Impact of Irrigation on Agriculture Development in Baghelkhand Region of Madhya Pradesh

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Abstract

The Indian agriculture has changed drastically from a scarcity of food to one of leading food exporting country in the world and this happened primarily due to innovation in science and technology. Despite dramatic increase in the irrigation infrastructure on a large scale over the past 5 decades, the richness of the world's production still comes from rainfed areas. Agriculture and irrigation is traditionally associated justified allocation of resources and agriculture. Irrigation plays a vital role in agricultural development. The Indian irrigation is mostly criticized for inefficient use of water and high wastage which cause a serious threat to land. The prime objective of this paper is to examine the relationship between extent and growth of irrigated area and major crops. Spatial and temporal variation of production and yield rate of major crops has also been discussed.

Keywords: Irrigated Area, Agriculture Development, Irrigation, Rainfed, Production, Consumption.

1 INTRODUCTION

The relation between crop growth and water consumption is inseparable in any agriculture planning; water need to be supplied several times at different intervals in huge quantities throughout the crop growth. The water requirement of various crops grown in the area not only varies from seasons but also to different crops over the same period. Nevertheless, irrigation water affects the domestic water supply system in different ways in terms of quality and quantity of water available in a particular area, e.g., use of fertilizer and pesticides and heavy pumping or canal irrigation affects the natural water balance (Bilas, 1988).

Developing an understanding of the role, water plays, in supporting livelihoods – through economic (agriculture production and income) and environmental effects and linkages – makes it much easier to predict the effects on different groups of water interventions. This, in turn, can indicate which types of water activities can do the most to reduce poverty. Water availability and deficits occur seasonally in regions due to inappropriate water management. Livelihood of the Baghelkhand people is in trouble because; the stage of ground water development is only 24 percent in region. In rural areas and forest villages of region peoples have no enough facilities for water so they use natural resources and utilize them with the help of traditional knowledge and skill. Here, people try different agricultural practices and irrigation provisions since fertility of soil, availability of rainfall and land use patterns are changing dramatically. Water can be seen as flowing through three interlinked systems: a hydrologic system, a food production system, and a livelihood system (Cook & Gichuki, 2006). Interventions for poverty reduction can be

targeted at any of these systems, and might include the provision of water resources, protection of environmental flows, protection from health hazards, and, especially for agricultural water use, increases in water productivity.

Water productivity expresses the socioeconomic and environmental benefits derived from the use of water (Molden, 2007). A system that can deliver more benefits with a given amount of water than another system has higher water productivity, and broadly speaking there are three ways to accomplish this: by increasing socioeconomic or environmental services, by reducing agricultural water depletion, and by decreasing negative impacts on other systems. In this method the focus is on crop production, and the water productivity concept employ is that of crop-water productivity. The basic links between water and crop-supported livelihoods are shown in (Figure 1). As shown in the figure 1, the water available for agricultural production is determined partly by the natural water availability (the hydrological system) and partly by the available water infrastructure (part of the food production system). The available water is then used to produce crops, in an amount determined by the water productivity (the rest of the food production system). The produce is then used to support livelihood goals resulting in livelihood outcomes.

