CHAPTER - IV

IMPACT OF IRRIGATION ON AGRICULTURAL PRODUCTIVITY AND FARM TECHNOLOGY

SECTION I : INTRODUCTION

The earlier chapter deals with spatio-temporal characteristic of irrigation. The study of the sourcewise distributional pattern of irrigation and its intensity has been made. Moreover, specific attention has been paid to examine the requirement and development of irrigation. Present chapter attempts to highlight the impact of irrigation on agricultural productivity, fertilizer consumption and level of mechanization.

Hypothesis :

Two hypotheses be posed for testing and verification.

(i) The patterns of crop productivity corresponds with the spatial patterns of intensity of irrigation.

(ii) The farm technology further helps to step up productivity of crops in areas of irrigation at the outset.

Database :

The relative primary data have been collected by field work. The secondary data were collected from statástical reports published by the government. Cartographic techniques were used to show spatial variations of different aspects in the region. The data were collected at circle level.

Methodology :

The crop productivity has been measured by employing Jasbir Singh's method (1972) of crop yield and crop concentration indices ranking co-efficient whereas index of fertilizer consumption is calculated by using Bhatia's location quotient method (1965). Composite index values for modern form machinary are considered to determine the degree of mechanisation in the region. Pearson's correlation co-efficient technique is used to calculate 'r' values for different variables and correlation matrix is attempted. In order to assess the impact of irrigation on productivity, fertilizer consumption and mechanization, a simple method of superimpostion of map is adopted in succeeding pages. The details of methods are given at appropriate places.

1. IRRIGATION AND AGRICULTURAL PRODUCTIVITY :

Agriculture has always occupied an important place in Indian economy. The proportion of cultivable land per man has been decreased considerably during the recent past. The increase in crop production is a must in India since the areal spread of crop land has almost reached to its saturation limit (Vidyanath,1985). It needs, therefore, to improve the agricultural productivity. Agricultural productivity is a measure of overall performance of a region which is quite useful in planning the developmental programmes in the rural areas.

The erratic nature of rainfall affect badly on agricultural productivity in the region (Fig.2.3). Generally, the crop needs optimum quantity of water for higher yields and irrigation plays a significant role in enhancing the yields of crops. Beside this, it ensures assured water supply in the areas where crops are victimised by scarcity conditions. There is significant scope for increasing the net area under cultivation by growing more than one crop on the same hectare with the help of irrigation which indeed, is the main plan of our agricultural strategy in all the five year plans (Swaminathan, 1980).

Agricultural productivity is a function of various factors like physical, socio-economic, technical and organizational. The level of agricultural productivity, as a concept, means the degree to which the economic cultural, technical and organizational variables are able to exploit the abiotic resources of the area for agricultural production (Singh, J. 1984). The agricultural productivity is also defined as 'the level of existing performance of a unit of land which differentiate from one area to another (Mohammad Ali, 1978). The differntials in productivity per unit area is determined partly by soil types and climate and partly by the farming techniques.

Agricultural productivity is not constant, it is changing from time to time. It is dynamic in its spatio-temporal perspectives. The development of irrigation facilities, farm mechanization, use of fertilizers and high yielding varieties of seeds, adoptions of other components of new technology may lead to the variations in agricultural efficiency per unit of time and space.

Many scholar's from different fields, like economics, agriculture, geography etc. have evolved different methods to measure the agricultural productivity. First employed by Buck (1937) and followed by Kendall (1939), L.D.Stamp (1943), Sapre and Deshpande (1964), Bhatia (1967), P.Sen Gupta (1968), Sinha (1972), Singh Jasbir (1972), M.Hussain (1976), Sharma and Cuntinho (1976), Singh (1979), Shinde and Jadhav (1979) and Vidhanath (1985). They have also suggested new methods for measuring agricultural productivity.

In the present analysis, major irrigated crops, in terms of their land occupance, have been considered, viz. sugarcane and wheat. In order to assess agricultural productivity, Jasbir Singh's method (1972) of crop yield and crop concentration indices ranking co-efficient has been employed. The statistical procedure of this method is as follows.

i) <u>Crop Yield Indix</u> -

$$Yi = \frac{Ya}{Yr} \times 100$$

Where, Yi = Crop yield index

Ya = The average yield per hectare of crop 'a' in the circle

Yr = The average yield per hectare of crop 'a' in the entire region.

ii) Crop Concentration Index -

$$Ci = \frac{Aau}{cu} - \frac{Tar}{cr} \times 100$$

Where, Ci = Crop concentration index

Aau = Area under 'a' crop in the circle

cu = Total cropped area in the circle

Tar = Area under 'a' crop in the entire region

cr = Total cropped area in the entire region

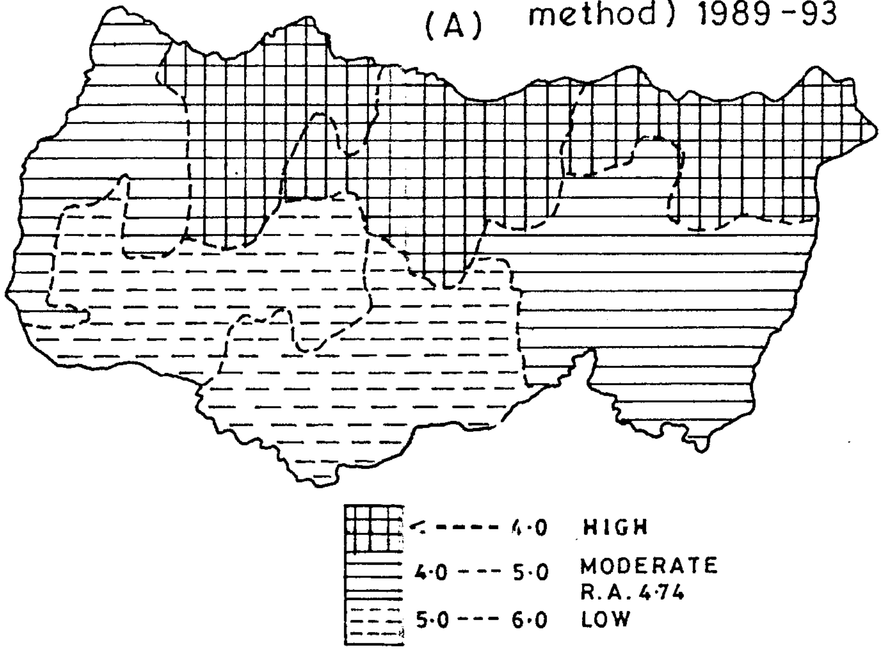
iii) Ranking co-efficient -

Crop yield and crop concentration indices for all the zones are ranked separately. Now, the two ranks are added and divided by 'n' (two crops) to find out the ranking co-efficient for each crop.

