CHAPTER - II

-:- PATTERNS OF IRRIGATION -:-

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1. INTRODUCTION :

In the foregoing chapter the study of physical bases viz. the terrain, drainage, slope, climate and soils has attempted in context of irrigation. As such, irrigation of a particular region is the outcome of physico-socio-economic conditions. However, due to the limitations of the present work, the socio-economic conditions are not discussed in detail. The earlier chapter, therefore, touches the salient features of those. The present chapter focusses on the patterns of irrigation in the region in relation to the sources, intensity, requirements and sourcewise and cropwise economics of irrigation. The emphasis here is on highlighting the spatial distribution pattern of the above points.

2. NEED OF IRRIGATION :

In the monsoon climate there is a high need of irrigation as there is remarkable variations in rainfall in time and space. 'In areas where rainfall is plentiful and well distributed over the year, there is no problem of water. But rainfall is very scanty in certain areas as well as uncertain - In these areas, artificial irrigation is absolutely essential. In certain areas rainfall may be abundent but may be concentrated in a short period of year. In these areas, provision of irrigation will facilitate growing of more than one crop in a year' (Datta and Sundharam, 1974).

Although the region is small in its areal extent (546 k^2) the spatial variations in rainfall distribution can be examined in Fig.1.4-A. The proportion of rainfall reduces by more than 4,500 mm within 50 km distance in east-west direction. Since the raingauge stations in the region have collected rainfall data for the last five years only, the variability of rainfall is not calculated.

The variations in rainfall are observed not only in amount but also in time and space. Although the region experiences sound reliability of rainfall, in the region needs irrigation even in the rainy season, particularly when there is a long gap in the chain of rainy days. Assured water supply is one of the conditions which is very essential for crop growth (Rayapati Ram,1979).

Fig.1.4-A shows the uneveness in the spatial distribution of rainfall. It shows that the need of water is more in the eastern part than the western where the reliability of rainfall is high.

The distribution of rainfall in the region within a year is highly uneven too (Table 1.5). The region, as a whole has 3360 mm annual average rainfall. Out of it more than 95 percent is concentrated in four months i.e. June to September. The months of December, January and February are almost rainless. Thus, there is greater need of irrigation after rainy season when growing crops require artificial supply of water. With the increase in temperature and consequent dryness during summer months (March-May), the requirement of irrigation water is further intensified, particularly, for sugarcane cultivation.

3. LIMITATIONS OF IRRIGATION :

The irrigation in Upper Vedganga basin is not uniformly developed. There are some patches of having high development whereas some areas are very poorly developed (Fig.2.4-A). The physico-socio-economic conditions restrict the development of irrigation in the region.

Physiography is the major constraint in this region which puts strong limitations for the development of irrigation facilities. Undulating topography restricts the development of canal and well irrigation, but the region welcomes the lift irrigation. The besaltic ranges do not permit the water to percolate. Hence the watertable is low in the region, particularly in the southern portion. Along the river side, though the wells are perennial, they faces the problem of scarcity of water for irrigation in the months of April and May. In the foot-hill zone, however, the natural springs are important sources of irrigation but the watertable is also very low. Mention should be made that these springs provide less water during summer months posing the problem of scarcity.

The prospect of irrigation varies from soil to soil. There is less scope for the development of irrigation in the inferior soils, particularly, in the western portion whereas irrigation is developed in the eastern region due to fertile soils. It is, therefore, necessary to plan irrigation schemes, keeping in mind the moisture deficiency, the texture, structure and alkalinity and salinity characteristics of the soils (Pawar and Shinde).

Vedganga river is not a perennial river. It becomes dry from March to May when there is acute need of water for crops and hence puts limits for the successful crop production. Another obstacle in the development of irrigation is the nature of watertable which goes down deeper during summer (Fig.1.6). Concequently, it affects the intensity of irrigation, cropping pattern and multiple cropping. The rationing of water for lifts upto February, the dry course of river in summer months and fluctuation in watertable, seem the major obstacles for planning the cropping pattern earlier.

The western part of the basin is forested. The animals like fox, pigs, etc. distroy the crops like sugarcane, groundnut. Under this situation, it becomes difficult to keep watch for twenty-four hours. As the both sides of the river course rises in altitude, the lift irrigation schemes need more capital investment which can not be offered by poor farmers. Besides these, poverty, ignorance, illitaracy of farmers and lack of guidance and demonstrations are some of the other constraints in the region. However, the healthy co-operative movement, growing awareness among farmers in the recent past have encouraged irrigation in the region.

4. SOURCES OF IRRIGATION :

Presently, the Upper Vedganga basin has different sources of irrigation viz. well, lift and other sources. Neither the three major means of irrigation have even share in irrigated areas nor there is uniformity in their spatial distribution. These sources of irrigation are largely affected by topography, soil and the presence of water resources. Due to variations in these factors, marked regional imbalances in irrigational facilities are observed in the basin.

TABLE 2.1 : Irrigated area by different sources 1985-86.

Mean	Irrigated area (hect.)	Percent to net area sown	Percent to net irrigated area
Well	418	1.98	18.78
Lift	1520	7.26	68.64
Other	280	1.33	12.58
Total	2218	10.57	100.00

SOURCE : Tahsildar Office and compiled by the author, 1986.

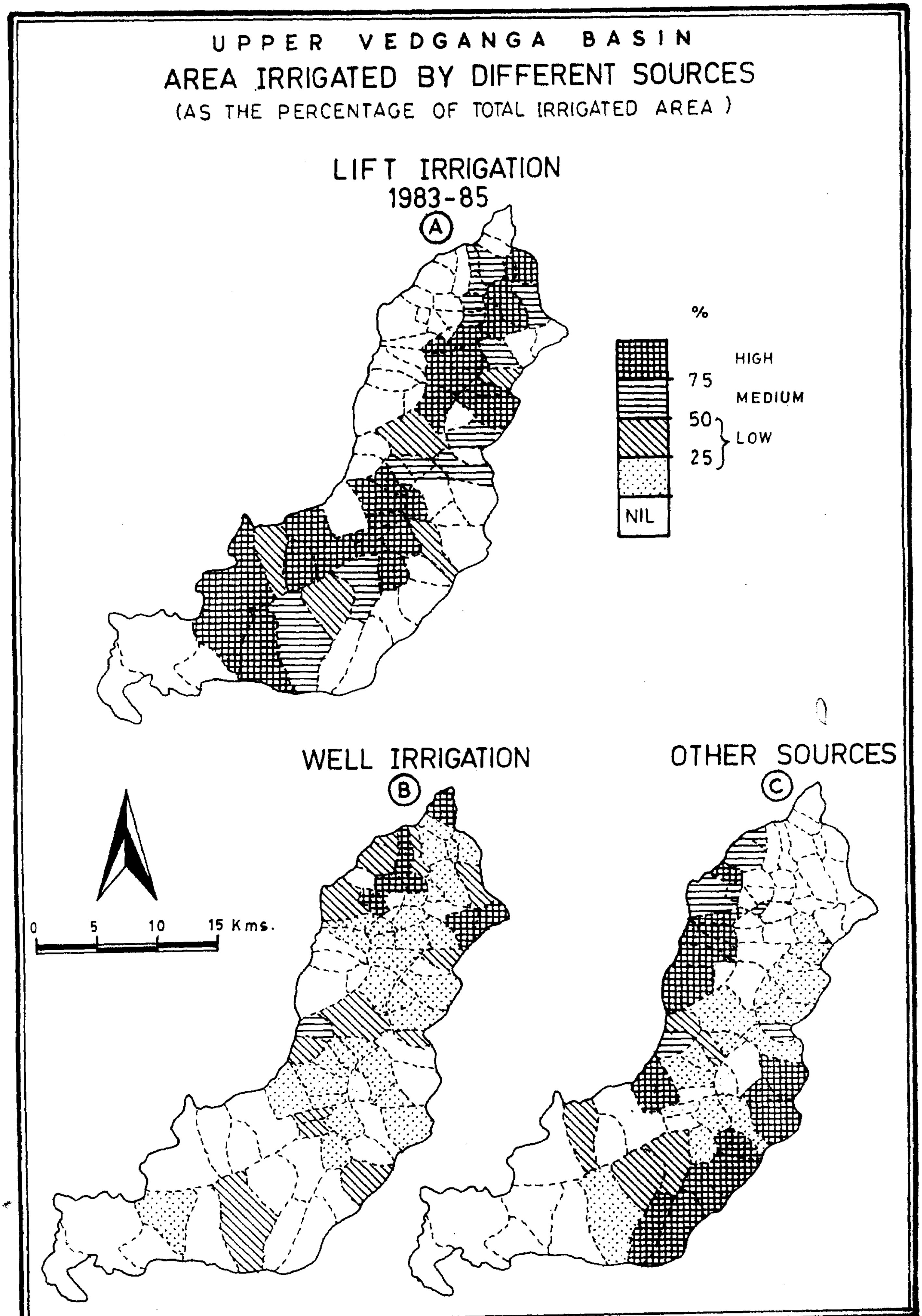

UPPER VEDGANGA BASIN
AREA IRRIGATED BY DIFFERENT SOURCES
(AS THE PERCENTAGE OF TOTAL IRRIGATED AREA)
LIFT IRRIGATION
1983-85
A
%
HIGH
75
MEDIUM
50
LOW
25
NIL
WELL IRRIGATION
B
OTHER SOURCES
C
0
5
10
15 Kms.

