots \quad \ldots \quad (5)$$

$$Y_W = \alpha + \beta_2 X_2 + \beta_4 X_4 + \beta_6 X_6 + \beta_7 X_7 + \beta_{12} X_{12} + u \quad \ldots \quad (6)$$

$$Y_W = \alpha + \beta_2 X_2 + \beta_4 X_4 + \beta_7 X_7 + \beta_9 X_9 + u \quad \ldots \quad \ldots \quad (7)$$

Note : The equations (1) to (2) , (3) to (5) and (6) to (7) are fitted to the cross-section data for the years 1960-61, 1970-71 and 1975-76 respectively.

LAND PRODUCTIVITY EQUATIONS

$$Y_L = \alpha + \beta_2 X_2 + \beta_5 X_5 + \beta_7 X_7 + \beta_{14} X_{14} + u \quad \ldots \quad \ldots \quad (1)$$

$$Y_L = \alpha + \beta_1 X_1 + \beta_7 X_7 + \beta_9 X_9 + \beta_{11} X_{11} + u \quad \ldots \quad \ldots \quad (2)$$

$$Y_L = \alpha + \beta_5 X_5 + \beta_7 X_7 + \beta_{10} X_{10} + u \quad \ldots \quad \ldots \quad (3)$$

$$Y_L = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + u \quad \ldots \quad \ldots \quad (4)$$

$$Y_L = \alpha + \beta_1 X_1 + \beta_3 X_3 + \beta_4 X_4 + \beta_{11} X_{11} + \beta_{12} X_{12} + u \quad \ldots \quad (5)$$

$$Y_L = \alpha + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_8 X_8 + \beta_{10} X_{10} + u \quad \ldots \quad (6)$$

$$Y_L = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_7 X_7 + \beta_{12} X_{12} + u \quad \ldots \quad \ldots \quad (7)$$

$$Y_L = \alpha + \beta_2 X_2 + \beta_5 X_5 + \beta_7 X_7 + \beta_{12} X_{12} + \beta_{14} X_{14} + u \quad \ldots \quad \ldots \quad (8)$$

$$Y_L = \alpha + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_8 X_8 + \beta_{10} X_{10} + u \quad \ldots \quad \ldots \quad (9)$$

Note : Equations (1) to (3), (4) to (6) and (7) to (9) are fitted to the cross-section data for the years 1960-61, 1970-71 and 1975-76 respectively.

where ;

Y_W = Product Per Farm Worker (in Rs.), Y_L = Product Per Hectare of NSA (in Rs.), X_1 = Cropping intensity (GCA/NSA), X_2 = Ratio of Area Under Cash Crops to GCA, X_3 = No. of Tractors Per 100 hectare of NSA, X_4 = Ratio of HYV Area to Food Cropped Area, X_5 = Composite Index of Infrastructure For Agriculture, X_6 = No. of draught animals per 100 hectare of NSA , X_7 = No. of Pumpsets per 100 hectare Gross Irrigated Area , X_8 = Fertilizer Consumption Per Hectare Gross Croped Area(in Kg), X_9 = Rural Literacy Ratio, X_{10} = Annual Rainfall (mm), X_{11} = Average size of holding (in hectare), X_{12} = Gini concentration Ratio of Land Holding, X_{13} = Man-land Ratio, X_{14} = Ratio of Net Irrigated Area to Net Sown Area, X_{15} = Agricultural implements per 100 hectare of NSA, α's and β's are the parameters to be estimated.

The parameters are estimated by employing the method of Least Squares Estimation Method.

B. RESULTS OF THE REGRESSION : PRODUCT PER FARM WORKER

After solving the problem of multicollinearity, as many as 40 possible Linear Multiple Regressions were tried by employing the method of Least Squares Estimation Method. However, seven multiple regressions were finally selected as the best in terms of $\bar{R}^2$ and the 't' values of coefficients . The selected equations represent an effort to include as many as variables specified as possible, because there is every reason to believe, on the theoretical ground, that each of the variables specified has some effect on labour productivity. The results of the equations finally selected for different years are presented in Table 6.10*.

The first two equations reveal that the selected variables explain only 31 % to 49 % of variation in product per farm worker in Karnataka for the period 1960-61. The results indicate that the rural literacy rate (X_9) and

---

* Regressions for two variables, viz., between product per farm worker and each of the explanatory variables included in the equations, are also run. The results are given in the Appendix Table 6.4 for the periods under examination.

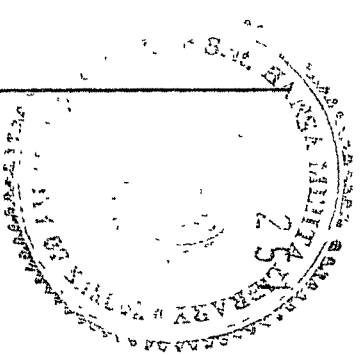
TABLE 6.10 : Factors Affecting The Product Per Farm Worker In Karnataka : Regression Coefficients, 1960-61, 1970-71 and 1975-76.