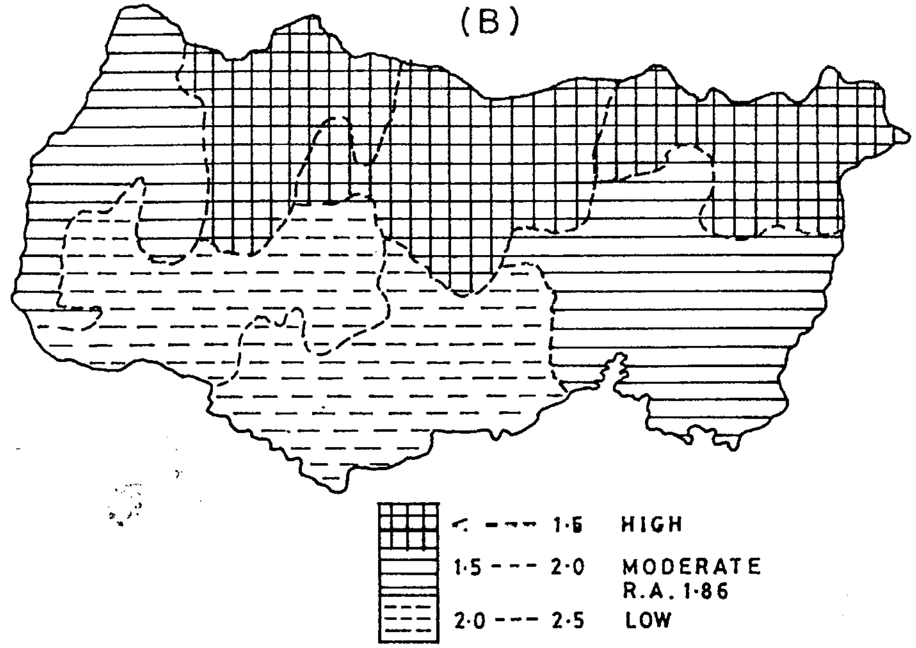
$$\text{Indices of ranking co-efficient for crop 'a'} = \frac{\text{Yield index of crop 'a'} + \text{Crop concentration index of crop 'a'}}{n}$$

The values, thus obtained, indicate that the lower is ranking co-efficient higher is the level of agricultural productivity and vice-versa.

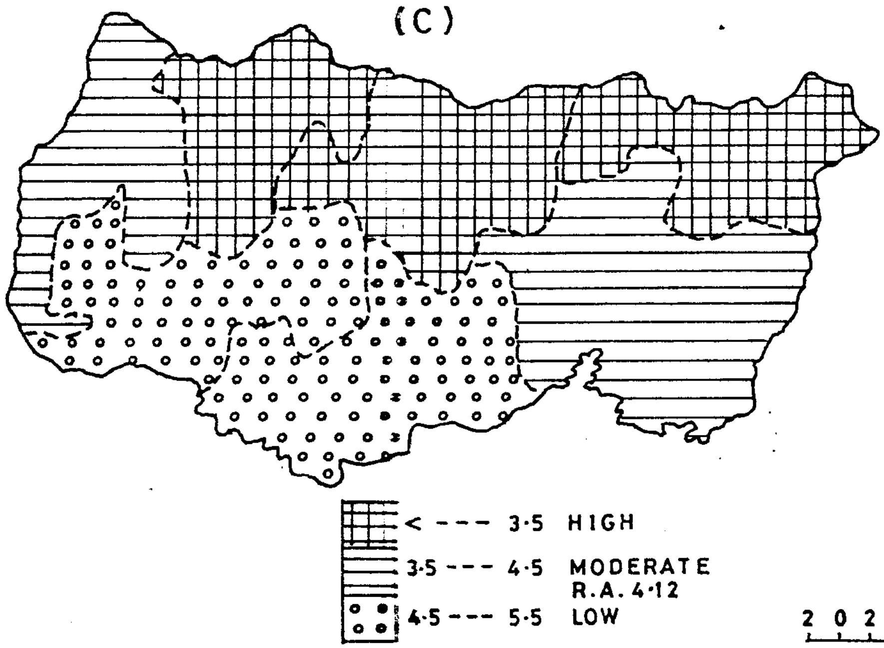
Sugarcane productivity (crop yield & concentration indices ranking co-efficient method) 1989-93
(A)

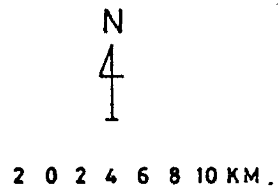


Sugarcane productivity (vol. of change) 1959-93
(B)

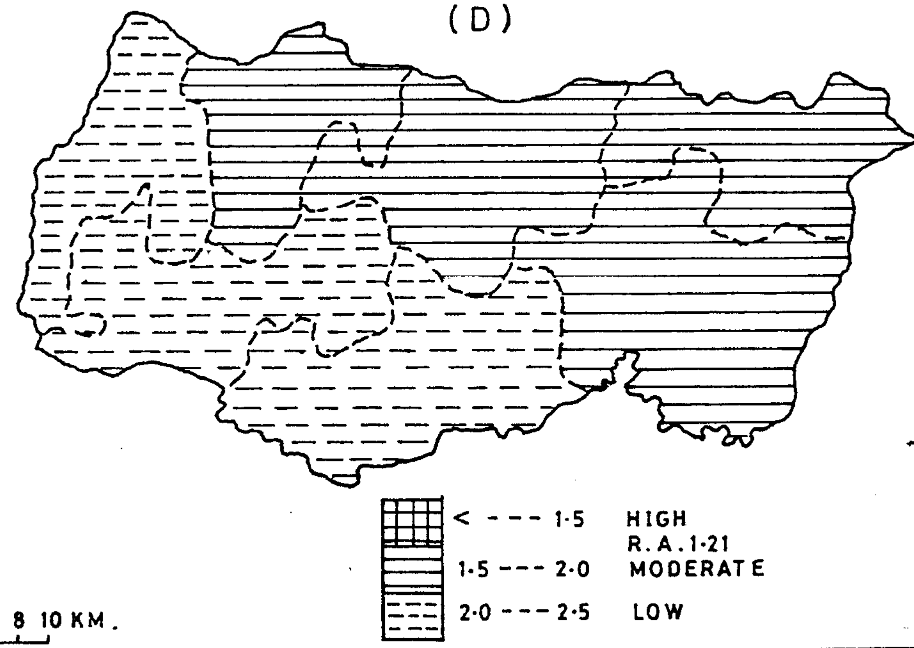


Wheat productivity (crop yield & concentration indices ranking co-efficient method) 1989-93
(C)





Wheat productivity (vol. of change) 1959-93
(D)