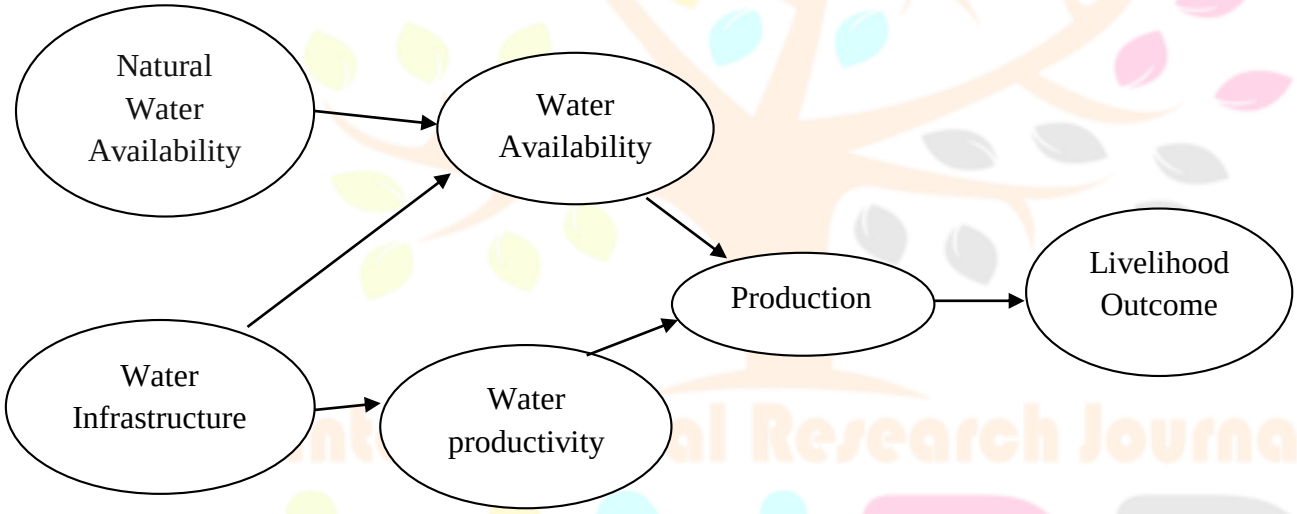


Figure 1: Basic links between water and livelihood

Study Area

Baghelkhand region of Madhya Pradesh extends between the latitudes 22° 50' to 25° 28' North and the longitudes 80° 20' to 82° 58' east. It is in the central part of the peninsular 'foreland' and situated between the alluvial stretch of the northern Great Plains and the Deccan. It naturally presents a transitional zone incorporating the Vindhyanchal. The very name of the region is derived from the combination of physical and cultural complex. The region's northern boundary touch with Allahabad and Chitrakoot district of Uttar Pradesh and north-east part touch with Mirzapur district. Sarguja (Baikunthpur), Jabalpur and Dindori district come to east and south of the region. Western limits of the region touch through Panna district (Singh, 1971).