(Dependent Variable : Product Per Farm Worker)

Sr. No.	Year-6	Equations	R^2	$\bar{R}^2$	F-Ratio
1	1960-61	$1403.76 - 1548.85X_1 - 57.3572X_7 + 6102.45X_9^{**} - 50.5374X_{11}$ (1.092) (1.142) (3.629) (0.693)	0.5998	0.4854	5.24**
2	"	$110.221 + 5.111X_5 - 45.8192X_7 + 0.3100X_{10}^{*}$ (0.848) (0.770) (2.004)	0.4229	0.3075	3.66*
3	1970-71	$-2826.73 + 1215.48X_1 + 5088.40X_2^{**} + 5.086X_3^{**} - 166.957X_4 - 5.5131X_5$ (0.875) (4.108) (2.757) (0.108) (0.924)	0.6826	0.5605	5.59**
4	"	$-1493.66 + 5952.06X_2^{**} - 419.499X_4 + 3.8146X_6^{*} + 0.866X_7 + 4.987X_8$ (3.728) (0.224) (2.334) (0.055) (0.354)	0.5804	0.4190	3.59*
5	"	$-1117.65 + 3475.62X_2^{*} + 21.6791X_4 - 4.6443X_7 + 4088.79X_9^{*}$ (2.434) (0.011) (0.322) (2.247)	0.5379	0.4059	4.07*
6	1975-76	$-5012.67 + 3737.28X_2^{*} - 677.859X_4 + 1.947X_6 - 6.973X_7 + 9365.83X_{12}^{*}$ (2.355) (0.470) (1.179) (0.606) (2.047)	0.6709	0.5443	5.30**
7	"	$-579.410 + 242.11X_2 - 1846.65X_4 - 11.2493X_7 + 5090.55X_9^{*}$ (1.491) (1.238) (0.942) (2.781)	0.5832	0.4641	4.89**

(Figures in brackets are 't' values of regression coefficients)

** Significant at 1 % level, * Significant at 5% level.



annual rainfall (X_{10}) are the only significant variables explaining the variation in product per farm worker. The regression coefficients of rural literacy rate and rainfall are positive and significant at 1% and 5% levels respectively. Similar relationships were also found when the product per farm worker was regressed on rural literacy rate and rainfall individually. The regression coefficients with rural literacy rate and with rainfall turned out to be highly significant at 1 % level with positive signs (see,Appendix Table 6.4). However , the results of regressions indicate that the cropping intensity, infrastructure, pumpsets and average size of holding seem to have no significant impact on labour productivity in 1960-61. Though labour productivity was significantly correlated, individually, with infrastructure and density of pumpsets, their coefficients were not found to be significant at 5 % level in the presence of other variables.

For the year 1970-71, the selected variables explain 41 % to 56 % of labour productivity variations in the state (Equations (3),(4) and (5)). Area under cash crops(X_2), tractor density(X_3), density of draught animals(X_6) and rural literacy rates(X_9) turn out to be the four significant factors to explain inter-district variations in the product per farm worker for the year 1970-71. The coefficients of

the four factors in the 1970-71 equations are significant and have positive signs before them. When labour productivity was regressed on each of the explanatory variables, separately, the regression coefficients with the three variables, viz., area under cash crops, tractor density and rural literacy rate, were found to be significant with positive signs, whereas the coefficient of draught animal was not found to be significant though it had a positive sign before it (see, Appendix Table 6.4). This means that, the factor density of draught animal becomes a significant factor in influencing labour productivity in agriculture only when it is associated with other factors. Factors, like cropping intensity, area under HYV, infrastructure, density of pumpsets and fertilizer consumption seem to have no significant impact on the variations of agricultural labour productivity in the state during 1970-71 since, none of their coefficients are found to be significant at the 5% level. Individually also, they were not found to be significantly correlated with the dependent variable.

It is observed, from regressions (6) and (7), that nearly 46 % to 54 % of the agricultural labour productivity differentials are explained by the selected factors in the state for the year 1975-76. Only three factors, viz., area under cash crops(X_2) the rural literacy rate(X_9) and

concentration ratio of land holdings (X_{12}) appear to be significantly affecting the product per farm worker during the mid-seventies. The coefficients of area under cash crops, rural literacy rate and concentration ratio, in the selected equations, have positive signs before them and are significant at 5 % level. Individually also, these were the only three factors which were significantly correlated with product per farm worker (see, Appendix Table 6.4). However, other factors, namely, area under HYV, draught animals and pumpsets, which are included in the equations, have no significant impact on product per farm worker neither singly nor when associated with other factors.

Thus, it can be inferred that rural literacy rate and annual rainfall are significant factors to explain the product per farm worker differentials for the year 1960-61 in Karnataka . However, nearly 50 % variation is unexplained. In 1970-71, area under commercial crops, tractor density, density of draught animals and rural literacy rate turn out to be significant factors to explain such differentials. The $\bar{R}^2$ is found to be higher in 1970-71 than that in 1960-61 . For the mid-seventies, area under cash crops, rural literacy rate and concentration ratio of land holdings are found to be the significant factors

to explain inter-district variations in product per farm worker in the state. However, it is observed that the selected variables in the regressions do not account for nearly 45 % of variations for the years 1970-71 and 1975-76.