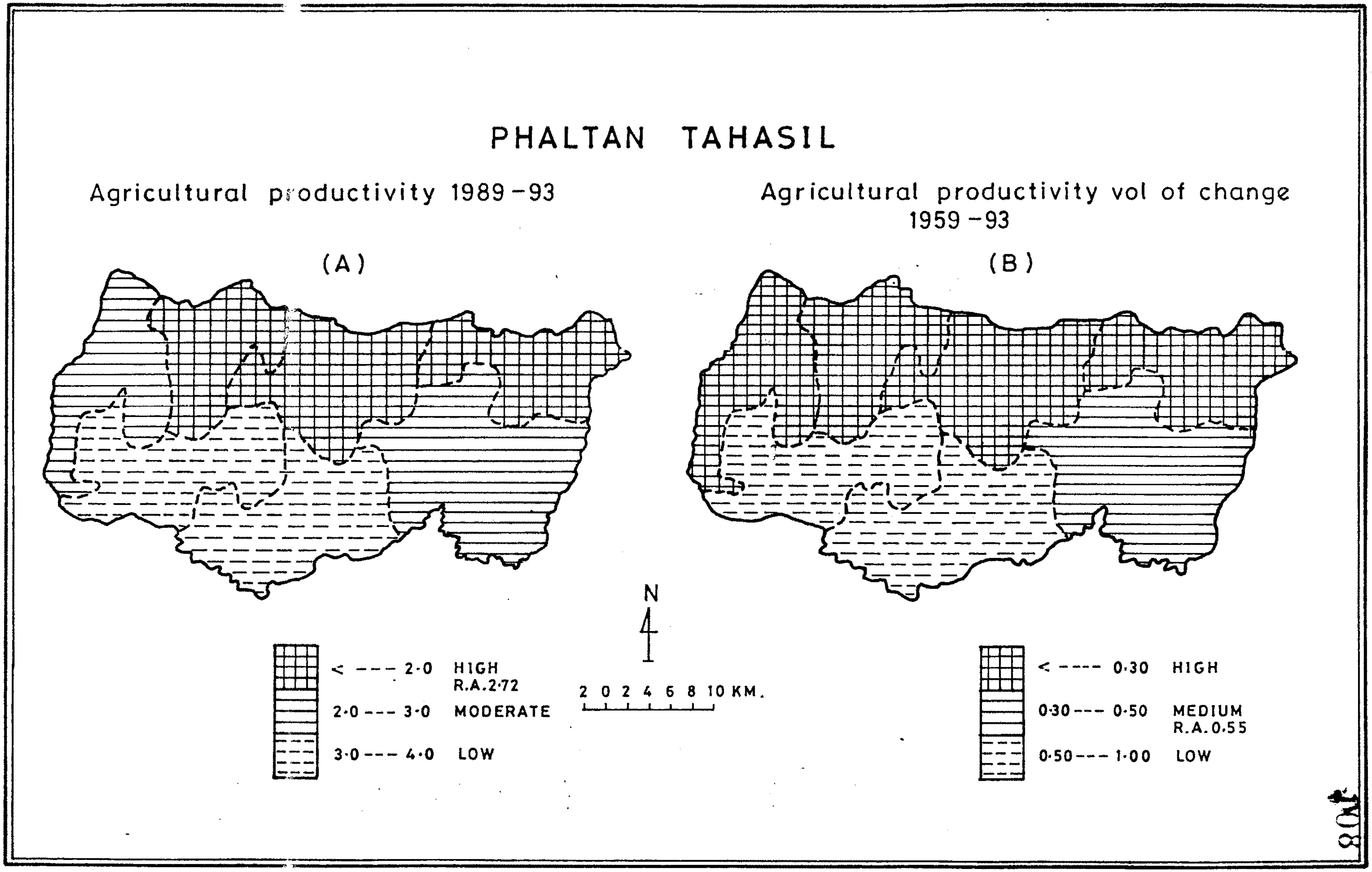

PHALTAN TAHASIL
Agricultural productivity 1989-93
(A)
Agricultural productivity vol of change
1959-93
(B)
N
< --- 2·0 HIGH
R.A.2·72
2·0 --- 3·0 MODERATE
3·0 --- 4·0 LOW
2 0 2 4 6 8 10 KM.
< ---- 0·30 HIGH
0·30 --- 0·50 MEDIUM
R.A.0·55
0·50 --- 1·00 LOW

FIG.4·2

This method is useful to identify the zones of each crop where they are grown and to delimit regions of different levels of productivity. As such, ranking co-efficient values for individual crops are derived and further arranged in ascending order. The co-efficient values are grouped into three classes i.e. high, moderate and low. Further, overall ranking co-efficient value has been derived by adding ranking co-efficients of each crop for each circle and divided by 'n' (i.e. number of crops). The results, thus derived are mapped. These maps are compared with the map showing intensity of irrigation (Fig.3.4-A). Further, the superimposition of map 4.2-A certainly exhibits the impact of irrigation on overall crop productivity. The crops of sugarcane and wheat, irrigated crops in the region, are also considered mainly for analysis.

i) Spatial pattern of sugarcane productivity :

Sugarcane covers 45.5 percentage, 29166.03 hectares of the total irrigated area in 1989-93. The superimposition of Fig.3.4-A on Fig.4.2-A clearly points out that level of agricultural productivity and the level of irrigation development are corresponding closely to each other.

Fig.4.1-A highlights the fact that the level of sugarcane productivity is high (ranking co-efficient below 5) in those areas where irrigation development is significant. The ranking co-efficient of sugarcane productivity in the region,

as a whole, is 4.74. The circle Hole, Phaltan and Aussu show the high level of sugarcane productivity where ranking co-efficient ranges between 3.97 to 4.0. The value of ranking co-efficient for the zonal average productivity is 3.99. The above circles are well endowed with developed stage of irrigation due to canal associated with black soil (Fig.2.2).

The moderate productivity is found in the circles of Tardgaon and Barad. In this category, the intensity of irrigation is also moderate with ranking co-efficient between 4 to 5 and the zonal average of 4.67. The rest of region, particularly south-western hilly tract (Girvi and Adarki) presents low sugarcane productivity where intensity of irrigation is poor (below 70 percent). The low productivity is affected by infertile soils (Fig.2.2) associated with hilly terrain and scarcity of water during summer months.

The area of high productivity has been increased during (ranking co-efficient below 1.5), the period under study. It is observed in Hole, Phaltan and Aussu circles. Moderate productivity has increased (ranking co-efficient 1.5 to 2.0). It is noted in Taradgaon and Barad circles. The low change is confined to Girvi and Adarki circles where ranking co-efficient is 2.0 to 2.5 (Fig.4.1-B).

ii) <u>Spatial pattern of wheat productivity</u> :

Wheat is a rabi crop. It covers 23.28 percent (14918.77 hect.) of the total irrigated area. Wheat productivity in all circles follows almost the picture to that of sugarcane productivity patterns in the region (Fig.4.1-A). The spatial pattern of wheat productivity is depicted in Fig.4.1-C, reaveling the high productivity of wheat in Hole, Phaltan and Aussu circles with ranking co-efficient below 3.50. This could be attributed to well developed irrigation facilities (Fig.3.3-D) and black soil too (Fig.2.2).

The moderate productivity (ranking co-efficient between 3.50 to 4.50) of wheat is observed in Taradgaon and Barad circles. In this zone the intensity of irrigation is also moderate. This area is partly irrigated by canal and partly by well leading to moderate position.

The low productivity zones are located to south-western parts of the region. This part is characterised by undulating topography with fertile soil where the ranking co-efficient account for 4.50 to 5.50.

The high productivity has been increased (ranking co-efficient below 1.5) in Hole, Phaltan, Aussu circles. Moderate productivity is also increased (ranking co-efficient 1.5 to 2) in only Barad circle. The low change is found in

Taradgaon, Girvi and Adarki circles with ranking co-efficient of 2.0 to 2.5 (Fig.4.1-D).

iii) Temporal changes in irrigation and in sugarcane, wheat productivity :

Table 4.1 reveals a comparative picture of positive changes in the area under irrigation and resulted increase in the productivity of sugarcane and wheat during 1959-93. The area under irrigation has been considerably increased from 35884.21 hect. in 1959-63 to 64085.42 hect. in 1989-93 with absolute increase of 28191.21 hectares. Similarly sugarcane also indicates positive change in area from 5000.64 hect. in 1959-63 to 29166.03 hect. in 1989-93 with absolute increase of 24165.39 hect. Sugarcane shows 31.58 percent increase to its total irrigated area during the last 30 years. An interesting fact is that per hectare productivity of sugarcane also shows upward trend. The productivity has been changed from 43 tonnes per hect. in 1963 to 80 tonnes per hect. in 1993. In fact, increase in irrigated area is not only single factor affecting productivity. The technological changes in sugarcane cultivation are also responsible for such changes. However, assured water supply is the basic factor which promotes an increase in productivity. Table 4.1 also shows same position of wheat.

Table 4.1 : Irrigated area and crop productivity, 1959-93.