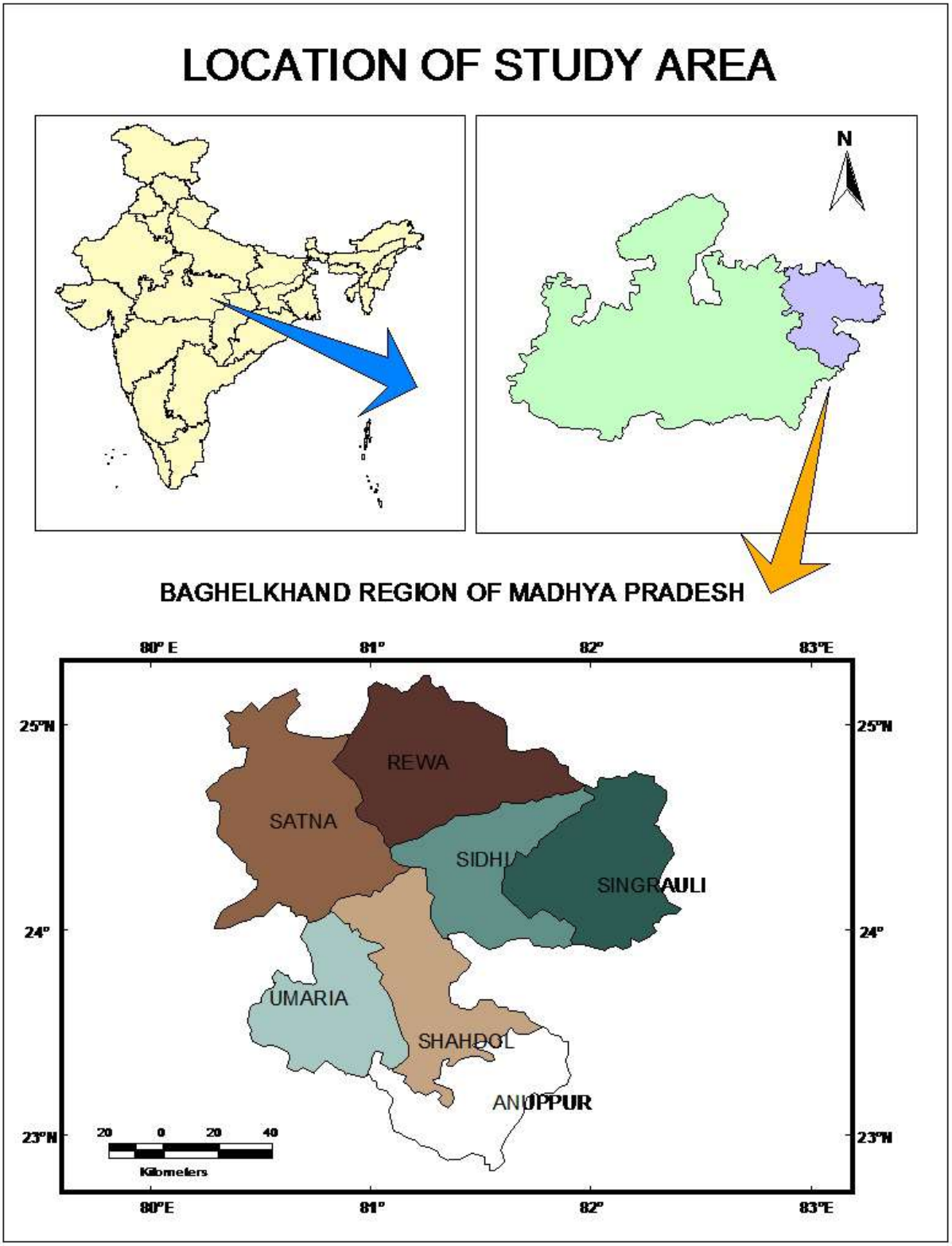


Figure 2: Location map of the study area.

2. Data Source and Methodology

The study is completely based on growth of irrigated area and agricultural development with the associated developmental work in Baghelkhand region. The data were extracted from central water commission, Directorate of economics and statistics, Agricultural statistics and Ground water. Several temporal data analysis of ground water

availability were also done based on regional variation and average annual rainfall in the last two decades. The comparison of Ground water fluctuation of almost one decade pre monsoon was also used by using ArcGIS.

The water and livelihood is well connected through 3 different linked systems and which are also a dominated and major role played by the cropped area and agriculture development. The gross and net cropped area of the region is shown through cropping intensity calculated in per cent. The distribution of Land use was shown through Net sown and Area sown more than once by using ArcGIS where line graph and percentage were used. Agricultural land use pattern was shown through culturable waste land and fallow land. Over the last 2 decades the cropping pattern also increased and decreased a lot. The present regional variation of major sown crops rice, wheat, gram soyabean, maize, and Jowar with their changes in yield rate also changed over the years.

With the increase in the population, there is a continuous increase in the production which has resulted in the expansion of Irrigated area. The area and yield under major crops were shown through maps between 2008-09. The various sources of net irrigated area and importance of tube well irrigation is calculated. The relation between the agriculture production and rainfall were also calculated and shown through line graph. The irrigation and agricultural development were calculated and highlighted though growth in irrigated area and cropping area. Coefficient of correlation between the irrigated area and consumption of fertilizers were calculated. At last, the crop combination were calculated by using Kikukaji Doi's Method which tell us about the rabi and kharif crop combination over a two decade.