Fig. 2·1

The above Table 2.1 shows that the lift irrigation is very dominant source of irrigation accounting 68.64 percent of the total irrigated area. This has followed by well irrigation (18.78) and other sources (12.58).

A) <u>Lift irrigation</u> :

Lift irrigation is a dominant source of irrigation in the region. The water, stored in the river, nala by an artificial way like bandhara or the water from surface flow, is lifted to irrigate fields, situated at high levels. It ranks first position, accounting 68.64 percent of the total irrigated area. The Kolhapur Type Weirs (K.T.W.) play a vital role in this part. The river becomes dry from January to May when there is acute need of water for crops. In order to overcome this problem, KTW are constructed at regular interval in the river course and the water is stored in the river course which is lifted and used for further 2/3 months i.e. January, February and March. The development of lift irrigation during the recent past essentially depends upon these K.T.Weirs. The lifts are operated on river banks. The topography, particularly in the districts of Western Maharashtra, provides ideal locations for such K.T.W. In fact, rural electrification is the major contributing factor for the development of lift irrigation.

There are, at present, nine weirs on the river and another seven are proposed in this region (Fig.2.2-A). The development of co-operative societies, encouragement and financial aid from the sugar factories and the innovative nature of the farmers are also partly responsible for heavy concentration of this source of irrigation'(Pawar 1982).

i) Spatial distribution :

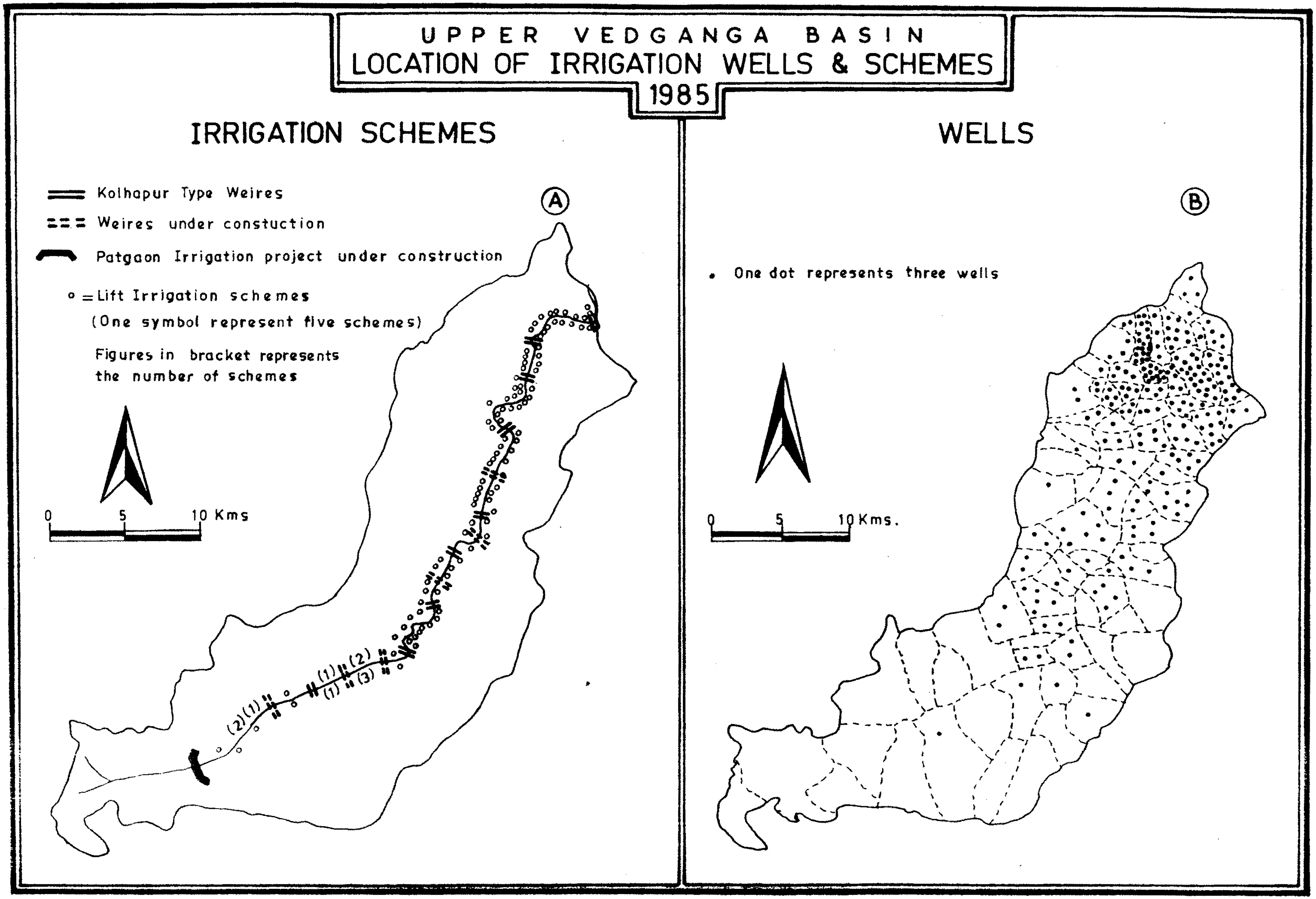
The dominance of lift irrigation is observed all along the river course but there is high concentration at two locations i.e. lower and central part (Fig.2.1-A). There are 44 villages in the region taking the advantage of lift irrigation. No village, out of these, has lift irrigation below 36 percent of the total irrigated area.

It is observed that above 68 percent villages have above 75 percent lift irrigation of the total irrigated area. These villages are located in relatively levelled extensive flood plains and therefore, these are capable of taking advantage of lift irrigation schemes. There are about 27 villages benefitted from lift irrigation (Fig.2.1-A). There are some villages in the west like Mani, Tambale, Kondoshi, Karambali which have no source of irrigation other than lift.

The moderate percent (50-75) is observed in the 13 villages and low percent (25-50) in remaining 4 villages. Due to lack of good soil and steep slope the lift irrigation is not developed in this part of the region.

ii) Lift irrigation schemes :

The region is noted for lift irrigation. There are 430 lift irrigation schemes including small and big, privately



UPPER VEDGANGA BASIN
LOCATION OF IRRIGATION WELLS & SCHEMES
1985
IRRIGATION SCHEMES
Kolhapur Type Weires
Weires under constuction
Patgaon Irrigation project under construction
= Lift Irrigation schemes
(One symbol represent five schemes)
Figures in bracket represents
the number of schemes
A
0 5 10 Kms
(2)
(1)
(3)
WELLS
B
One dot represents three wells
0 5 10 Kms.

Fig. 2·2

owned and co-operative. Ten schemes are co-operative and remaining are privately owned. The lift irrigation schemes in co-operative sector have average capacity ranging from 10 to 40 HP.

TABLE 2.2 : Major weirs, villages covered, number of lift irrigation schemes and area irrigated in Upper Vedganga basin, 1986.

Sr. No.	Name of Weir	No.of villages under command	Total lift irrigation schemes	Area irrigated (Hect.)
1	Waghapur	6	90	299
2	Nilpan	9	87	349
3	Gargoti	8	114	296
4	Vêngarul	5	23	175
5	Kadagaon	6	69	251
	Total	34 *	383	1370
	Actual Number	30		

* Four villages take advantage of two weirs

SOURCE : Compiled by the author, 1986.

It is observed that out of the total lift irrigation schemes more than 50 percent are small having an average command area of 4 hectares with the average 5 H.P. capacity of each.

Inadequacy of water, poor economic condition of farmers have restricted the extension of lift irrigated areas. It is interesting to note here that the big schemes (30 to 40 H.P.) are located in the command area of K.T.W. due to availability of water. It is further observed that K.T.Weirs and number of lift irrigation schemes and the length of pipe line have positive relationship. The weirs make available water upto March in their command area. The upstream villages, which are far away from the boundaries of impounded water of weirs, have either small schemes or very less number of schemes.