Year	Total irrigated area (Ha)	Sugarcane			Wheat		
		Area (Ha.)	Percentage of total irrigated area	Yield per hect. (tonnes)	Area (Ha.)	Percentage irrigated area	Yield per (Ha.) Qui.
1959-63	35894.21	5000.64	13.93	43	5396.77	15.04	14.00
1989-93	64085.42	29166.03	45.51	80	14918.77	23.28	22.00
Change	28191.21	24165.39	31.58	+37	9522.00	08.24	+8.00

SOURCE : Compiled by the author, 1994.

iv) Irrigation and overall agricultural productivity :

Based on agricultural productivity, Phaltan tahsil can conveneintly be grouped into three major categories (Fig.4.2-A) viz. high, moderate and low. The ranking co-efficient of agricultural productivity ranges from 1.5 in Phaltan circle to 4.0 in Adarki and Girvi circles. The average ranking co-efficient for the entire region is 2.73. The regional disparities in agricultural productivity correspond with intensity of irrigation (Fig.3.4-A).

A - High productivity region (below 2) :

It comprises the circles of Hole, Phaltan and Aussu with ranking co-efficient below 2.0, as against the zonal average of 1.7. Comparatively, this part is agriculturally developed as it possesses favourable attributes like deep black fertile soil (Fig.2.2) assured irrigation facilities from canal and technological development in general. Farmers use new techniques and the level of mechanization is also high (Fig.4.3-B). The use of fertilizers is also more in these circles (Fig.4.3-A). Therefore, the region has recorded high productivity.

Thus, the circles with high intensity of irrigation has shown high agricultural productivity which indicates positive relationship.

B - Moderate productivity region (2 to 3) :

Moderate productivity is found where there is moderate development of irrigation facilities (Fig.3.4-A). The circles of Taradgaon and Barad are included in this zone, where ranking co-efficient vary from 2.0 to 3.0. This circle has less fertile soil scarcity of water for irrigation, the use of fertilizers and mechanization are moderate (Fig.4.3-B). Hence, the zone of moderate intensity of irrigation coinsides with the tract of moderate agricultural productivity.

C - Low productivity region (above 4) :

The southern parts of the region have experienced low level of agricultural productivity. Adarki and Girvi circles with productivity index value of 3 to 4.0, the region has rugged topography with slopy lands (Fig.2.1). There is persistence of laterite soils (Fig.2.2) and moreover this tract has lack of irrigation facilities. There is also low proposition of fertilizer use (Fig.4.3-A) and the poor economic conditions of farmers do not permit the use of modern implements. The level of mechanization is also low in these circles (Fig. 4.3-B).

<u>Changing pattern of agricultural productivity</u> :

Considerable changes in the productivity are noted along the Nira river and right bank canal. It comprises the areas of Taradgaon, Hole, Phaltan and Aussu circles with ranking co-efficient below 0.30, perhaps this may be due to introduction of irrigation and increasing use of fertilizers and mechanization. The moderate change is found in Barad circles where there are moderate irrigation facilities (Fig. 3.4-A) with ranking co-efficient between 0.30 to 0.50.

The low change is noted in Adarki and Girvi circles with ranking co-efficient between 0.50 to 1.0. This part has been characterised by poor development of irrigation facilities (Fig.3.4-A).

It is evident from the fact that when map 3.4-A, showing the changes in the intensity of irrigation, is superimposed on map 4.2-B, of changing pattern of agricultural productivity, gives corresponding spatial pattern. Thus, the changing intensity of irrigation is closely linked with the agricultural productivity.

Intensity of irrigation and other variables :

Fig.4.4 shows the position of each circles in relation to irrigation intensity.

(a) Intensity of irrigation and agricultural productivity :

Intensity of irrigation is closely related with the level of productivity. The circles of Hole, Phaltan and Aussu have recorded high productivity. Similarly they possess high intensity of irrigation. Assured irrigation facilities promote more use of fertilizers to increase high yielding varieties of production. In all these circles, there is high level of mechanization.

The circle of Barad is located on the normal line and Taradgaon is nearer to the normal line. It means that the circle has normal intensity of irrigation. The use of fertilizer and mechanization is also low in these circles.

The circles of Girvi and Adarki have low productivity of agriculture where there is low intensity of irrigation.

(b) Intensity of irrigation and fertilizer consumptions :

Fig.4.4-B show the relationship between two variables viz. irrigation intensity and fertilizer consumption. The positions of each circle indicates that how both are correlated. In Tardgaon, Girvi and Adarki circles, the level of fertilizer consumption is low and the intensity of irrigation is also low

due to inadequate water for irrigation. The position of Barad circle is near to the normal line indicating that both irrigation intensity and the level of fertilizer consumption are moderately available. This circle therefore, shows the balanced position of intensity of irrigation and level of fertilizer consumption. Where well irrigation has acquired dominant position. The circles of Hole, Aussu and Phaltan show different positions where the intensity of irrigation is high and the level of fertilizer consumption is also high. This may due to assured irrigation promoting the farmers to use fertilizers. This has resulted into increasing productivity of agriculture.

(c) Intensity of irrigation and level of mechanization :

Fig.4.4-C exhibits the position of Adarki circle which is nearer to the normal line. This reveals the relationship of intensity of irrigation with the level of mechanization. It is obvious fact that low irrigation has not promoted mechanization in this circle. Poor irrigation facilities have discouraged modernization of agriculture. Taradgaon and Girvi circles are located close to the normal line recording low intensity of irrigation but the level of mechanization is quite moderate. This indicates the dependence on non-irrigated crops.

Barad and Phaltan circles have recorded high intensity of irrigation but moderate level of mechanization. The farmers are inclined to adopt mechanization.

Hole and Aussu circles have high intensity of irrigation due to assured irrigation from the canal. The farmers use modern technology to obtain high yields of crops. Therefore, both circles have attained high level of productivity.

2. IRRIGATION AND LEVEL OF FERTILIZER CONSUMPTION :

The application of fertilizers to agricultural land has become common phenomena during the recent past. This has boosted up the agricultural productivity considerably. Fertilizer is land saving as well as labour saving input and its land augmenting character has attracted much attention (Jadhav and Shinde,1975). Therefore, in improved agricultural practices like hibreed seeds and use of chemical fertilizers are closely related with irrigation facilities. The per hectare consumption of fertilizer is fair representation of the regional resources like resource endowment and infrastructural facilities in agricultural sector (Sharma P.V.,1974).

In the present investigation, an attempt is made to assess the impact of irrigation on fertilizer consumption. The decided hypothesis is as 'an assured irrigation promotes the use of chemical fertilizers'.

Methodology :

The present study analyses the spatial pattern of fertilizer consumption per 100 hectares of irrigated land.

The data of fertilizer consumption per hectare, in each circle, is obtained with sample method through fieldwork. The data has been analysed with the help of the following formula to calculate the index values of fertilizer per unit areas.

$$FI = \frac{fc}{fr}$$

Where, FI = Index of fertilizers consumption

fc = Fertilizer consumption per 100 hect. of irrigated area in 'a' zone

fr = Fertilizer consumption per 100 hect. of irrigated area in the region.

The index value where arranged in ascending order and designated the respective zones as low, moderate and high on the basis of their fertilizer consumption. The map (Fig.4.3-A) showing the spatial pattern of fertilizer consumption, is superimposed on the map showing the intensity of irrigation (Fig.3.4-A) and further the relationship is observed. Here, sugarcane is chosen as irrigated crop which may reveal proper picture of fertiliser consumption in the region.