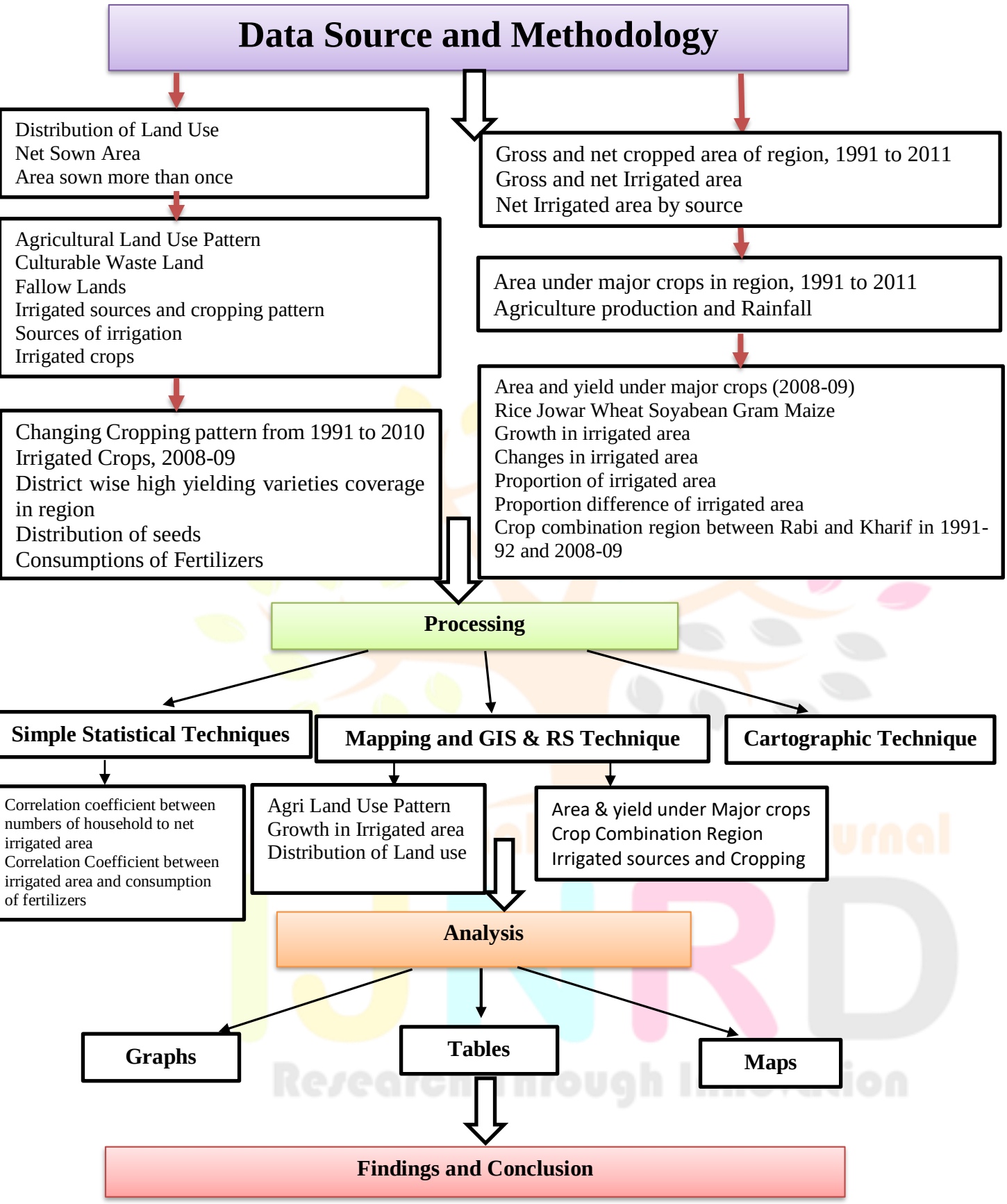


Figure 3: Flow diagram representing data source and methodology

3. EXPANSION OF IRRIGATED AREA

Irrigation has been practiced since quite a long time in few part of the state of Madhya Pradesh. But in other parts, development of irrigation is the phenomenon of the plans. As a result of these efforts total irrigated area increased 50 thousand hectares in 1978-79, constituting 3 percent of gross cropped area and recording an increase of 576.34 percent. The progress of irrigated area is furnished in Table 1 below.