RESULTS OF THE REGRESSION : LAND PRODUCTIVITY

As many as 45 possible Linear Multiple Regressions were tried, after solving the problem of multicollinearity (with the help of correlation matrix of explanatroy variables presented in Tables 6.7, 6.8 and 6.9), with the help of Least Squares Method of Estimation. However, only the results of the equations, where product per hectare of net sown area has been considered as dependent variable, finally selected as the best in terms of $\bar{R}^2$ and 't' values of the coefficients are given in Table 6.11*.

It can be seen from the regression results (Equation (1),(2) and (3))that the selected variables explain 53 % to 77 % of land productivity variations in Karnataka for the year 1960-61. Factors, namely, cropping

---

* Regressions for two variables, viz., between product per hectare of net sown area and each of the explanatory variables included in the equations, are also run. The results are given in Appendix Table 6.5 for the periods under examination.

TABLE 6.11 : Factors Affecting The Product Per Hectare Of NSA In Karnataka : Regression Coefficients, 1960-61, 1970-71 and 1975-76.

(Dependent Variable : Product Per Hectare of NSA)

Sr. No.	Year	Equations	R^2	$\bar{R}^2$	F-Ratio
1	1960-61	$-765.907 + 857.722X_2 + 9.6579X_5^{*} - 6.3633X_7 + 1624.98X_{14}^{*}$ (1.686) (2.429) (0.149) (1.954)	0.6376	0.5341	6.15**
2	"	$-2030.57 + 2074.26X_1^{*} - 31.1712X_7 + 4233.95X_9^{**} - 98.6150X_{11}^{*}$ (2.138) (0.907) (3.681) (1.979)	0.7247	0.6460	9.21**
3	"	$-348.390 + 6.0212X_5^{*} - 19.5702X_7 + 0.4015X_{10}^{**}$ (2.123) (0.699) (5.520)	0.8122	0.7747	21.63**
4	1970-71	$-4725.75 + 3196.35X_1^{**} + 1918.37X_2^{*} + 2.7521X_3^{*} + 453.987X_4 + 11.7125X_5^{**}$ (3.697) (2.487) (2.395) (0.475) (3.153)	0.7955	0.7169	10.11**
5	"	$-6700.91 + 3201.48X_1^{**} + 3.2106X_3^{**} + 1108.51X_4 + 2.6830X_{11} + 7154.41X_{12}^{*}$ (3.479) (2.721) (1.128) (0.037) (3.204)	0.7769	0.6911	9.05**
6	"	$-1901.01 + 527.959X_2 + 1.8105X_3 + 5.4681X_4 + 9.9116X_8 + 0.3964X_{10}^{**}$ (0.771) (1.692) (0.006) (1.549) (5.890)	0.8324	0.7680	12.92**
7	1975-76	$-8365.55 + 4416.17X_1^{**} + 632.816X_2 + 1.6923X_3 - 367.605X_4 + 8.3163X_5^{*}$ (4.834) (0.696) (1.657) (0.429) (2.100)			
		$- 6.6737X_7 + 6445.61X_{12}^{*}$ (1.007) (2.458)	0.8754	0.7961	11.04**
8	"	$-4369.22 + 2200.63X_2^{*} + 7.3816X_5 + 11.4593X_7 + 5556.93X_{12}^{*} + 4716.27X_{14}^{**}$ (2.129) (1.711) (1.637) (1.974) (4.895)	0.8145	0.7432	11.42**
9	"	$-58.209 + 73.667X_2 - 0.3185X_3 - 572.137X_4 + 15.828X_8^{*} + 0.5364X_{10}^{**}$ (0.846) (0.263) (0.716) (2.435) (6.439)	0.8455	0.7861	14.23**

(Figures in brackets are 't' values of regression Coefficients). ** Significant at 1% level,
* Significant at 5% level.

intensity, infrastructure, rural literacy rate, rainfall, average size of holding and irrigated area are found to be significant factors to explain such variations. The coefficients of all the factors are found to be significant and the coefficients of all the factors, except the size of holding, have the expected signs before them. The coefficient of average size of holding has a negative sign before it. It only means that, even with the association of other factors, increase in size has a negative effect on product per hectare of land under plough. When the land productivity was regressed on each of the above mentioned factors, separately, the coefficients of each of the factor turned out to be significant and the coefficients of all the factors, except average size of holding, bear the expected signs before them (see, Appendix Table 6.5). Since the coefficients of area under cash crops and density of pumpsets are found to be non-significant at 5 %, nothing can be said about their influence on land productivity.