<u>Spatial pattern of fertilizer consumption</u> :

The average fertilizer consumption for the entire region is 88.32 tonnes per 100 hectares of irrigated land. The consumption, within the region, varies between 59.88 to 121.26 tonnes

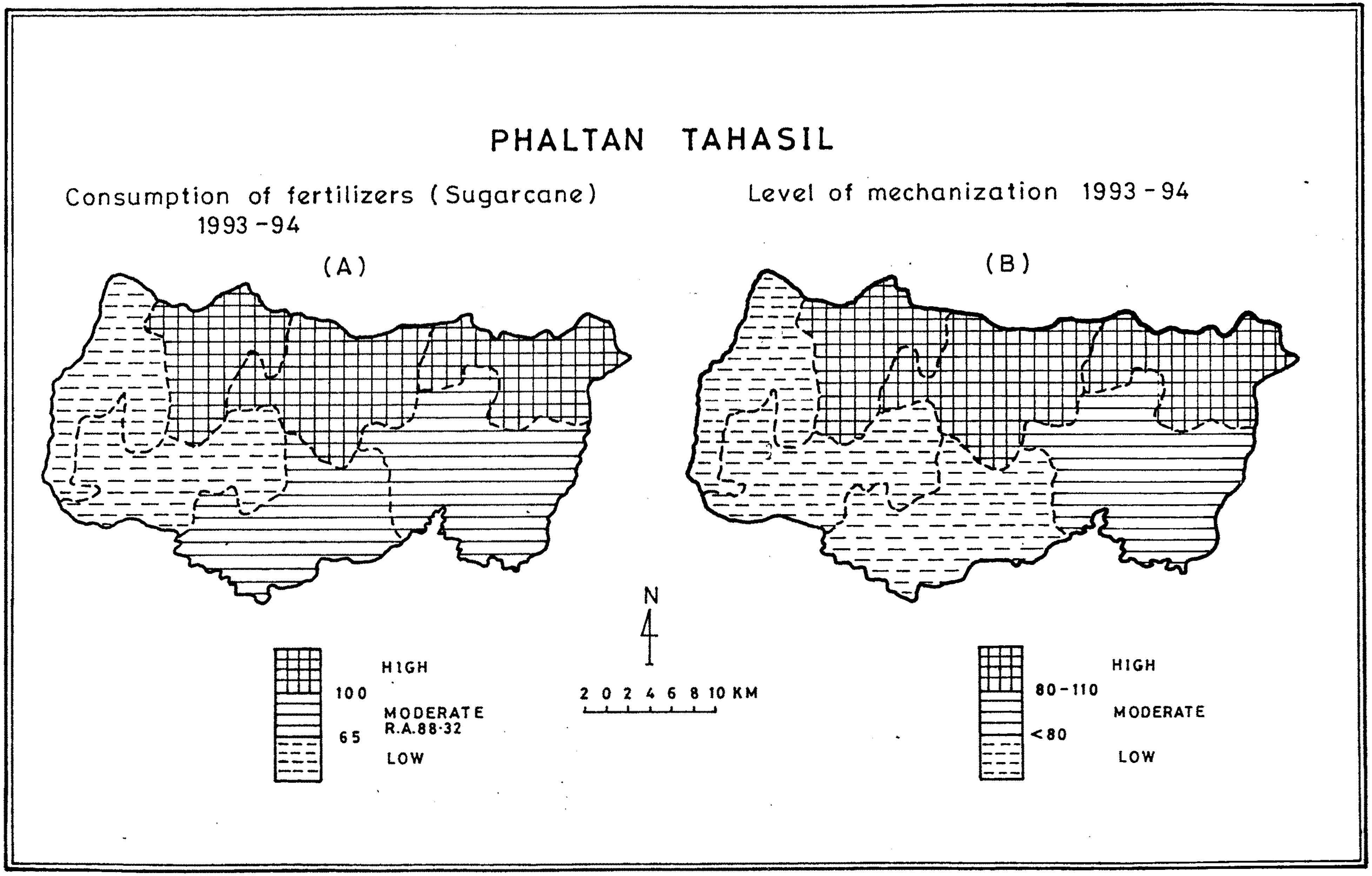

PHALTAN TAHASIL
Consumption of fertilizers (Sugarcane) 1993-94
(A)
HIGH
100
MODERATE
R.A.88·32
65
LOW
Level of mechanization 1993-94
(B)
HIGH
80-110
MODERATE
<80
LOW
N
2 0 2 4 6 8 10 KM

FIG. 4·3

per 100 hect. of irrigated area. Fig.4.3 shows the spatial pattern of consumption for the year of 1993-94. The figure clearly points out that the fertilizer consumption is uneven in the study region. It is also evident from the superimposition of Fig.4.3Aand Fig.3.4-A that there is high positive correlationship between these two variables. The entire region can be grouped into three distinctive units having the variation in the levels of fertilizer consumption. They are characterised as follows.

(i) Region of low consumption (below 6.5) :

The western most two circles viz. Adarki and Tardgaon are included in this category. This has been characterised by low intensity of irrigation (below 70 percent) and the level of fertilizer consumption is less than 65 tonnes per 100 hect. which is below the average (88.32 tonnes) of the region. The main constraints are the natural factors in the form of hilly nature and scarcity prone zone associated with poor soils. This zone, therefore, can be referred to as 'problem area'.

(ii) Region of moderate consumption (65-100) :

This zone is confined to southern parts of the region which comprises the parts of Barad and Girvi recording the intensity of irrigation between 70 to 90 percent. Especially, Girvi circle possesses low intensity of irrigation (below 70%), resulted from adverse enviromental conditions. All this has discouraged the use of fertilizers in the region. As a result, this zone has moderate level of (65 to 100 tonnes) fertilizer consumptions. Mention may be made that this part has the supply of water for irrigation from other sources mainly of life irrigation schemes. However, there are tracts of poor soils and poor economy in general have all led to moderate level of fertilizer use.

(iii) Region of high consumption (above 100) :

This zone is parallel to Nira river course and well endowed with black deep soils, presence of right bank canal providing perennial water, substantial level of productivity and sound income level of farmers. This tract has also recorded high intensity (Fig.3.4-A) level which is more than 90 percent. The farmers are also well conversant with the use of modern technology. Besides, the village co-operatives have also played positive role in the supply of inputs. All these have resulted into increasing use of fertilizer (above 100 tonnes per 100 hect.). Moreover, Phaltan circle has attained better position 121.26 tonnes regarding fertilizer use as this circle is relatively well endowed with favourability of natural and socio-economic conditions.

It is evident from the above analysis that variation in fertilizer consumption corresponds with the spatial variation in the intensity of irrigation. The irrigation encourages farmers to use fertilizers to gain increasing production from agriculture. These areas, with high intensity of irrigation, have same considerable use of fertilizers. An assured irrigation has bearing on fertilizer consumption.

3. IRRIGATION AND MECHANIZATION :

The contemprary agricultural development reveals the fact that irrigation has promoted the development in mechanization of agriculture. The developments in irrigation are always regarded as stimulant to modernize agriculture. Such modernization takes place only when the farmers can afford themselves to invest in the process of development of agriculture. Such economic ability of farmer to invest in agricultural sector has been determined by irrigation as it promotes income level. Mechanization of agriculture is essential characteristic of irrigated areas. Invariably assured irrigation, therefore, paves the way for mechanization. Mechanization here refers to the available number of modern and mechanically improved implements in the form of tractors, electric pumps, oil pumps etc. Thus, mechanization indicates the use of inanimate power in agriculture.

Agricultural mechanization is one of the most important indicators of agricultural development which, in turn, reflects the social, economic background of the region (Rajapati Ram, 1979). Any region moves fast towards modernization with the adoption of mechanization in agriculture. The adoption of different machines in agriculture are closely related with irrigation facilities. It is a common belief that Indian farmers can increase their agricultural production to a considerable extent by adopting most of the agricultural innovations if they are supported with adequate and assured irrigation facilities (Mohammad and Masjeed, 1979).

In the following analysis, an attempt has been made to examine the spatial pattern of the levels of mechanization and its correlation with irrigation. This would certainly reveal the fact that how irrigation is instrumental to enhance the rate of mechanization. It is, therefore, proposed to formulate the hypothesis as 'Irrigation influences the level of mechanization and it is positively correlated to mechanization'.