The rise in cropping intensity has been made possible by the expansion of area under irrigation. The region has a relatively high proportion of waste and uncultivated lands—about 21 percent. Another about 22 percent of the land is under forest cover. Only 37 percent is cultivated. Irrigation facilities are very poor as only about ten per cent of the cultivated land is irrigated (Pandey, 2000). Till early 1980s only 3 per cent of the gross cropped area was irrigated in region. Irrigated area went up by nearly six times (from 50 thousand hectares in 1978-79 to 340 thousand hectares in the 2006-07 when the ratio of gross irrigated area to gross cropped area reached 18 per cent (Table 1). Driven by the impetus of hybrid seed technology, agriculture in Madhya Pradesh moved into a water and energy- intensive regime during the last two decades (Shankar, 2005).

Table 1: Gross and net Irrigated Area in Baghelkhand Region in ('000 ha)

Years	NIA	GIA	Irrigated Area more than once	GIA/GCA (in percent)	NIA/NSA (in percent)
1978-79	50	50	-	2.7	3.3
1991-92	177	177	-	10.0	11.9
1996-97	268	268	-	13.3	17.0
2001-02	309	311	2	15.9	20.4
2003-04	312	326	14	16.2	20.3
2006-07	321	340	19	17.5	21.6
2007-08	309	329	20	17.1	21
2008-09	335	355	20	18.24	23

Sources: Directorate of Economic and statistic 2010.
Note: **GIA**: Gross Irrigated Area; **NIA**: Net Irrigated Area; **GCA**: Gross Cropped Area; **NSA**: Net Sown Area.

The source- wise break-up of irrigated area is given in Table 2. The share of canals and tanks ("surface water") has steadily declined from 39 percent in 1978-79 to 11 per cent in 2007-08. This decline is despite the fact that gross irrigated area went up by nearly two times during the same period. The main source of the rapid expansion in irrigated area since the 1990s tube wells ("groundwater") now account for nearly 85 percent of the total irrigated area in region.

Table 2: Net Irrigated Area by Source in Baghelkhand region (In percent)

Source	**1978-79**	**1991-92**	**1996-97**	**2002-03**	**2006-07**	**2007-08**
Canals	33	27.7	17.7	14.8	12.7	9
Tanks	6	2.2	1.6	1.3	2.6	2
Surface water	**39**	**29.8**	**19.3**	**16.0**	**15.3**	**11**
Wells	27	33.3	31.0	31.9	27.9	29
Tubewells and other	34	36.9	49.6	54.3	56.8	60
Ground water	**61**	**70.2**	**80.7**	**86.2**	**84.7**	**89**
Net irrigated area	100	100.0	100.0	100.0	100.0	100

Source: Department of Agriculture, Government of India, 2011

Moreover, groundwater accounted for more than 80 percent of the incremental irrigated area in between 1996 to 2005 then; it was indicating a virtual stagnation in irrigation from surface water.

3.1 Growing Importance of Tubewell Irrigation

The most remarkable feature of the increasing use of groundwater for irrigation has been the explosive growth in the number of tubewells and pumpsets since 1970s (Jain, 1988). While the total number of wells used for irrigation purposes are declined due to the increasing of pumping set between 1996 to 2006 (Table 2). There was astronomical increase in the number of tubewells, now touching a figure more than 25 thousand. Along with this, the number of electric and diesel powered pumpsets also shot up from around 41 thousand in 1996 to over 51 thousand in 2006. The pumpsets to well ratio was 96 percent in 1996-97 which went up to 108 percent in 2006-07. This expansion of irrigation facilities established the basis for adoption of green revolution package comprising high-yielding varieties of seeds and high dose of fertilizer application.