Today 9 weirs have been completed and other 7 are under construction (Fig.2.2-A). The data about the number of lift irrigation schemes under the command area of five weirs is presented in Table 2.2.

Of the 81 villages about 44 villages are on either side of the river in the study region. Out of those 44 villages 30 are in the vicinity of impounded water of weirs which have 383 irrigation schemes and irrigate 90 percent of the total lift irrigated area. Whereas, the remaining 14 villages have only 46 schemes, which irrigate 10 percent area. This is because these villages are located at considerable distance and they can not enjoy the vicinity of weirs as in the case of above villages. It is observed that in the area of newly completed weirs, the number of schemes and the length of pipe line is increasing. This situation will develop at its peak after the completion of Patgaon Medium Irrigation Project.

B) <u>Well Irrigation</u> :

Well irrigation is a traditional source of irrigation to man. It ranks second and accounts for about 18.78 percent (418 hect.) of the total irrigated area in the study region. However, its spatial distribution varies from west to east. There is large scale concentration of well irrigation in the lower region i.e. away from the river course.

i) <u>Spatial distribution of wells</u> :

The behaviour of watertable and the topography determine the physical settings of the well (Pawar, 1982). Well irrigation is an important source of irrigation in the region where the irrigation by lift or other source is not possible. As the cost of construction of well is comparatively low, they are well suited to poor and marginal farmers.

There are 660 wells in the region but their spatial distribution is very uneven. There is great concentration in the lower part whereas they are absent in the extreme west (Fig.2.2-B). Thirteen villages in the east possess more than 50 percent of the total wells whereas 14 villages have no well at all. The highest number of wells (56) is recorded by Nadhavade village. The high concentration of wells can be attributed to the favourable watertable, moderately sloping land particularly the foot-hill zone and medium to fertile soils. This is the only source of irrigation in many villages. The low intensity in the west is due to the surface run-off and

and steep slopes. In the southern region the soils are thin and sub-soils are rocky and hence cannot absorb and retain water.

ii) Spatial distribution of well irrigation :

The very high percent (100) of well irrigation is found in the villages, namely, Amadapur, Mudhal, Ambavane, Minche (Kh), Lotewadi, Nadhavade as they do not have any other source of irrigation. The watertable in this part is high encouraging well irrigation .

The moderate development (25-50) of well irrigation (Fig.2.1-B) is observed in the hilly tracts which comprise 14 villages. The low percent (below 25) is observed in the river plain which is replaced by the heavy lift irrigation. This category consists of 47 villages.

Apart from the physiographic impediments and fluctuation of watertable, though the well irrigation accounts for only 19 percent; there is large potential for further development. The Ground Water Survey And Development Agency (GSDA) of Government of Maharashtra has surveyed areal drainage, calculated recharge, withdrawal and balance of ground water in terms of feasible number of wells. According to this agency, the region has a very high potential (over 2500 wells) and it is due to higher recharge of ground water as compared to its withdrawal (GSDA, 1979). At present, only 25 percent of thetotal potential wells are existed in the region.

Thus, there is a plenty of scope for digging additional wells in the region. The technical and financial aid should be provided to the farmers in a cheaper but careful manner so that there will not be any misuse of the aid. The government should provide the information regarding the watertable and geological structure at the location of well, so that the farmer could manage the time and cost.

C) <u>Other sources</u> :

The other sources of irrigation includes mainly springs, nalas in the region. It shares 12.58 percent (280 hectares) of the total irrigated area. Many springs which rises in the hilly tracts are perennial and used for irrigation purpose. The villages Phaye, Khedage, Padkhambe, Yarandape, Vasanoli, Antiwade, Palya-chahuda are well noted for this type of irrigation (Fig.2.1-C).

The moderate percent (25-75) of such irrigation is at Minche (Br.), Tkewadi, Karivade, Kondoshi and Morewadi. In these villages the streams are perennial and their water is stored with the help of small earthern bandhara and through small channels, taken out from such bandara, the water is provided to the fields situated at low levels.

The low percent (below 25) of irrigation is along the foot-hills of southern range (Fig.2.1-C). During the field work the discussions held with the farmers, it was observed that the water from other sources was double in volume during the last fifteen years than what it is today. It may be attributed to forest cutting, reducing regularity in rainfall and lowering of watertable.

This is a natural source of irrigation. Very little efforts are being made to water the land. It is very useful source even during the rainy season when there is considerable break of rain. This requires better management of storage and distribution of water.

5. METHODS OF IRRIGATION :

The study pertaining to the methods of irrigation has become very important today. This issue is mainly connected with the plants and agricultural land. Therefore, the method of application of water should be based on the fact that the water should be provided according to the needs of plants without wastage of water and damage to crops or agricultural land. It is observed in the region that the water is provided to crops irrespective of their requirements. The lack of awareness among the farmers, some misconcepts about the use of water are the reasons for this.

The methods by which irrigation is applied to the plant should depend upon under ideal conditions on individual land features such as the slope of the land, the crops to be raised, the nature of the water supply and the ability of soil to absorb and hold water (Cantor,1967). In case of lift irrigation, on co-operative basis, due to less frequency of irrigation turns, the farmers intend to use rather more quantity of water leading to excess use of water. This is, however, not observed in case of well irrigation and privately owned lifts.

The economic use of water depends on the methods of irrigation practised by the farmers. There are various methods of irrigation prevailing in different parts of the world i.e. surface, underground and overhead. The surface irrigation method including furrow and flood has been practised in the study region. The information collected for this is through schedules for 15 sample villages and field observations.

The furrow irrigation method is very dominant in the study region. It is the method by which the water is regulated through furrows to irrigate the crops. Furrow irrigation is very common because it is adaptable to a great variety of land slopes and soil textures and can be used with either large or small streams of irrigated water (Cantor,1967). This method is comparatively economic but the water loss through evaporation and leaching is more. However, through this method, due to ignorance, the water is excessively used by the farmers leading to the development of saline problems particularly in black irrigated soils. Although such problem is not existing but the possibilities can not be neglected.

Flood irrigation is ~~also~~ practiced at very small scale, particularly for wheat and vegetables. Such method carries demerits of high rate of evaporation too.

The modern methods in the form of drip and sprinkler irrigation are absent in the region. This may be either due to more capital investment which is not within the reach of small farmers. Besides, the absence of awareness about these methods and regarding water management, among the farmers, are the constraints for the development of such methods. The traditional furrow irrig tion is and will be dominant unless the people are mentally, socially and economically prepared to adopt modern innovations in the methods of irrigation.

6. INTENSITY OF IRRIGATION :

The intensity of irrigation (percent of net area irrigated to net area sown) from all sources varies markedly in the region (Fig.2.4-A). This regional imbalance in the development of irrigation facilities is due to the restrictions put by the physico-socio-economic conditions. The present intensity of irrigation for the region as a whole is about 10.50 percent.

Analysis :

A low and very low intensity of irrigation (below 8 and 8-16 percent) is noted in the large part of the region, comprising the western and north and south hill tracts. Traditional sources of irrigation are dominant in this belt. The water from springs, nalas is provided to the fields. The rugged topography in the west, the steep slopes on the