Methodology :

In the present study, tractors, electric pumpsets and oil pumpsets have been taken into consideration in measuring the levels of mechanization. The data pertaining to the number of tractors, electric and oil pumpsets in each circle, were collected and the index values, for each machine in each zone were obtained with the help of following formula.

$$Ia = \frac{Ca}{Ra} \times 100$$

Where, IA = Index 'a' machine

Ca = The number of 'a' machine per 100 hectares of irrigated land in 'c' circle

Ra = The number of 'a' machine for per 100 hectares of irrigated area in the entire region.

The indices were obtained for each machine for seven circles. The composite index of mechanization is then derived by adding the three indices and dividing them by 'n' number ie. three. The indices were arranged in ascending order and the emerging respective zones were designated as low, moderate and high. The map, showing the levels of mechanisation, is then superimposed on the map showing the intensity of irrigation to find out relationship. This has enabled the author to assess the impact of irrigation on mechanization.

Spatil pattern of levels of mechanization :

Fig.4.3-B exhibits the levels of mechanization in the region. The superimposition of Fig.3.4-A on Fig.4.3-B clearly indicates that the level of mechanization corresponds with the patterns of irrigation intensity. The levels of mechanization are shown spatially and grouped into three categories as -

(i) Region of low level of mechanization (below 80) -

This category comprises the area of hilly ranges in the south, west and southwest. It includes the circles of Adarki, Girvi and Taradgaon. The zone records, low intensity of irrigation (below 70 percent). Poor soils, and hilly topography exerting the limits to irrigation developments which inturn has resulted into low level of mechanization.

(ii) Region of moderate level of mechanization (80-110) -

Barad circle has attained moderate level of mechanization where irrigation intensity is also moderate (70 to 80%). This circle has different sources of irrigation. Water from canal is available in the northern parts whereas remaining parts receives irrigated water mainly from wells. The adverse climatic and geological conditions have also limited the scope of irrigation which has led to moderate position of this circle.

(iii) Region of high mechanization (above 110) -

This is agriculturally productive and 'sugarcane core' area of the region which is supplied with perennial irrigation from Nira right bank canal. This irrigated tract comprises the parts of Hole, Phaltan and Aussu circles recording high intensity (above 110) of irrigation (Fig.3.4-A). The zone possesses comparatively an extensive flood plain with fertile soils. It has been characterised by the farms devoted to to sugarcane where some parts are irrigated by either individual or co-operative lift irrigation schemes. Many farmers have also set pumps independently on Nira river. Assured water supply has resulted into high productivity of crops. As a result, people earn more and they can offord to have machines of their own. Besides this, the scarcity of labourers has also forced farmers to purchase tractors. This zone, therefore has more number of tractors.

It could be concluded from the above analysis that irrigation has immense impact on the levels of mechanization. Since irrigation favourably affects on productivity and income level of farmers as well. The farmers, therefore, afford themselves to purchase improved implement. Thus, increase in the number of improved implements is affected by irrigation and irrigation is one of the important components to determine the level of mechanization. Hence, higher the intensity of irrigation more is the level of mechanization.

4. CORRELATION ANALYSIS :

In order to study the relationship of irrigation with other variables, the author has attempted to examine the correlationship of various variables. The correlation matrix has been prepared (Table 4.2) indicating positive and negative correlationships of selected dependent and independent variables. The correlation matrix is attempted here by using Pearson's co-efficient correlation (r).

$$r = \left\{ \Sigma xy - \frac{\Sigma x . y}{n} \right\} \Big/ \sqrt{\frac{x^2 - (\Sigma x)^2}{n}} \; X \sqrt{\frac{\Sigma y^2 - (\Sigma y)^2}{n}}$$

Where, x = Independent variable

y = Dependent variable

n = Number of observations

Irrigation (X_1) has been considered as dependent variable where as four other variables viz. per hectar consumption of fertilizer, (X_2), level of mechanization (X_3), mean annual rainfall (X_4) and gricultural productivity (X_5) as independent variables, are chosen in the analysis.

Table 4.2 : Correlation Matrix.

	Intensity of irrigation	Consumption of fertilizer	Level of mechanization	Mean annual rainfall	Agricultural productivity
	X_1	X_2	X_3	X_4	X_5
Intensity of irrigation X_1	1.00	0.94	0.04	0.00	0.14
Consumption of fertilizer X_2		1.00	0.36	0.00	0.12
Level of mechanization X_3			1.00	0.00	0.93
Mean annual rainfall X_4				1.00	0.00
Agricultural productivity X_5					1.00

SOURCE : Compiled by the author, 1994.

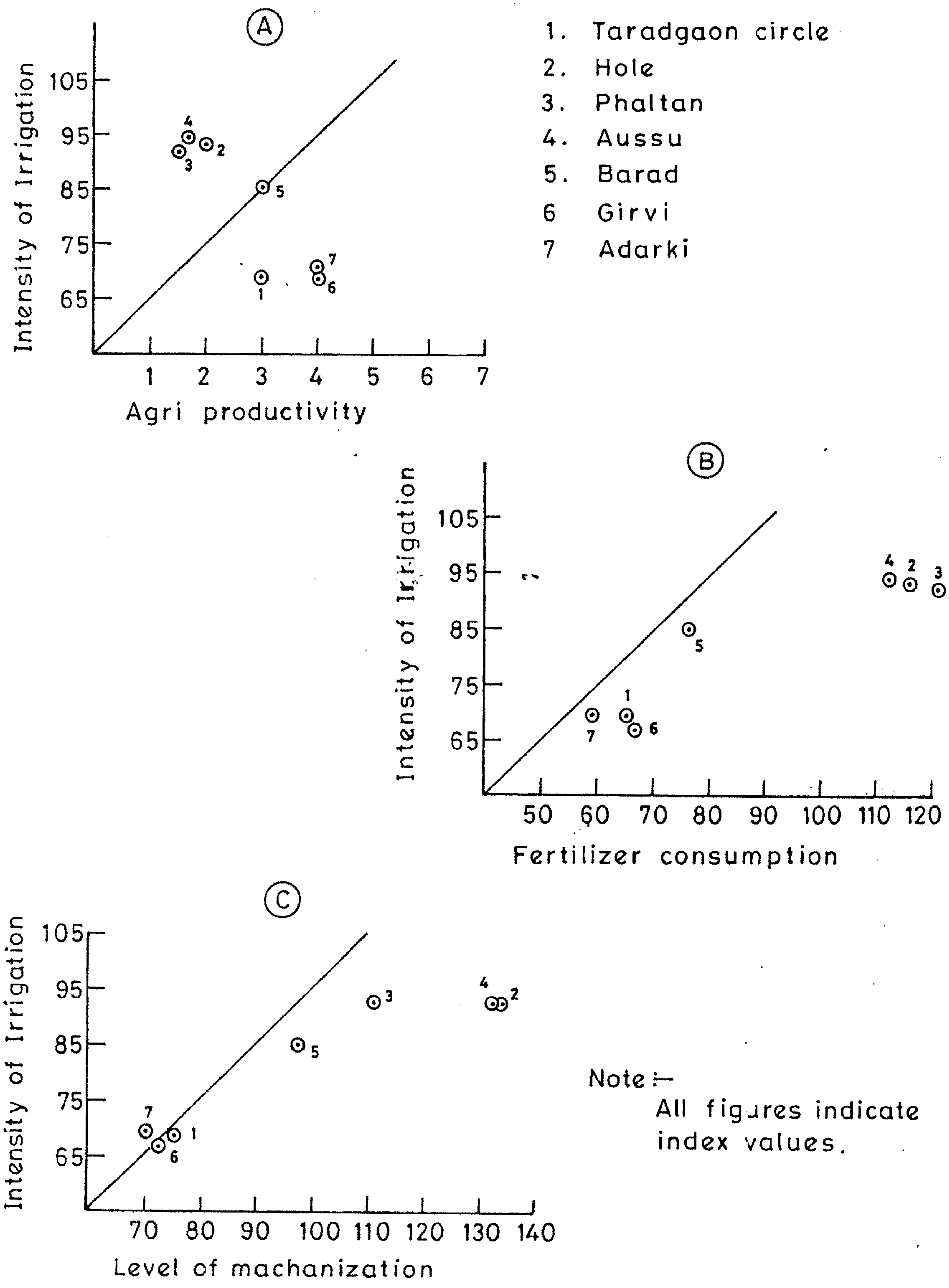


FIG. 4·4 – POSITION OF EACH CIRCLE IN RELATION TO INTENSITY OF IRRIGATION AND OTHER VARIABLES.