3.2 Spatial Variation in Growth of Irrigated Area:

There is wide a range of variation in growth rate of irrigated area during 1977-09 (Fig. 5). In the region between 1977-09 irrigated area growth was 606 percent while mean of all districts net irrigated was 657.5 percent. Standard deviation of these rates also proves very high variability growth a rate varies from 995 percent in Umaria and 750 percent and in Satna to 372 percent in Rewa districts. Very high growth occurred where initial proportion of irrigated area was extremely low. Except Rewa district, all districts have high growth rate than mean. In Sidhi district number of canal irrigation developed largely at personal initiative of the farmers. Farmers also have access to advance technology which maximizes the benefit of irrigation. Some districts such as Rewa, Satna, Sidhi districts have risen sharply in the irrigation of tube well and canal irrigation has been a decline in total percentage.

There are three well marked tracts of high irrigated area.

1. One is the Tamsa, Behar and Kevati river basin area encompassing, Sirmour, Jawa, Teonthar block of Rewa district.
2. Second tract of highly irrigated area in region extends over Rampur-Baghelan, Unchera and Satna (Suhowal) blocks of Satna district.
3. The third tract of highly irrigated area encompasses Churhat and Gopadbanas block of Sidhi district.

3.4 IRRIGATION AND AGRICULTURAL DEVELOPMENT

The immediate effect of the creation of irrigation facilities may be manifested in the expansion of net area sown by annexing cultivable wastelands into it, and by intensifying the cropping pattern. Total Net Sown Area had increased from 14.88 lakh hectares in 1991-92 to 15.79 lakh hectares in 1996-97 and 15.88 lakh hectares in 1999-2000. At the same time, production of cultivable waste lands, not available for cultivation area and fallow lands increased 2, 14 and 14 thousand hectares respectively, in 2001-07.

There seems to be least effect on intensification of cropping because of irrigated area is increased by about 2 percent in 2000-07. However, there is very clear imprint of growth of irrigation an increasing productivity of crops such as Paddy, Barley, Tuar, Urad and oilseeds (Soyabean) which are major recipient of additional irrigational facilities. Expansion of area under horticulture crops is also facilitated by the development of irrigation. Further, use of fertilizers and improved seeds also seems too associated with the irrigation (Jain, 1988).