The regressions (Equations 4,5 and 6) fitted to the 1970-71 data reveal that the selected variables explain inter-district variations in land productivity to the extent of 69 % to 77 % for the period. The significant factors to explain such variations are cropping intensity, area under cash crops, density of tractors, infrastructure, annual

rainfall and concentration ratio of land holdings. The coefficients of these factors are found to be significant and positive. However, in equation six, area under cash crops and tractor density turned out to be the non-significant factors, though they had positive signs before their coefficients . It may seen the rainfall catches all the variations. This becomes clear when the regression results of two variables are observed (see, Appendix Table 6.5). Rainfall alone explains 73 % of variations. However, land productivity bore individually, a positive and significant correlation with cropping intensity, density of tractors, infrastructure and concentration ratio of land holdings. Area under cash crops, although not found to be a significant factor individually, here emerges as a significant factor to explain inter-district variations in land productivity when associated with other factors. Though, area under HYV and fertilizer have positive signs before them (in Equations 4, 5 and 6), they are found to be non-significant factors to explain the land productivity variations in Karnataka. It seems that fertilizer, though a significant factor individually in land productivity variations, turns out to be a non-significant factor in the presence of other factors. But area under HYV is significant neither singly nor in

the presence of other variables in explaining the inter-district land productivity variations in Karnataka for the period 1970-71.

For the mid-seventies, the selected variables explain a still higher percent of variation in land productivity in Karnataka. The adjusted Multiple Coefficient of Determination($\bar{R}^2$) varies from 74 % to 80 % for the period 1975-76 (see Equations 7 to 9). As many as seven factors, viz., cropping intensity, area under cash crops, infrastructure, fertilizer consumption, rainfall, concentration ratio of land holdings and irrigated area, emerged as the significant factors to explain inter-district land productivity variations in mid-seventies. The coefficients of all the factors are found to be significant with positive signs before them. When land productivity was regressed on each of the explanatory variables, separately, the coefficients of cropping intensity, infrastructure, rainfall, concentration ratio of land holding and irrigation alone were found to be significant with the expected signs (see, Appendix Table 6.5). However, area under cash crops and fertilizer, though not significant individually (see, Appendix Table 6.5), become significant factors in explaining the inter-district variations in equation 8 and 9 respectively. That, area under cash crops becomes significant

in the absence of variables, like cropping intensity and rainfall, while fertilizer becomes significant in the presence of rainfall may be confirmed by examining the results presented in equations 7, 8 and 9. It is also to be noted that the unequal distribution of land, as represented by the concentration ratio of land holdings, affects positively land productivity in Karnataka in 1975-76, which was also true in 1970-71. The coefficient of concentration ratio of land holdings is found to be significant and positive. However, it is difficult to conclude about the effects of HYV seeds, tractors, pumpsets on land productivity, since their coefficients are found to be not at all significant at 5 % level in all the three equations run for the 1975-76 data.

Thus, it is found that cropping intensity, infrastructure, rural literacy rate, rainfall, average size of holding and irrigated area in 1960-61; cropping intensity, area under cash crops, tractor density, infrastructure, rainfall and concentration ratio of land holdings in 1970-71 ; and cropping intensity, area under cash crops, infrastructure, fertilizer consumption, rainfall, concentration ratio of land holdings and irrigated area in 1975-76, are the most significant factors influencing land productivity in Karnataka. The selected variables explain inter-district

land productivity variations in Karnataka to the extent of 53 % to 77 % in 1960-61, 69 % to 77 % in 1970-71 and 74 % to 80 % in 1975-76.

7. CONCLUSION

i) It is found that the highest inter-district variation is displayed by the product per worker in the primary sector for the years 1960-61 and 1970-71 . Further, the correlation analysis suggests that the regional inequality in Karnataka is explained mostly by the variations in product per worker in the primary sector for the periods 1960-61 and 1970-71.

ii) The nature of agricultural productivity variation is studied through product per farm worker and product per hectare of NSA in the state. The study shows that the inter-district variations are very wide in both measures of agricultural productivity for the periods 1960-61, 1970-71 and 1975-76. Though agricultural productivity has increased over the years 1960-61 to 1975-76, there is a remarkable stability in the rank order of districts with respect to product per farm worker and product per hectare of net sown area for the years under examination. The highest and the lowest positions are, in all the periods, those of Kodagu and Bijapur respectively, with only exception in respect

of land productivity in 1975-76. The high ranks are consistently maintained by Shimoga, Uttar Kannada, Chikmagalur and Dakshina Kannada, while the reverse is true, in totality, in the case of Gulbarga, Raichur, Bidar and Dharwad.

iii) The analysis of district agricultural productivity relatives indicates that there are no conclusive evidences either of convergence or of divergence in the product per farm worker over the period 1960-61 to 1975-76, while the land productivity disparities are, for the period, converging in Karnataka.

iv) The impact of several factors upon agricultural productivity in Karnataka is explored.