<u>Analysis</u> :

In Phaltan tahsil, significant positive correlationship is existed between the intensity of irrigation and per hectare consumption of fertilizers (0.94). In fact, the farmers tend to apply chemical fertilizers, without any risk to irrigated area as there is assured supply of water. Therefore, the areas having high intensity of irrigation (Fig.3.4-A) have recorded high consumption of fertilizers (Fig.4.3-B) in the region. There is also significant correlationship between agricultural productivity and level of mechanization (0.93) which indicates close link between these two variables. Obviously, the farmers, in irrigated parts, generally grow cash crops which may give lucrative gains to farmers. Some parts of such high income has been diverted to purchase improved implements so as to save animate and human labour for achieving high agricultural productivity. Thus, high level of mechanization corresponds with increasing agricultural productivity. There is also moderate correlationship between consumption of fertilizers and level of mechanization (0.36). This is also quite indicative fact that with the increase im fertilizer consumption, the agricultural production is augmented which is altimately reflected in the purchase of improved implements by the farmers.

Interesting fact is that annual rainfall is not correlated (0.00) to any other variable. This might be due to the dominance of canal irrigation and the rate of percolation of water for underground source of irrigation which is also favourably affected from the canal and its distributories. Further, this has been tapped in the form of well irrigation (Fig.2.1-B). Therefore, mean annual rainfall has insignificant role to play in the region which is generally about 2631.53 mm. However, the water regime of the Veer Dam from which water is regulated to canal, is important area where rainfall is substantial (located within the Leeward Valley of Wn.Ghats). Besides the above correlationships, there is also positive but insignificant correlationship between intensity of irrigation and level of mechanization (0.04) and agricultural productivity (0.14). The mechanization has always shown upward trend in irrigated tracts which is common phenomenon in the region. Moreover, intensity of irrigation is positively correlated to agricultural productivity. But, the region does not show sound correlationship. This might be due to continuous use of land for sugarcane cultivation with high application of fertilizers vise of vanal water. This might have degraded the inherent characteristics of soil leading to infertile nature of the land which is reflected less significant correlationship.

SECTION II : PROBLEMS OF IRRIGATED AREAS

The soil is a natural medium of plant growth and it is a natural body developed by natural forces acting on earth surface. Moreover, it is the medium from which crops draw water and nutrients. Hence, soils must be carefully husbanded, and conserved. A proper combination of texture, salt and humus yields good results but sometimes due to unwise exploitation, misuse of soil and excess use of irrigation and fertilizers results into soil degradation.

Land degradation is a comprehensive term often used to denote the decrease in productivity, fertility status and property of land in general. Soil degradation may also be caused due to improper management of soil. The degraded land defined by Stamp (1986) as the land which has been previously used but now abandoned and no further use has been found for such land. Land degradation includes soil erosion, salinization, waterlogging and misuse of land. Moreover, it is the land available for cultivation, but not taken up for cultivation after a few years for some reasons or other. Degraded land is that land which is not being utilized at present may be called degraded land and includes the lands which are left fallow due to various constaints or whose productivity has declined more than 50 percent due to misuse and overuse by human and cattle population (Patil,1988). The negative impact of irrigation are reflected in decreasing productivity level of soil. In fact, such problems have emerged out due to improper use of irrigated water to soils.

Methodology :

In the present section the author has attempted to analyse the spatial distribution of degraded soils in Phaltan tahsil. The degraded soils in the irrigated tract are considered. The degraded soils here mainly include saline, alkaline, waterlogged areas of the region. These problems are resulted from the negligence towards this valuable resource. The data were collected through fieldwork for which the author made spot visits frequently. The cropped areas of 21 villages were carefully observed during different seasons and the problems of irrigated lands were identified. The extent and nature of such problematic soils were then determined. This kind of work would be useful for adopting proper strategy in planning.

5. SPATIAL DISTRIBUTION OF DEGRADED SOILS :

The negative effect of irrigation are observed in the areas where black and deep black soils are dominant and inadequate drainage facilities are existing. Excess use of irrigation water and heavy application of chemical fertilizers have together caused the problem of soil degradation. Thus, region has been divided into following generalized zones which are based on pH values.

A) Soil Degradation Zones :

The salinity and alkalinity of soils is serious problem as it is a limiting factor with respect to crop productivity.