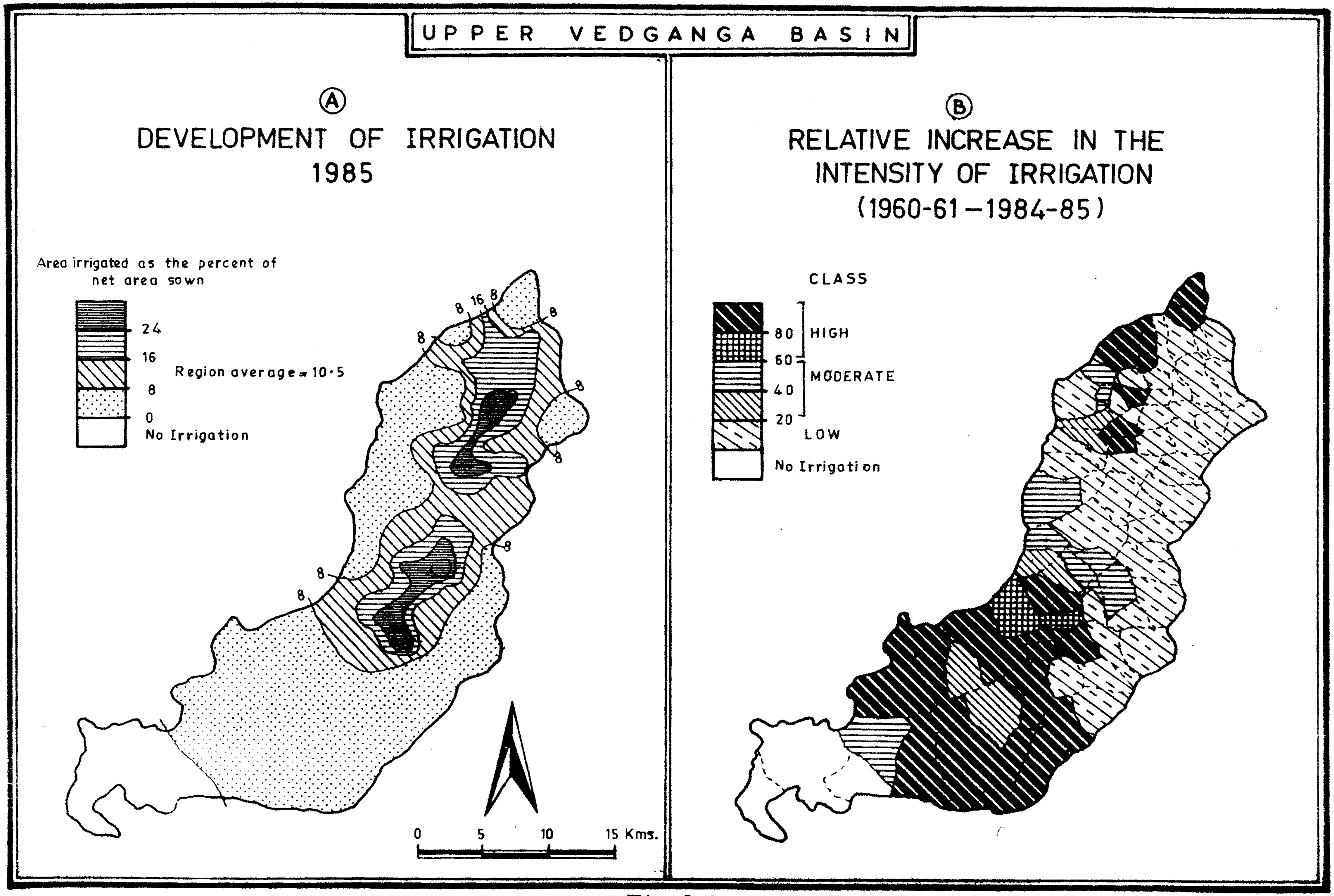

UPPER VEDGANGA BASIN
(A)
DEVELOPMENT OF IRRIGATION
1985
Area irrigated as the percent of net area sown
24
16
8
0
No Irrigation
Region average = 10·5
8
16
0
5
10
15 Kms.
(B)
RELATIVE INCREASE IN THE INTENSITY OF IRRIGATION
(1960-61 – 1984-85)
CLASS
80
60
40
20
HIGH
MODERATE
LOW
No Irrigation

Fig. 2·4

north and south ranges, do not encourage any type of irrigation. In the extreme western portion of the region, the intensity goes down to zero where there is insignificant development of water resources.

Another belt of moderate intensity (16-24 percent) is located in the lower part of the river valley. Well irrigation is dominant in this belt, followed by lift irrigation. The main villages in this belt are Konavade, Nadhavade, Koor, Ambavane and Karadwadi.

The intensity of irrigation is high (above 24 percent) in the heart of the basin. In this belt, the villages like Kumbharwadi (43 percent), Nandoli (41 percent), Mhasane (30 percent), Donavade (35 percent) have recorded very high intensity of irrigation. This belt has comparatively fertile level plain and sufficient water resources. Due to the nearness of the river, the lift irrigation is very dominant in this area. It is observed that above 90 percent irrigated area in this belt is under lift irrigation.

<u>Changes in the intensity of irrigation</u> :

The relative increase in the intensity of irrigation is calculated in percentage as follows (Dhillon, S.S. and Sandhu D., 1979).

$$\text{Relative increase} = \frac{Ic - Io \times 100}{Io}$$

Where, Ic = represents net area irrigated of 1984-85

Io = represents net area irrigated of 1960-61.

Fig. 2·4 , shows the relative increase in the intensity of irrigation. A high and very high (61-80 and above 80 percent) relative increase is confined to extreme east and the western part of the basin. In the eastern part the ground water is the only source of irrigation and hence there is increase in the well irrigation after 1960-61. In the western part there is steady growth of irrigation every year as the sloppy land is converted into plane and it is being brought under cultivation.

The moderate increase (20-60 percent) is noted in the north-central part of the basin which includes Pacharde, Kumbharwadi, Donavade, Nitawade, Tambale, Kariwade, Lotewadi and Pandivare.

In the remaining area, in the southern hill tract and river plain there is very low increase (below 20 percent). In the southern hilly tract the watertable is very deep and natural water resources are also least important.

However, there is considerable scope for the development of irrigation in the basin. According to the sources of Patgaon Medium Project, the irrigable land will be three times more than what it is today.

7. IRRIGATION REQUIREMENTS AND DEVELOPMENTS :

The water resources of Vedganga basin are not uniformly distributed. The physico-socio-economic conditions affect the development of irrigation. In a country like India, where the spatio-temporal distribution of rainfall is much varied, irrigation needs most and same is true regarding the development of irrigation. The distribution of water is a very widely discussed subject of todays, on a state level platform of Maharashtra. The region, where there is very acute need of water, should get given first priority. It is because, in few pockets there is plenty of water available for agriculture, whereas, much more regions are dry, even thirsty for drinking water. The thought, therefore, is developing that the water should be distributed to the regions as per their requirements.

There are number of attempts made by the scholars to measure the water requirements of crops. However, a very few studies were made to calculate the irrigation requirements. The geographers are more concerned with such studies as spatial pattern of agricultural landscape is largely influenced by irrigation facilities. Further, the micro level study, i.e. village level, is of paramount importance to understand the regional pattern of irrigation needs and priorities.

More and Mustafa (1984) have developed a method to quantify the need for irrigation facilities. According to them, three basic factors, namely, annual average rainfall, rural population density and percentage of area cultivated, determine the requirements of irrigation facilities of region. It is largely true that greater the annual rainfall lower is the need for irrigation. Obviously greater the rural population density higher is the percentage of cultivable area and more is the need for irrigation. In view of this, the main objective of the present analysis is to identify the areas of varying irrigation requirements and to demarcate the priority zones for irrigation in Upper Vedganga basin.

Methodlogy :

In the present investigation an attempt has been made to quantify the irrigation requirements of Upper Vedganga basin by employing the equation developed by More and Mustafa. Obviously, these variables, namely, annual average rainfall, density of rural population and percentage of cultivated area of the areal unit were considered to calculate the index, indicating the irrigation requirements.

The data pertaining to cultivated area and rural population were collected for each village, as the unit of study in the present analysis. The data, related to average annual rainfall, were collected by irrigation department of some villages and visiting personally to the raingauging staion in the region, were used here to representing the respective areas. The index values thus derived were arranged in descending order, indicating lower value for minimum requirement and vice-versa.

The formula is :

$$In = \frac{Pr \times Ac}{R}$$

Where, In = need of irrigation

Pr = rural population

Ac = percentage of cultivated area of the areal unit

R = average annual rainfall

TABLE 2.3 : Scheme for determining priority.

Sr. No.	Actual irrigation development	Need of Irrigation	Priority
1	Very high	very high	No
		High	No
		Moderate	No
		Low	No
2	High	Very high	Third
		High	No
		Moderate	Third
		Low	No
3	Moderate	Very high	Second
		High	Third
		Moderate	No
		Low	No
4	Low	Very high	First
		High	First
		Moderate	Second
		Low	No

SOURCE : Mustafa and More, Transactions, July 1984, p.75.