The Multivariate Regression Analysis indicates that rural literacy rate and annual rainfall in 1960-61; area under commercial crops, tractor density, density of draught animals and rural literacy rate in 1970-71 ; and area under cash crops, rural literacy rate and concentration ratio in 1975-76, are the significant factors to explain the product per farm worker differentials in Karnataka. However, the selected variables in the regressions are unable to provide an explanation to the extent of nearly 50 % in 1960-61 and 45% in 1970-71

and 1975-76, for the inter-district variations in product per farm worker in the state.

v) When the product per hectare of NSA was regressed on the selected variables, it has been found that cropping intensity, infrastructure for agriculture, rural literacy rate, annual rainfall, average size of holding and irrigated area in 1960-61; cropping intensity, area under cash crops, tractor density, infrastructure, rainfall and concentration ratio of land holdings in 1970-71; and cropping intensity, area under cash crops, infrastructure for agriculture, fertilizer consumption, rainfall, concentration ratio of land holdings and irrigated area in 1975-76, are the most significant factors influencing land productivity in Karnataka. The selected variables provide more than 75 % explanation in the inter-district variation in product per hectare of net sown area in all the periods under examination.

vi) There are indications of inverse relationship between the size of land and the output per hectare, the latter falling, with the former rising, in Karnataka State.

APPENDIX TABLE 6.1 : Basic Data For Explaining The Variations In Agricultural Productivity, Karnataka : 1960-61.

Sr. No.	Districts	Total Area (in hectares)	Net Sown Area (in hectares)	Gross Cropped Area (in hects.)	Area under Food crops (in hects.)	Agricultural workers (AL+C)	Literate workers
1	2	3	4	5	6	7	
1	Kodagu	409415	97156	97895	47529	57155	22771
2	Shimoga	1034938	269374	280532	231224	211786	60761
3	Uttar Kannada	1022565	121504	130888	89148	135168	48079
4	Chikmagalur	706988	203513	209777	115318	128910	37332
5	Dakshina Kannada	828175	195551	277082	22876	384789	128212
6	Bellary	990877	576236	589262	366082	255756	50665
7	Hassan	654654	277138	287469	196753	228319	56806
8	Tumkur	1043010	496060	506355	411738	371622	85101
9	Chitradurga	1073855	524067	536038	398422	307025	75375
10	Belgaum	1345677	942943	962727	631154	539335	137207
11	Mysore	1132775	421716	480463	389178	385213	59708
12	Mandya	474567	240614	254987	201554	249016	42109
13	Dharwad	1377659	1115295	1162510	670977	504078	175520
14	Bangalore	719443	351701	361849	325520	388864	78978
15	Kolar	730775	278921	285038	224035	356082	65163
16	Raichur	1391441	1053886	1053945	612342	321740	49870
17	Gulbarga	1590395	1263762	1265891	1020820	358873	47299
18	Bijapur	1712333	1449770	1473941	1126071	453870	113150
19	Bidar	540372	349064	371131	299751	166546	23233
	Karnataka State	18779914	10228271	10587780	7579492	5804147	1357339

Contd...

APPENDIX TABLE 6.1 : (contd..)

Sr. No.	Districts	Rainfall (Annual average) in mm	Net area Irrigated (in hect.)	Gross Irrigated Area (in hect.)	Agricultural implements (plough+carts)	Draught Animals	Pumpsets (Electric + Oil)
1		8	9	10	11	12	13
1	Kodagu	2792.0	6310	6310	43051	172342	66
2	Shimoga	1402.0	128418	128418	167664	612935	467
3	Uttar Kannada	2695.0	21153	21336	94619	294026	150
4	Chikmagalur	1955.0	46822	75061	102793	402526	90
5	Dakshina Kannada	4489.9	83420	89708	263862	550862	1200
6	Bellary	585.7	27238	27238	129419	378686	704
7	Hassan	957.2	35214	60744	183474	595024	195
8	Tumkur	667.5	58244	68554	24171	647780	2699
9	Chitradurga	504.9	33129	36694	164037	517984	2352
10	Belgaum	833.9	59263	62232	219656	509557	4031
11	Mysore	682.8	53874	56112	260054	833424	389
12	Mandya	725.4	69459	92086	210268	349163	140
13	Dharwad	696.1	57909	58788	248443	619867	762
14	Bangalore	763.7	42353	45861	222834	719344	1941
15	Kolar	638.5	47281	52527	197088	557357	3891
16	Raichur	738.0	34006	34089	132024	467108	124
17	Gulbarga	724.4	15614	15614	105303	658872	496
18	Bijapur	639.4	30144	35719	170866	488326	1833
19	Bidar	787.9	28035	9403	38045	317818	699
	Karnataka State	1225.9	857886	976494	3189273	9673001	22520

Sources : 1) Tables of Agricultural Statistics of Mysore State For the Year 1960-61. Table Nos. I,II,III, B.of E. & S., Karnataka, ii) Area, Production and yield per hect. of Principle Crops from 1955-56 to 1960-61(Fully Revised), The Dept. of Statistics, Govt. of Mysore, Sept. 1964, p. 42-43, iii) Appendix Table 3.4, iv) Statistical Abstract of Mysore 1960-61, State Dept. of Statistics, Bangalore, 1963, p 2, v) 10th Quinquenmial Livestock Census 1961, Department of Animal Husbandry & Veterinary Services., Statistical Cell, Govt. of Karnataka, Bangalore.