PHALTAN TAHASIL

General Soil reaction zones 1959 - 1994

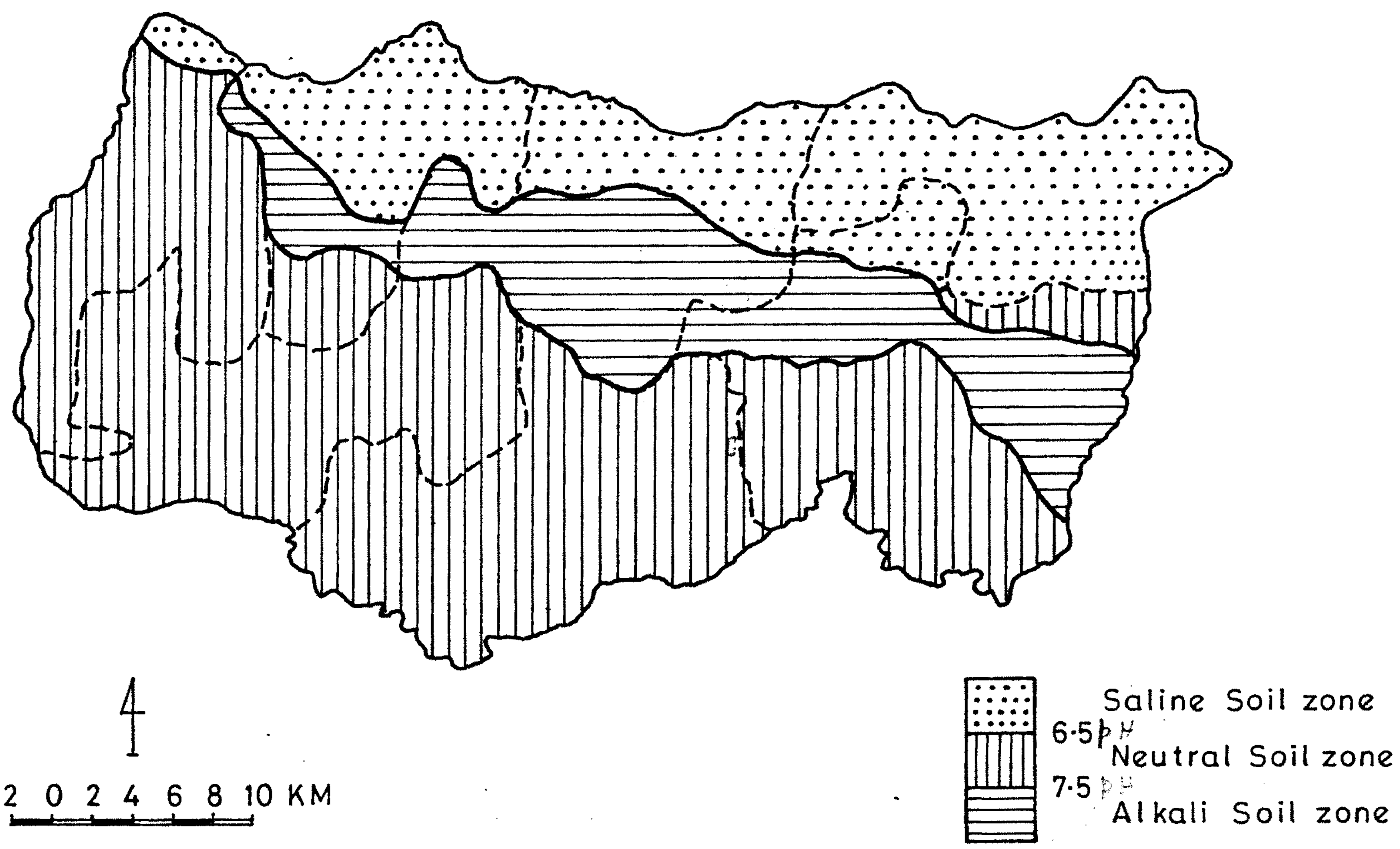


FIG.4·5

Saline soils refer to those soils which contain excess of salt with pH 6.5 value whereas soils containing more exchangeble sodium clorides, calcium magenesium with pH 7.5 to 10 are called alkaline soils. Quality of irrigation water, topographical position, poor drainage, high watertable, inadequate planning of irrigation are some of factors responsible for soil degradation. Three generalized soil degradation zones are recognized as below.

(i) Saline soil zone -

It includes the soils having pH value below 6.5 and it covers about 35.51 percent of northern part of the study region (Fig.4.5-A). This is due to the extent of over irrigation. It raises sub-soil watertable. The sub-soil water is saline and is confined to 1.2 metres below surface ground. The growth of various irrigated crops affected adversely by the salinity level of the soil.

(ii) Neutral soil zone -

Neutral soil zone with pH value ranging between 6.5 to 7.5 covers about 43.33 percent of total area. These soils are mainly observed in Taradgaon, Adarki, Girvi and southern parts of the Barad circle of the study region (Fig.4.5).

(iii) Alkaline soil zone -

Alkaline soil zone includes soils having more than 7.5 pH value. These soils have often been called black alkali soils.

Table 4.3 : Area and percentage of saline, alkaline and waterlogged soils in Phaltan tahsil, 1993-94.

Sr. No.	Name of the Village	Area in Hect.	Percentage
1	Hole	10.5	6.60
2	Jinti	11.0	6.92
3	Khunte	4.0	2.52
4	Kambaleswar	5.0	3.15
5	Somanthali	12.0	7.55
6	Sangavi	8.5	5.35
7	Songaon	3.0	1.88
8	Vidani	2.5	1.57
9	Algudewadi	4.0	2.52
10	Takalewadi	5.0	3.14
11	Mathachiwadi	9.5	5.97
12	Gunaware	12.5	7.86
13	Choudharwadi	10.5	6.60
14	Rajale	16.0	10.06
15	Sathe	9.0	5.66
16	Khatakevasti	10.0	6.30
17	Pawarwadi	3.5	2.20
18	Assua	3.5	2.20
19	Jadhavwadi	9.5	5.97
20	Hanumanthwadi	4.0	2.52
21	Sastewadi	5.5	3.46
	Total	159.0	100.00

SOURCE : Based on the fieldwork conducted by the author, 1993-94.

The percentage of exchangable sodium saturation in alkali soils is greater than pH 10. Alkaline soil comprises about 21.16 per cent area of the region.

The last thirty four years have witnessed significant development in irrigation i.e. gross irrigated are in 1959-63 was about 35894.21 hectares which rose upto 64085.42 in 1989-93 (Table 2.3).

The empirical study carried out reveals that soil degraded area is mainly confined to the canal system in the region. At present the soil degraded area is about 159 hect. and is observed in 21 villages of the tahsil. Table 4.3 exhibits the extent of degraded soils in different villages. The villages of Rajale (16 hect.), Gunaware (12 hect.), Somanthali (12 hect.), Jinti (11 hect.), Hole (10.5 hect.) and Khatakewasti (10 hect.) have recorded high proportion of degraded soils. This has been followed by moderately degraded soils in Mathachiwadi (9.5 hect.), Jadhavwadi (9.5 hect.), Sathe (9 hect.) and Sangavi (8.5 hect.). The low proportion (below 6 hect.) is observed in rest of the selected villages. In some parts of villages of Hole, Jinti, Kambleswar, Somanthali and Sangavi the surface run off is negligible, drainage is poor and high rate of evaporation leaves salt on surface.

B) <u>Waterlogged Areas</u> :

Water-logging is distinct hazard in the development of agriculture. Waterlogging results from the excess use of water in the absence of drainage. Moreover percolating water from unlined canal accumulates in sub-alluvial soil which assists to rise in underground watertable. When watertable is just below three metres from the ground due to capillary action underground water appears on the surface and do not allow crops to grow. Surface watelogged land is that land where the water is at or near the surface and water stands for most of the year. It is observed during the field study that about 63.0 hect. of land is waterlogging. Such degradation process has converted large fertile irrigated parts into unproductive barren land. Waterlogged areas covers about 39.62 percent of total degraded area. It is confined mainly to Gunaware, Mathachiwadi and Takalewadi villages. Moreover waterlogged lands are also noted in Hole, Jinti, Khunte, Kambleswar, Sangavi, Songaon, Vidani, Altudewadi and Choudharwadi, Mathachiwadi, Gunaware, Jaklewadi villages of the study region (Table 4.3).

<u>Summary</u> :

Foregoing analysis reveals the fact that as how crop productivity, fertilizer consumption and level of mechanization in agriculture have been affected by the intensity of irrigation. The regional variations in these aspects correspnd with spatil pattern of intensity of irrigation.

Irrigation has certainly greater bearing on agricultural productivity. The spatial disparities in agricultural productivity (Fig.4.2-A) coincide with regional distribution in intensity of irrigation. The circles clese to Nira river course and having perennial supply of canal water records high intensity of irrigation (Fig.3.4-A). Further, this zone has attained high agricultural productivity. Thus, assured supply of water has influenced crop production. Irrigation minimizes risk in the use of fertilizers which may lead to high production. Contrasting to this, por intensity of irrigation is confined to southern circles recording low productivity level.

A close relationship between intensity of irrigation and fertilizer consumption has been emerged out in the analysis attempted. The regional patterns of fertilizer consumption have also been determined by intensity of irrigation. This indicates that use of chemical fertilizer needs assured water supply and farmers never take risk in using such input when water supply is inadequate. The zones having high intensity of irrigation have, therefore, recorded, high concentration of fertilizer (Fig.4.3-A).

The irrigated tracts with intensity of irrigation (Fig.3.4-A) possess relatively more number of modern implements which determine the level of mechanisation (Fig.4.3-B).

The farmer, who have substantial income can afford to invest for the development of agriculture. The regional patterns of level of mechanization, therefore, correspond with the spatial distribution in the levels of mechanization.

Thus, irrigation has influenced agricultural productivity, fertilizer consumption and level of mechanization in the region.

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