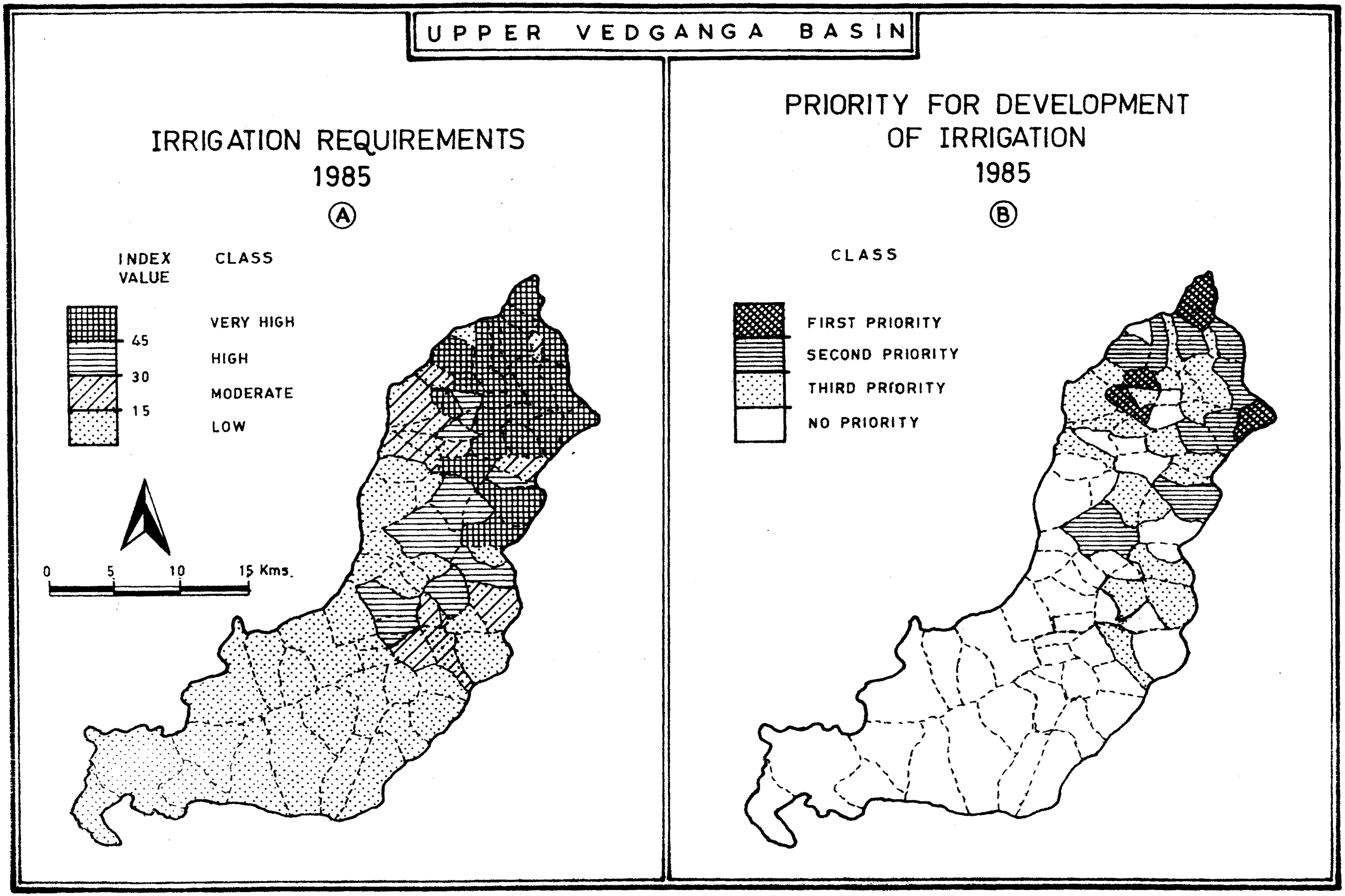

UPPER VEDGANGA BASIN
IRRIGATION REQUIREMENTS
1985
A
INDEX VALUE
CLASS
45
30
15
VERY HIGH
HIGH
MODERATE
LOW
0
5
10
15 Kms.
PRIORITY FOR DEVELOPMENT OF IRRIGATION
1985
B
CLASS
FIRST PRIORITY
SECOND PRIORITY
THIRD PRIORITY
NO PRIORITY

Fig.2·3

The index values drawn for each village were located on the map to show the spatial pattern of irrigation requirements. Further, the maps showing irrigation requirement and actual development of irrigation were superimposed to identify the zones of priority for development of irrigation facilities. The above scheme (Table 2.3) was adopted to determine the irrigation priority.

Analysis :

i) **Irrigation requirement zones :**

Fig.2.4-A shows the present development of irrigation in Upper Vedganga basin. Fig.2.3-A shows the requirement of of irrigation. The very high requirement area (above 45 index value) is noted in the eastern portion including the villages like, Gargoti, Madur, Pushpanagar, Madilage (Br.), Waghapur, Gangapur, Koor, 'Ambavane, Mudhal, Amadapur etc. as these villages have big population, substantial cultivable land and relatively low rainfall (below 1600 mm).

The high requirement (30 to 45) zone is observed in the central basin covering the area of villages like Nishnap, Shengaon, Sheloli, Kadagaon, Tiravade etc. It is due to low rainfall (below 2400 mm) more cultivated area and large size of population.

The indices ranging between 15 to 30 shows moderate requirement of irrigation in the southern and northern hill tracts and the region of low requirement (below 15) lies in the western basin. It is because of high rainfall, low population density and consequent percentage of cultivated area.

Based on the composite picture of both irrigation requirement and present development of irrigation, the priority zones of irrigation facilities have been determined. With the help of above scheme the map, showing priority zones, is prepared in which four categories are considered - first, second, third and no priority.

ii) <u>Irrigation priority zones</u> :

Fig.2.3-B shows the regional pattern of irrigation priority. The villages, Amadapur, Palshivane, Minche (Kr.), Pachavade (k) in the eastern part of the basin, have first priority where there is low development of irrigation. The second priority is observed in the far east especially in the villages of Gangapur, Waghapur, Nadhavade, Ambavane, Khanapur etc. where moderate development and high need of irrigation exists.

The third priority zone is confined to the foot-hill tract as well as in the river plain too.

No priority region covers an extensive area of the west and some pockets in the river plain. This can be attributed to the low development of irrigation with low need of irrigation in the west as against to high need and high development of irrigation in the river plain. Besides this, the western part has assured rainfall during south-west monsoon.

The above analysis reveals the fact that there is considerable imbalance in the development of irrigation facilities. The present development of irrigation is not according to the need of the areas. The priority for irrigation should be given to those areas where there is greater requirement of water for agriculture. Such studies at micro level are of immense significane in the planning process so as to avoid the greater imbalances in the development of agriculture.

8. <u>ECONOMICS OF IRRIGATION</u> :

<u>The Concept</u> :

The increasing pressure of population on land resources demands for increase in farm production. This can be achieved with the adaption of new farm technology. Irrigation happens to be a significant input to enhance agricultural production. It is the key factor responsible for the development of agriculture. The farmers in irrigated areas tend to cultivate cash crops and try to earn more as considerable capital investment is made already to develop irrigation facilities. It is obvious that more investment is attempted in the farm activity expecting more earnings. This, clearly, will lead to transformation of agriculture which is profit oriented. Unfortunately in India, the farmers do not keep such records and accounts which need very much in the process of modernization of farm practices.

There are a number of problems pertaining to planning and management of irrigation. Since, irrigation is an inter-disciplinary issue no single discipline could tackle all those problems. It requires, therefore, insights and skills from many fields like engineering, agriculture, geography, economics, political science, sociology and so on. No doubt there are many difficulties inherant in integrative thinking but these in no way negate the importance of applying inter-disciplinary analysis to the complex issues posed by the question of water resources planning (Sinha and Bhatiya,1982).

With the big investment made in irrigating the land, the farmer induces changes in cropping pattern leading the profit oriented agriculture. Although significant efforts have been made to develop the irrigation potential of this country through major and minor irrigation, yet there has been rather inadequate awareness of the economics of irrigation through different sources (Joshi,1987).

Irrigation has important bearing on the qualitative and quantitative nature of agriculture. Irrigation leads to the increase in both the human and labour requirements, water lifting and its supply to the fields, increase in the use of costly inputs etc. All these operations in irrigated farming raise the per hectare cost of cultivation. This is debit side. The credit side includes the farm output per hectare.

The cost of output per hectare differs in different irrigated crops, in different sources of irrigation, i.e. well and lift. Hence, the benefits of well irrigation differs from the benefits obtaihed from the lift irrigation. Not only this but the cost benefit of different irrigated crops differs spatially within well and lift.

Keeping this in view, the present work highlights the spatial variations in the economics of cost benefit of sugarcane and wheat raised under different sources in the study region. The economics of irrigation, in the present analysis means, the difference between per hectare cost incurred for producing irrigated crops and the per hectare output in terms of money value obtained. This would certainly shows whether the irrigation is profitable to the farmer or not. An attempt is made here to assess the spatial variations in the economy of well and lift irrigation. The work also tries to examine, irrigated cropwise economy of irrigation as the impact of irrigation is always reflected through the output of irrigated crops.

Objectives :

The present work pertaining to economics of irrigation aims to :-

i) Examine the spatial pattern of the economics of well irrigation,

ii) Assess the benefits received to farmers from well irrigation in the selected villages,

iii) Examine the spatial pattern of the economics of lift irrigation in the region, and

iv) Observe the spatial pattern of economics of privately owned and co-operative lift irrigation schemes in the region.