APPENDIX TABLE 6.2 : Basic Data For Explaining The Variations In Agricultural Productivity, Karnataka : 1970-71

Sr. No.	Districts	Total area (in hect.)	Net sown Area (hect.)	Gross Cropped Area (in hect.)	Area under Food Crops (in hect.)	Area under HYV Crops (in hect.)	Agricultural Workers (A1+C)	Literate Workers	Rainfall (Annual Average) in mm
1	1	2	3	4	5	6	7	8	9
1	Kodagu	410775	110027	122503	51457	1680	66049	31869	2914.5
2	Shimoga	1039246	303997	340677	287733	39400	293307	109228	1894.9
3	U. K.	1022677	103596	116049	91717	8050	157100	68119	3615.5
4	Chikmagalur	711867	224384	241688	145559	6380	144460	53234	1972.4
5	D. K.	834227	186299	269216	191980	31350	405536	184478	5044.8
6	Bellary	951010	598978	621106	364271	56800	310187	71777	644.6
7	Hassan	650611	307403	338316	244762	5280	257045	80892	1033.3
8	Tumkur	1064755	491613	504306	396781	32000	430822	130108	738.5
9	Chitradurga	1078535	493325	551182	417374	31200	379690	116793	590.6
10	Belgaum	1346400	911974	926388	605674	32000	626626	187737	744.7
11	Mysore	1233125	460273	547084	412547	30000	477704	93391	849.5
12	Mandya	487396	264559	293240	237233	22700	304867	69235	424.9
13	Dharwad	1378040	1114812	1144335	634541	89680	569943	223304	768.5
14	Bangalore	758524	395339	412267	351566	21200	433914	124707	975.6
15	Kolar	732858	282744	306289	247165	28400	402453	95623	627.3
16	Raichur	1393237	1034989	1054340	5594677	83200	401971	83530	523.3
17	Gulbarga	1592319	1199930	1243863	801578	23454	429696	72533	745.9
18	Bijapur	1712348	1429174	1444892	1024795	43200	506816	137449	712.1
19	Bidar	545100	334738	409036	314163	8000	192230	38523	872.6
	Karnataka	18943050	10248154	10886777	7415574	611574	6790416	1972530	1352.3

Contd...

APPENDIX TABLE 6.2 : (contd..)

Sr. No.	Districts	Net area irrigated (in hect.)	Gross irrigated area (in hect.)	Agricultural implements (Ploughs+Carts)	Draught Animals	Tractors (All types)	Fertilizer (N+P+K) (in m.tons)	Pumpsets (Electric + Oil)
1		10	11	12	13	14	15	16
1	Kodagu	8498	9217	46391	222256	248	4664	1133
2	Shimoga	135365	165022	199561	977615	906	9754	3412
3	U. K.	27448	27448	91889	470169	85	1740	2749
4	Chikmagalur	31318	34075	113992	530530	322	4895	1979
5	D. K.	111946	128922	216811	822344	222	9532	20952
6	Bellary	47875	66326	120263	528192	383	13455	6892
7	Hassan	36908	43197	182197	689174	249	8300	2257
8	Tumkur	77864	90121	221434	740175	181	9903	18598
9	Chitradurga	83404	118849	163799	723661	483	16673	11543
10	Belgaum	119196	123713	247937	939336	561	13008	23288
11	Mysore	80916	88760	226896	981816	258	8534	8512
12	Mandya	85884	102591	201362	511374	91	14095	5058
13	Dharwad	71936	72410	239895	933873	493	6184	8489
14	Bangalore	91238	103557	221991	934359	1032	10306	21781
15	Kolar	104934	118075	177564	677804	335	8300	25749
16	Raichur	138961	169309	127421	657791	910	13861	5457
17	Gulbarga	28858	33287	153346	763087	170	1240	6259
18	Bijapur	66287	72158	182914	749615	558	4824	18405
19	Bidar	16707	16848	45954	381419	63	2670	9317
	Karnataka	1365543	1583885	3181618	13234590	7540	161763	2018880

Sources : i) Annual season and crop reports, Tables I, II, III, BES , Karnataka, 1970-71, ii) Estimates of Area, yield rate & production of principle crops in Karnataka (fully revised) 1969-70 to 1975-76, BES , Karnataka 1981. iii) Statistical Abstract of Mysore, 1970-71, BES , Karnataka 1971. iv) Eleventh Live-stock Census, Dept. of A.H.&Vet.Ses. Govt. of Karnataka, Bangalore, 1972. v) Consumption of fertilizers in terms of NPK (Nutrients) in the state from 1962 to 1975-76 (District wise) Dept. of Agri., Govt. of Karnataka. vi) Census of India 1971, series 14 Mysore, Part I-A, Vol. II, General Report p 615. vii) Our estimates.

APPENDIX TABLE 6.3 : Basic Data for Explaining The Variations In Agricultural Productivity, Karnataka : 1975-76.