Methodology :

The present work is purely based on the data obtained through intensive fieldwork. The author has attempted to assess the comparative cost benefit analysis of the two major irrigated crops i.e. sugarcane and wheat, under well and lift irrigation sources in their spatial perspective. The sugarcane and wheat are the major irrigated crops in the region which accounts for 66 and 22 percent of the total irrigated area respectively. Therefore, these two crops are chosen in the present study. Sugarcane is a perennial crop and wheat is a seasonal crop. Wheat is grown after rice and is not raised in Mathagaon due to adverse climatic and soil conditions.

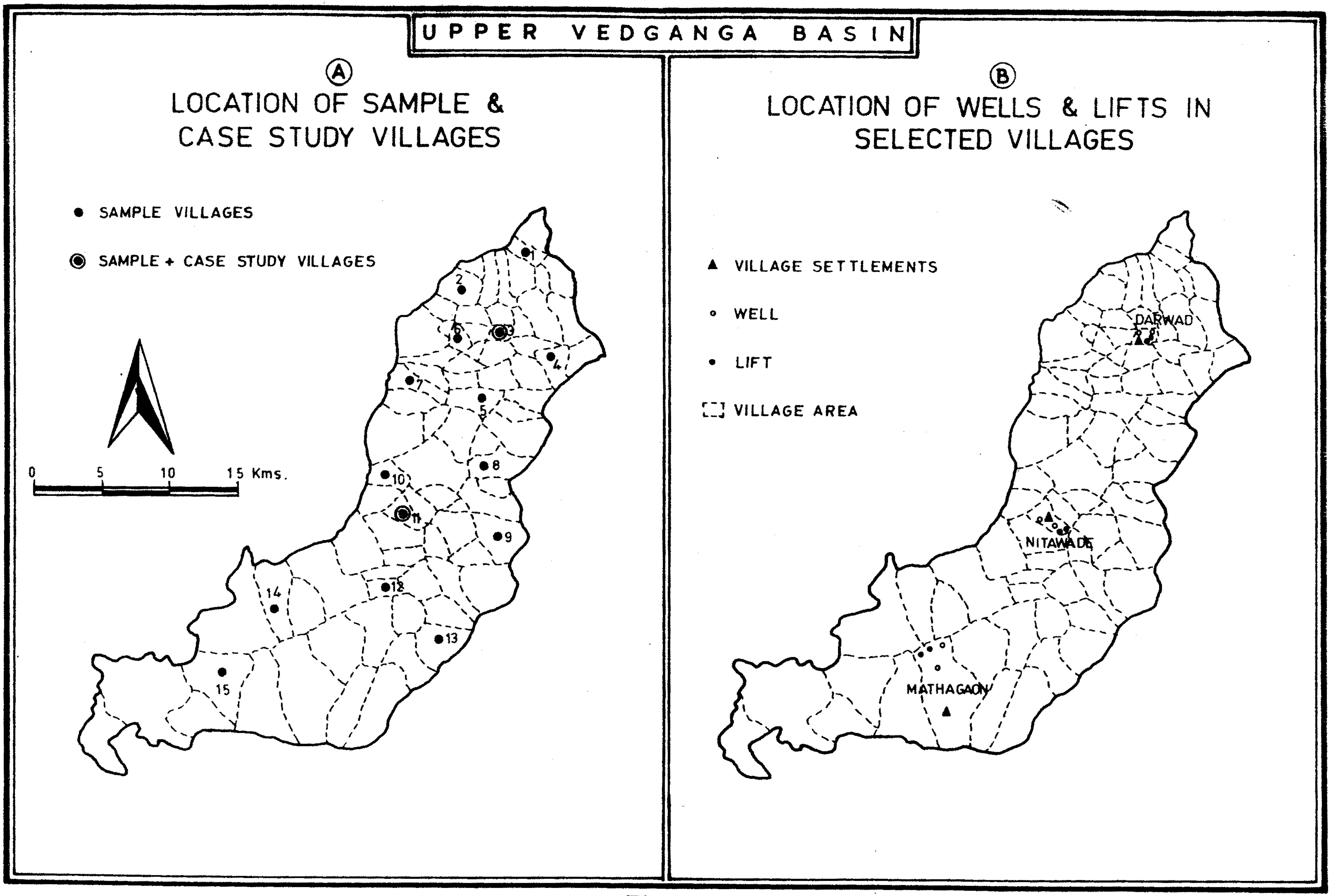

UPPER VEDGANGA BASIN
A
LOCATION OF SAMPLE & CASE STUDY VILLAGES
SAMPLE VILLAGES
SAMPLE + CASE STUDY VILLAGES
0
5
10
15 Kms.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
B
LOCATION OF WELLS & LIFTS IN SELECTED VILLAGES
VILLAGE SETTLEMENTS
WELL
LIFT
VILLAGE AREA
DARWAD
NITAWADE
MATHAGAON

Fig. 3·1

Three representative villages, located in the western, central and eastern part of the region (Fig.3.1-B) were selected which are having the simultanious availability of lift and well irrigation. Present analysis includes two wells and two lifts from each of three villages and the cost benefit for each crop under each source of irrigation in each village is calculated. Thus, the regional variations in their economics is analysed at micro level. In Darwad village two lifts are selected, one is privately owned and anather is co-operative, to study the differences in cost benefit if any. The two wells in each village are selected in such a way that one is located near the river course (I) and another at foot-hill zone (II), so as to see the difference in cost benefit within well in the village.

The averages of different items of cost benefit in a village are considered to analyse the spatial pattern of the economy of well irrigation. The net returns per hectare are obtained by deducting per hectare cost from per hectare net annual benefits for which following formula is employed.

$$NR = AI - Cp$$

Where, NR = Net returns per hectare

AI = Annual income per hectare

Cp = Cost of production per hectare

The cost comprises the human and animal labour cost, material cost, energy charges, maintainance and repair charges, government taxes and other cost. Family labour, owned bullock labour, and own material and equipments used in cultivation are accounted and their values are computed at the prevailing market rates.

Limitations :

Generally, the farmers do no keep an account of his farm management. The analysis is, therefore, based on the information given by the farmers and the relevant authorities. Thus, the data has been generated through field interviews of farmers from selected villages. The accuracy regarding different costs is subject to the limitations of the memory of the farmers.

Components of cost-benefit analysis of irrigation :

The components of cost-benefit analysis which are considered here are as follows :-

(I) Cost structure :

This consists of :-

i) Labour cost :

It includes both human and animal labour cost farming, dry or irrigated requires labour cost. It is obvious that the human labour requirement increases with the availability of irrigation facilities. It is observed that many times, particularly at the times of harvest, the family labour is not sufficient for agricultural operations. Therefore, the farmer has to take help of hired labour. Hence, labour cost includes both family labour and hired labour.

The use of non-mannual or mechanical devices in agriculture is rather less in the region. There is extensive use of animal labour.

ii) Material cost :

It includes the cost per hectare for seeds, manures, chemical fertilizers and pesticides.

iii) Energy charges :

The devices for lifting the water are either electric motors or diesel engines in the region. The energy charges in case of electric motors and diesel engines are calculated, considering the consumption of electricity bill and diesel oil to irrigate the per hectare land respectively.

iv) Maintainance and Repair charges :

The farmers spend money for the maintainance of farm land, irrigation scheme etc. The maintainance of wells, pipe line, cleaning of engine or electric motors etc. and the repairing of the same are important items of cost which are calculated for per hectare per annum for sugarcane and per season in case of wheat.

v) Other charges :

It includes government taxes, transport charges etc. The government taxes includes the land revenue charges, water

TABLE 2.4 : Comparative statement showing the various components of well irrigation of selected villages, 1986-87.

Village	Well Number	Depth of Well (Meters)	Watertable (M.)		Lifting device	Yearly no.of turns of irrigation	Area irrigated (hect.)
			December	May			
Darwad	I	9.0	Surface level	8.0	EM *	14	2.5
	II	7.6	"	7.0	EM	10	1.5
Nitawade	I	6.0	"	4.5	EM	14	0.4
	II	8.6	"	7.5	DE @	14	0.7
Mathagaon	I	7.5	"	6.0	DE	14	0.7
	II	7.6	"	6.6	DE	14	0.3

Note : * EM - Electric Motors, @ DE - Diesel Engines

SOURCE : Compiled by the Author (based on field work), 1986-87.

ion,

(Average in Rs.)

Villages	Other charges	Total Cost	Out put	Net Benefit
1. **Darwad**	175	4,347	19,875	15,528
	40	1,970	3,150	1,180
	450	4,870	22,500	17,630
	50	2,075	2,930	855
	450	5,140	15,000	9,860
2 **Nitawade**	175	5,900	25,500	19,600
	30	2,200	4,025	1,775
	460	6,955	29,500	22,545
	85	2,470	6,750	4,220
3 **Mathageon**	175	5,465	16,700	11,235
	535	6,975	22,500	15,525

charges, education tax etc. The water taxes are collected by Irrigation Department only from those farmers who use river water through lift irrigation. The farmers of well irrigation are free from such taxes. The water charges for sugarcane are Rs.200/- per hectare and Rs.15/- for wheat. The education tax is Rs.100/- for per hectare sugarcane. The transport cost includes the transport charges of farm equipments, fertilizers upto the fields etc.

(II) **Benefit :**

The value of output is calculated at the prevailing market rates. The net returns for particular crop are obtained by deducting the total cost per hectare from the total output per hectare.

A) Cost benefit analysis of well irrigation :

Table 2.4 presents consolidated aspects of wells in three selected villages which are closely related to the economics of well irrigation. The same table indicates that all the wells are perennial but their seasonal fluctuation of watertable is notable. The depth of watertable in well is important aspect which determines the energy consumption ratio which further relates to the energy charges. Generally, the depth of wells is above 7.5 meters except the well in Nitavade (6 M). The greater depth is found in Darwad. The watertable is high in Nitavade following Mathagaon and Darwad. All the wells in the region are having the surface level watertable upto December but from April onwards it goes down.

The electrified well irrigation is dominant in Darwad and Nitavade whereas diesel engines are set up on wells in Mathagaon.

The annual number of turns of irrigation are same except the IInd well in Darwad. But their total capacity of irrigating the land differs as it depends upon the depth and size of well.

Spatial Pattern :

The economics of well irrigation for sugarcane and wheat in different villages is spatially differed. It is observed in the following manner :

Labour cost :

Table 2.6 indicates that the labour cost for sugarcane per hectare is Rs.1,882, Rs.1,700/- and Rs.1,785/- for the village Darwad, Nitavade and Mathagaon respectively. The labour cost is high at Darwad because of high labour charges due to high dependance on hired labour. Almost every farmer in Darwad has got some irrigated land. There is, therefore, scarcity of hired labour. Same is true regarding wheat crop.

Material cost :

Table 2.6, shows that the per hectare seed cost for sugarcane is same in all the three villages and similar position is observed in case of wheat. It is because there is no marked difference in the method of cultivation of these crops. The seed cost incurred for sugarcane and wheat is Rs.750 and Rs.240 per hectare respectively.

It is observed that per hectare consumption of manures in well irrigated areas increases from east to west. It accounts for Rs.50/-, Rs.190/- and Rs.250/- for Darwad, Nitavade and Mathagaon respectively. This may be attributed to the fact that the total cultivated land is comparatively more (248 hect.) in Darwad and the manures, therefore, are distributed to the dry farming lands. The proportion of cultivated land in Mathagaon is less and the use of manures is, therefore, high per hectare. No manures are used for wheat in the region.

The cost of chemical fertilizers per hectare for sugarcane is high at Nitavade (Rs.2400) following Mathagaon (Rs.1650) and Darwad (Rs.1150). It is positively related to the availability of water in the well. The cost decreases in Darwad because the wells faces the problem of scarcity of water to lift. The pesticides are not used by the farmers in all these villages.

<u>Energy Charges</u> :

Energy charges mostly depend upon the availability of water in the wells end river to be lifted and the kind of water lifting devices used i.e. EM and DE. Table 2.7 shows that energy charges for DE are more than EM. The oil engines are used in Nitavade and Mathagaon. In the absence of rural electrification the farmers have no alternative except the diesel engines. The energy charges per hectare for sugarcane are highest Rs.610 at Mathagaon following Rs.435 at Nitavade and Rs.190 at Darwad. The energy charges in Mathagaon seem to be high because the oil engines being used whereas in Nitavade both oil engine and electric motor are in use.

Maintainance and Repair charges :

The maintainance and repair charges differes in case of EM and DE. The annual per hectare cost for sugarcane for this item is Rs.150, Rs.250 and Rs.245 in Darwad, Nitavade and Mathagaon respectively. Both wells in Mathagaon and one well in Nitavade had DE costing more than EM in Darwad. In case of wheat the cost is Rs.50 and Rs.35 for Darwad and Nitavade respectively.

Other charges :

This includes transport cost only as the government taxes are not charged to well irrigation. The per hectare cost of well irrigated area for this item (Rs.175 for sugarcane and Rs.40 for wheat) is uniform in all the villages.

Cost composition :

The total per hectare cost incurred for different purposes is highest in Nitavade i.e. Rs.5900, following Darwad and Mathagaon as Rs.5465 and Rs.4347 respectively for sugarcane and Rs.2175 and Rs.1970 for wheat in Nitavade and Darwad (Table 2.6). Material cost of the wells in Nitavade for sugarcane accounts for 57 percent of the total cost as compared to 49 percent and 44 percent in Mathagaon and Darwad respectively. The wells in Nitavade and Mathagaon are possessed by small scale farmers (Table 2.4). Consequently they use substantial inputs in view to get maximum output from a small piece of land. In case of medium farmers in Darwad, however, the use of inputs is low which has resulted into the decrease in total cost.

The another striking item, affecting to total cost, is energy charges. Due to diesel oil the cost is increased twice and thrice to that of EM for well irrigation in Nitawade and Mathagaon respectively.

Output and benefit :

The average output per hectare for sugarcane is substantially high in Nitavade (Rs.25,500) followed by Darwad (Rs.19,875) and Mathagaon (Rs.16,000). In the wells in Nitavade, the water is sufficiently available even in summer months while the wells in Darwad faces the scarcity of water in months of April and May.

In spite of the high total cost, the wells in Nitavade earn more per hectare than the wells in other two villages.

The benefit per hectare for sugarcane is Rs.19,600 in Nitavade and Rs.15,528 and Rs.10,535 for Darwad and Mathagaon respectively. Same is the case of wheat cultivation in Nitavade. Table 2.4 shows that well in Nitavade are owned by small farmers who cultivate their land intensively to get maximum production. Owing to sufficient water, particularly in summer months, the well irrigated area in Nitavade records considerable use of chemical fertilizers which has enhanced the net returns. In case of Mathagaon, though the wells are perennial, the poor soils put limits to the output. They, therefore, rank in third position in regards to the total benefit.

B) <u>Well to well cost-benefit</u> :

In the earlier section the cost benefit for different crops of well irrigation in three villages, located at different places, in the region, is analysed. These three villages represent their surrounding area. Apart from the regional picture, the author has also observed, at micro level, the cost benefit within the wells in each of these three villages. The cost benefit of a well, located in the river plain (I), differes from the well, located at foot-hill zone (II) of the village (Table 2.7).

The wells located in the river plain (I) are associated with the fertile land whereas the surrounding lands of the wells located in the foot-hill zone (II) have comparatively poor soils. It is, therefore, the cost for labour inputs, material input and altimately the total cost is high for II wells than I wells.

An interesting example regarding the power cost of wells can be sighted here. In Nitarade I well has EM & II has DE. The annual power cost of sugarcane for the well having DE is Rs.700 per hectare while for EM, it is Rs.170 only.

The total output for I wells is more than II wells. It is because I wells are located near the river course and hence have more water to lift. The II wells have no sufficient water in summer months which adversely affects per hectare production of crops. Hence, the net returns for I wells in Darwad, Nitavade and Mathagaon for sugarcane are Rs.18,925, Rs.20,665 and Rs.10,625 and for II wells the figures are Rs.12,130, Rs.19,150 and Rs.10,440 respectively (Table 2.7).

C) Cost-benefit analysis of lift irrigation :

The study of some aspects is essential before analysing the cost benefit of lift irrigation. Table 2.5 gives the comparative picture of various aspects of lift irrigation in selected sample villages of the study region.

The length of pipe line for each lift irrigation scheme differs, particularly it decreases from east to west as the river valley becomes narrow. But the overall trend shows that the length of pipe line and the total area irrigated are inversely related. The area, irrigated by these lifts, is largely affected by the availability of water or the turns of irrigation. The pipe lines of the II lift in Darwad, having 2100 M length,

TABLE 2.5 : Comparison of various components of lift irrigation for selected villages, 1986-87.