Sr. No.	Districts	Total area (in hect.)	Net sown Area(hect.)	Gross Cropped Area (in hect.)	Area under Food Crops (in hect.)	Area under HYV Crops (in hect.)	Agricultural Workers(AL+C)	Literate Workers	Rainfall (Annual Average)in mm
1	2	3	4	5	6	7	8	9	
1	Kodagu	410775	146005	151620	59919	35946	72849	35150	3164.5
2	Shimoga	1057554	299846	335550	271809	135688	331521	123458	1687.5
3	U. K.	1022678	107829	119605	94227	28604	176440	76504	3630.8
4	Chikmagalur	711805	238467	258521	145291	24991	160435	59120	2221.7
5	D. K.	834595	185448	264903	183330	72834	448617	204076	5495.7
6	Bellary	956220	577250	614442	414043	170192	356981	82605	915.9
7	Hassan	678059	333544	377976	263522	33960	284628	89572	1166.8
8	Tumkur	1064755	542040	575233	430561	68438	474483	143294	1043.4
9	Chitradurga	1078535	517663	578141	443397	149277	427909	131625	789.5
10	Belgaum	1346382	904278	928885	596697	105222	694198	207982	1064.0
11	Mysore	1246283	497924	601279	439709	82979	532874	104177	882.1
12	Mandya	498244	278453	333308	262592	34244	337414	76627	853.4
13	Dharwad	1378200	1119194	1151649	615285	161022	638558	254657	901.7
14	Bangalore	791546	396351	410709	332292	44832	524593	150768	1375.1
15	Kolar	779467	337538	370423	246767	60719	450241	106977	972.5
16	Raichur	1393237	989973	1043173	588705	135389	450798	93676	1245.3
17	Gulbarga	1610208	1179068	1245813	832151	58626	469320	79221	1101.8
18	Bijapur	1712348	1362581	1385285	978435	158185	557086	151082	712.8
19	Bidar	545100	346364	412650	300141	64126	211093	42303	1341.2
	Karnataka	19115991	10359816	11159165	7498874	1595274	7600038	2212874	1745.6

Contd...

APPENDIX TABLE 6.3 : (contd..)

Sr. No.	Districts	Net area irrigated (in hect.)	Gross irrigated area (in hect.)	Agricultural implements (Ploughs+Carts)	Draught Animals	Tractors (All types)	Fertilizer (N+P+K) (in m.tons)	Pumpsets (Electric + Oil)
1		10	11	12	13	14	15	16
1	Kodagu	16388	20927	64110	245555	301	1875	1263
2	Shimoga	127184	161109	203196	943625	737	15127	5000
3	U. K.	22061	22145	102919	490186	148	1172	3867
4	Chikmagalur	27928	33019	130534	560677	532	3441	2718
5	D. K.	75392	87343	238948	820185	702	8095	31980
6	Bellary	87515	122643	113166	491555	538	22001	8473
7	Hassan	57145	68117	234085	718035	317	7292	3332
8	Tumkur	85527	108023	272923	826188	747	9358	24232
9	Chitradurga	76324	110086	173867	753208	1217	19565	14278
10	Belgaum	133898	143830	241727	997944	1287	17306	28230
11	Mysore	84938	96146	292653	977774	274	12006	11809
12	Mandya	90650	123600	242843	530088	312	21049	8447
13	Dharwad	77940	94141	236806	1006598	2616	12887	13568
14	Bangalore	69317	82635	251796	927590	1072	16348	28818
15	Kolar	70823	96730	227037	704748	706	8832	32354
16	Raichur	120712	172204	149725	668060	898	18402	8791
17	Gulbarga	29104	32366	138600	705512	396	1452	10016
18	Bijapur	91908	108978	174408	790369	984	6316	25485
19	Bidar	19843	22749	46082	342191	118	2191	11102
	Karnataka	1364507	1706791	3537225	13500088	13992	203820	273763

Sources : i) Annual Season and Crop Reports (Corrected Copy) Tables I,II,III, BES , Karnataka, Bangalore, 1975-76. ii) Estimates of Area, Yield Rate & Production of Principle Crops in Karnataka, 1969-70 to 1975-76, BES , Govt. of Karnataka, Bangalore, 1981. iii) Statistical Abstract of Karnataka, 1976-77, BES , Govt. of Karnataka, Bangalore. iv) 12th Quinquennial Livestock Census - 1977, The Dept. of A.H.& V.S., Govt. of Karnataka, Bangalore, 1979. v) Consumption of Fertilizer in Terms of (NPK) in the State from 1962 to 1975-76 (District-wise), Dept. of Agriculture, Govt. of Karnataka. vi) Our Estimates.