Sr. No.	Village	Lift Number	Length of pipe line (Meters)	Lifting device with HP	Yearly number of turns of irrigation	Area irrigated (hect.)
1	DARWAD	I	900	*EM 20	6	4.00
		II	2,100	EM 30	6	4.00
2	NITAWADE	I	400	EM 5	9	5.40
		II	800	EM 20	9	8.00
3	MATHAGAON	I	75	@DE 5	7	1.50
		II	70	DE 5	7	1.50

Note : * EM - Electric Motor, @ DE - Diesel Engine

SOURCE : Compiled by the Author (based on field work), 1986-87.

irrigates only 4 hectares of land whereas in Nitavade with 400 M length, irrigates 5.4 hectares of land.

The device of water lifting, another important component, determines the working efficiency and total cost of irrigation which is further related to the net profit. The lifts in Darwad and Nitavade are operated by electric motors which provides cheap source of power. In Mathagaon, however, diseal engines are used. The water is made available through K.T.Weirs in Nitarade and Darwad and the lifting of water is controlled by the Irrigation Department.

The annual number of turns of irrigation are more in Nitavade (Table 2.5) because it has good river water resources. The lifts in Nitavade enjoys a turn of irrigation after every 15 days as against to the lifts in Darwad after 20 days due to the inadequate water supply. In case of Mathagaon the water resources are satisfactory but the frequent breakdowns in the operation of diesel engines has resulted in poor utilization of water. Therefore, the annual turns of irrigation are 6, 9 and 7 for Darwad, Nitavade and Mathagaon respectively, especially for sugarcane crop. Such variations lead to differentiations in cane productivity.

Regional Pattern :

Cost structure :

(i) Labour cost : Table 2. , indicates that the labour cost for sugarcane is high in Darwad (Rs.1875) followed by Rs.1800 and 1650 in Mathagaon and Nitavade respectively. The reason is the same to that of well irrigation.

(ii) Material cost : The total material cost for sugarcane is high in Nitavade (Rs.3920) followed by Mathagaon (Rs.3240) and Darwad (Rs.2020) and for wheat Rs.720 and Rs.660 in Nitawade and Darwad respectively. In material inputs the chemical fertilizers varies greatly in the region as its use is related to the availability of water. There is adequate supply of water in the river for the lifts at Mathagaon, the river course however, becomes dry mid-March onwards in Darwad and after April in Nitavade. There is no much difference in the use of seeds and manures per hectare in the areas irrigated by all lifts.

(iii) Energy charges : The energy charges for diesel engines and electric motors differs greatly. The energy charges are high at Mathagaon (Table 2.6) as the lifts are operated by diesel engines. The per hectare cost of oil consumption for sugarcane is, therefore, always high (Rs.1100). The lifts, on the other hand, operated by electric motors in Nitavade and Darwad cost less in regards to power consumption. Both villages have recorded Rs.750 and Rs.400 respectively. The cost incurred for electricity differs from lift to lift according to the number of turns of watering to the crops (Table 2.5). The water in the river is available upto April in Nitavade and upto 15th March in Darwad. Another thing is that Darwad and its nearby villages have more irrigated area. Nitavade and its surrounding villages, on both banks, have less area under irrigation. Consequently, the use of water is high in Darwad as compared to Nitavade. The taxes are charged by the government for lifting the water. Owing to substantial availability of water in Nitavade the frequency of turns of irrigation (for every fifteen days) is high whereas it is less in Darwad (for every twenty days). The permission to lift the water is given for six days at Nitavade and for three days only at Darwad. Hence, though the power charges are high at Nitavade, it has positively affected the output of crops.

(iv) Maintainance and Repair charges : The maintainance and repairing charges are less for EM than DE. These charges for sugarcane are Rs.125, Rs.175 and Rs.300 for lifts in Darwad, Nitavade and Mathagaon respectively (Table 2.6). The charges are high at Mathagaon because there are frequent breakdowns in DE resulting into high cost of repair. The maintainance of DE is also higher than EM.

(v) Other charges : Other charges for lift irrigation for sugarcane are Rs.450, Rs.460 and Rs.535 for Darwad, Nitavade and Mathagaon respectively (Table 2.6). Mathagaon costs more to this item because of high transport cost since it is located far away from the farm.

Cost composition :

Table 2.7, indicates that the total cost is increased from east to west in the region i.e. Rs.4870, Rs.6955 and Rs.6975 for Darwad, Nitavade and Mathagaon respectively. Of the total cost incurred for sugarcane, Darwad ranks first in labour cost (35 percent), Nitavade in material cost (52 percent) and Mathagaon in power charges (11 percent). The total cost for sugarcane in Nitavade is increased because of high use of chemical fertilizers which is more than double to that of Darwad. The total cost seems to be high at Mathagaon due to high power charges. In case of wheat, the total cost is Rs.2075 for Darwad, Rs.2470 for Nitavade.

Output and benefit :

The total output by lifts for sugarcane is Rs.22,500, Rs.29,500 and Rs.22,500 in Darwad, Nitavade and Mathagaon respectively. The per hectare yield of sugarcane is high in Nitavade (97.5 metric tonns) while it is 85 M.tons each in Darwad and Mathagaon. The more number of turns of watering and substantial use of fertilizers is positively related to the output. Though the water is fairly available in Mathagaon, it is not properly used due to diesel engines. The soils are also poor in Mathagaon. The per hectare output of sugarcane in Mathagaon is, therefore, less than in Nitavade. The water scarcity has also adversely affected the wheat crop yield. The output in Nitavade is three times more than in Darwad.

The aforesaid situation has resulted into the decrease in net returns. The per hectare benefit for sugarcane in Nitavade is high (Rs.22,545) followed by Darwad (Rs.17,630) and Mathagaon (Rs.15,525). In case of wheat it is Rs.4,280 in Nitavade and Rs.855 in Darwad.

D) <u>Cost benefit analysis of privately owned and co-operative lift irrigation schemes</u> :

A remarkable difference in cost benefit is observed between the privately owned and co-operative lift irrigation schemes in Darwad. The sugarcane is grown only on the area irrigated by co-operative scheme and sugarcane is associated with wheat, in the area irrigated by privately owned lift.

Table 2.7, shows the equal labour cost but per hectare use of fertilizers is higher in private scheme (Rs.1150) than co-operative (Rs.975). The small scale farmers are economically poor in co-operative and the water is inadequate leading to the low consumption of chemical fertilizers. The energy charges, however, are also considerably high (Rs.550) in the areas irrigated by co-operatives as compared to private schemes (Rs.400) which is mainly devoted to sugarcane.

It is observed that the length of pipe line for private and co-operative scheme is 900 M and ~~24~~ 2100 M respectively. The former has 20 HP EM whereas the latter is having 30 HP. Besides this, the sugarcane farms of the members of co-operative schemes are scattered which, therefore, leads to the wastage of water. This, in fact, also invites the operation of electric motor frequently.

The maintainance and repair charges of co-operative scheme are also very high (Rs.500) as compared to private scheme (Rs.125). It may be due to the mismanagement of the scheme.

In view of the above situation, the total cost for co-operative is Rs.5140 per hectare for sugarcane and that of private scheme is Rs.4870.

The output per hectare is considerably low from co-operative scheme (Rs.15,000) as against the private scheme (Rs.22,500). The non-cooperation, lack of mutual understandings among the members and mismanagement of water may be some of the reasons for the low output per hectare in co-operative scheme. The per hectare yield of sugarcane in co-operative scheme, for example, is 50 metric tons, whereas it is 85 metric tons in private scheme. In private scheme, the farmer pays full attention to each and every farm operation. Therefore, the net benefit per hectare is higher (Rs.17,630) than from co-operative scheme (Rs.9860).

9. <u>SUMMARY</u> :

The foregoing analysis reveals the fact that there is spatial variation in the economics of well and lift irrigation.

Notwithstanding the spatial variation occurs within well irrigated areas and lift too. The villagewise, cropwise and sourcewise analysis clearly indicates the regional variations in the economics of irrigation.

The cost of well irrigation in Nitavade village is comparatively higher than the remaining two villages. This may be attributed to the variations in fertilizer consumption and energy charges. The cost incurred for others seems to be equal. The well irrigation in Nitavade, therefore, shows upward trend in the profit. Due to poor soils and use of diesel engines, Mathagaon ranks third in benefit.

Apart from the differences in cost-benefit of well irrigation in different villages, the spatial pattern is also uneven at micro-level i.e. well to well in a village. The study indicates that the wells in river plain have shown less total cost but high output than the wells located at foothill zone and hence the former accounts for high benefits.

The costs for labour, seeds, manures, repair and other itemsin lift irrigation are almost equal but differ markedly in the use of chemical fertilizers and energy charges. The former affects positively and the latter affects negatively on the benefit.

The analysis of cost benefit in private and co-operative irrigation schemes in Darwad shows a noticiable difference.

The co-operative scheme shows high total cost, low out put per hectare, consequently low benefit which is the reverse condition of private scheme.

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