APPENDIX TABLE 6.4 : Regression Results of Two Variables : (Dependent Variable : Product Per Farm Worker) 1960-61, 1970-71 and 1975-76.
(Regression Coefficients)

Sr. No.	Year	Equation	R^2	Sr. No.	Year	Equation	R^2
1	1960-61	$1089.01 - \underset{(0.165)}{199.693X_1}$	0.0006	8	1970-71	$678.961 + \underset{(1.143)}{18.0876X_8}$	0.0713
2	"	$-321.530 + \underset{(2.137)}{12.097X_5}^{*}$	0.2118*	9	"	$-524.074 + \underset{(2.861)}{5326.58X_9}^{**}$	0.3250*
3	"	$1162.51 - \underset{(1.831)}{109.696X_7}$	0.1648	1	1975-76	$-349.233 + \underset{(2.847)}{4590.02X_2}^{**}$	0.3229*
4	"	$-676.100 + \underset{(4.05)}{6456.38X_9}^{**}$	0.4915**	2	"	$1366.28 - \underset{(0.635)}{1139.69X_4}$	0.0232
5	"	$375.436 + \underset{(3.026)}{0.4102X_{10}}^{**}$	0.3501**	3	"	$818.640 + \underset{(0.879)}{1.555X_6}$	0.0435
6	"	$1442.44 - \underset{(1.509)}{136.031X_{11}}$	0.1182	4	"	$1442.99 - \underset{(1.168)}{18.0759X_7}$	0.0743
1	1970-71	$231.276 + \underset{(0.380)}{779.589X_1}$	0.0084	5	"	$-576.238 + \underset{(3.078)}{5551.13X_9}^{**}$	0.3578**
2	"	$-213.470 + \underset{(2.959)}{4374.14X_2}^{**}$	0.3398**	6	"	$-6899.42 + \underset{(4.229)}{1544.4X_{12}}^{**}$	0.5126**
3	"	$565.088 + \underset{(2.341)}{5.2890X_3}^{*}$	0.2438*				
4	"	$866.235 + \underset{(0.957)}{211.41X_4}$	0.0512				
5	"	$132.787 + \underset{(1.149)}{9.1505X_5}$	0.0721				
6	"	$784.183 + \underset{(0.912)}{1.5977X_6}$	0.0466				
7	"	$1383.81 - \underset{(1.182)}{19.8455X_7}$	0.0759				

(Figures in brackets are 't' values of coefficients).
** Significant at 1 % level. * Significant at 5 % level.

APPENDIX TABLE 6.5 : Regression Results of Two Variables : (Dependent Variable : Product Per Hectare of NSA) 1960-61, 1970-71 and 1975-76. (Regression Coefficients).

Sr. No.	Year	Equation	R^2	Sr. No.	Year	Equation	R^2
1	1960-61	$-2216.05 + \underset{(1.949)}{2750.76X_1^{*}}$	0.1827	7	1970-71	$280.281 + \underset{(6.786)}{0.4643X_{10}^{**}}$	0.7303**
2	"	$259.428 + \underset{(1.968)}{1276.99X_2^{*}}$	0.1857	8	"	$1640.40 - \underset{(2.571)}{228.564X_{11}^{**}}$	0.2799*
3	"	$-646.515 + \underset{(3.279)}{13.4781X_5^{**}}$	0.3865**	9	"	$-3502.19 + \underset{(2.841)}{8563.31X_{12}^{*}}$	0.3220*
4	"	$948.683 - \underset{(2.064)}{99.776X_7^{*}}$	0.2004	1	1975-76	$-3863.48 + \underset{(3.104)}{4385.27X_1^{**}}$	0.3618**
5	"	$-643.717 + \underset{(4.397)}{5540.41X_9^{**}}$	0.5321**	2	"	$971.138 + \underset{(0.054)}{87.3127X_2}$	0.0001
6	"	$91.108 + \underset{(6.789)}{0.4887X_{10}^{**}}$	0.7305**	3	"	$299.780 + \underset{(3.031)}{4.3893X_3^{**}}$	0.3508**
7	"	$1216.87 - \underset{(1.742)}{127.001X_{11}^{*}}$	0.1514	4	"	$611.806 + \underset{(1.194)}{1702.32X_4}$	0.0773
8	"	$304.517 + \underset{(3.237)}{2777.19X_{14}^{**}}$	0.3813**	5	"	$-746.806 + \underset{(3.322)}{16.8277X_5^{**}}$	0.3936**
1	1970-71	$-3150.92 + \underset{(2.785)}{3688.19X_1^{**}}$	0.3133*	6	"	$1049.76 - \underset{(0.208)}{2.7408X_7}$	0.0025
2	"	$648.617 + \underset{(0.624)}{871.450X_2}$	0.0224	7	"	$747.237 + \underset{(1.077)}{11.3282X_8}$	0.0639
3	"	$470.329 + \underset{(2.587)}{4.4178X_3^{**}}$	0.2825*	8	"	$198.064 + \underset{(7.128)}{0.4977X_{10}^{**}}$	0.7493**
4	"	$722.652 + \underset{(1.030)}{1762.84X_4}$	0.0587	9	"	$-3776.13 + \underset{(2.521)}{9208.37X_{12}^{*}}$	0.2721*
5	"	$-859.901 + \underset{(3.433)}{16.9150X_5^{**}}$	0.4093**	10	"	$248.678 + \underset{(3.717)}{4369.84X_4^{**}}$	0.4483**
6	"	$407.066 + \underset{(1.910)}{22.0899X_8^{*}}$	0.1768				

(Figures in brackets are 't' values of Coefficients).

** Significant at 1 % level, * Significant at 5% level.