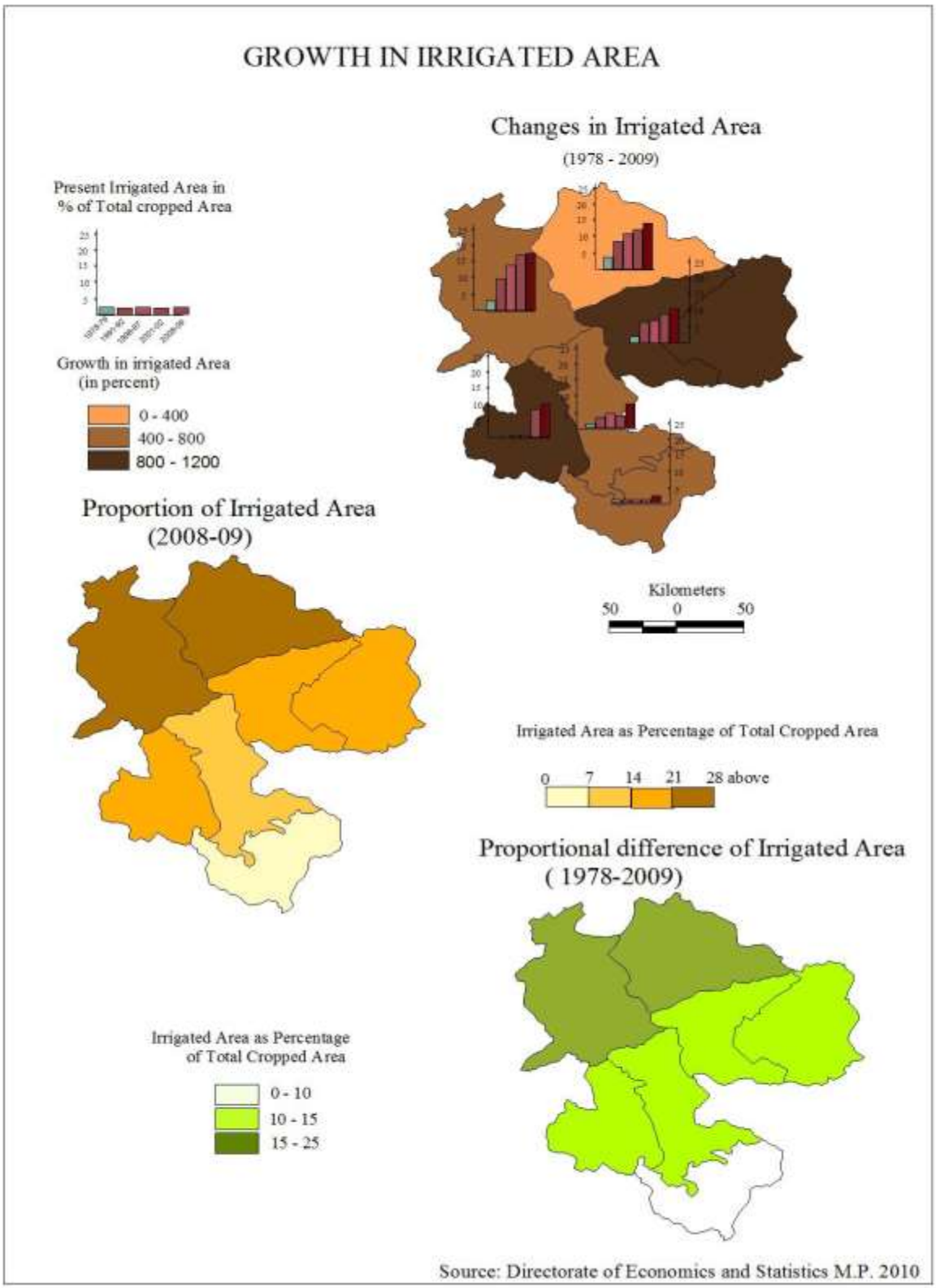


Figure 4: Growth in irrigated area

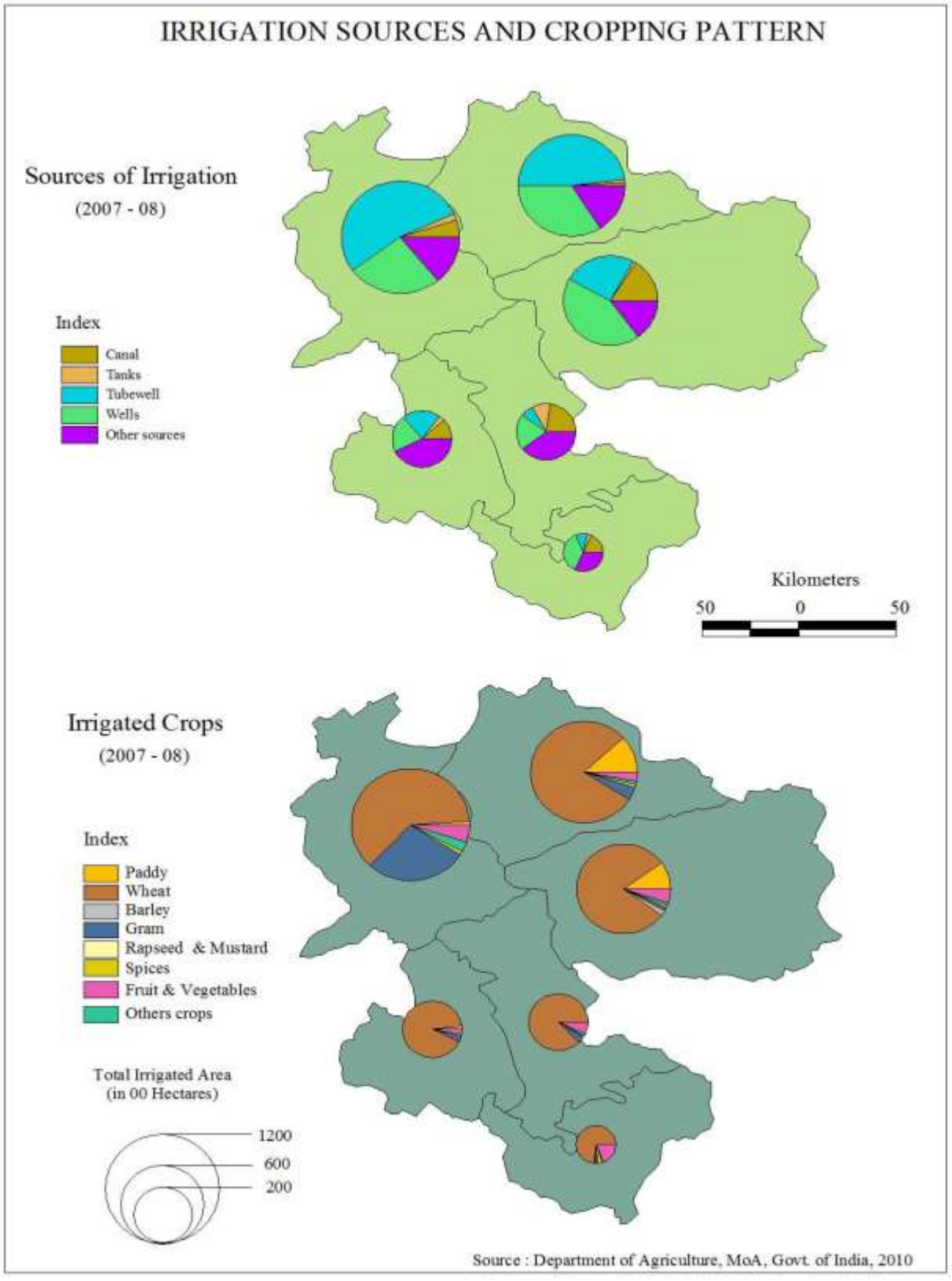
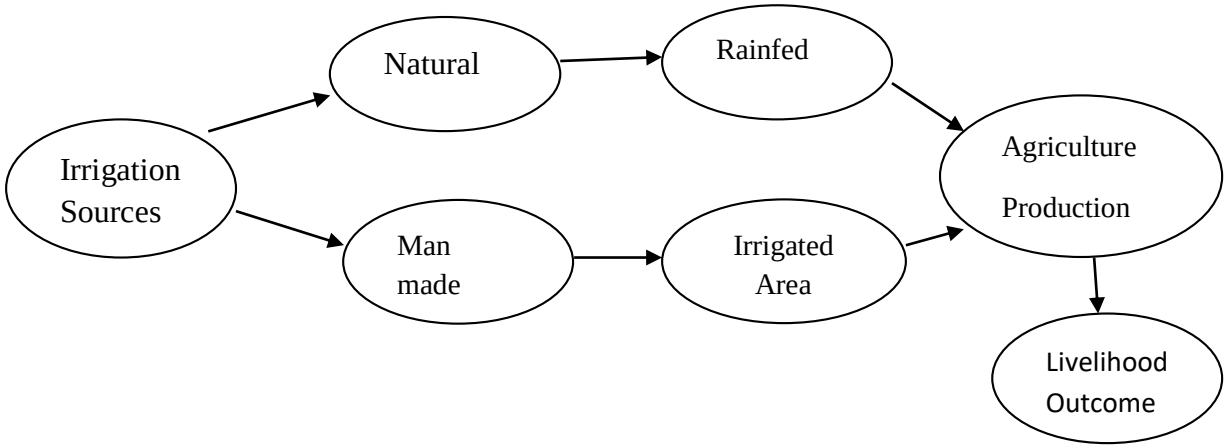


Figure 5: Irrigation source and cropping pattern

Figure 6: Linkage between Irrigation sources and Agriculture Production



This region belongs to rainfed agriculture so agriculture is mainly dependent upon intensity of precipitation. Though, this region acquires huge amount of water in monsoon period for Kharif crops. Maximum area of region belongs to rainfed, so that more water consumption crops such as paddy, wheat, Barley, pigeon pea (arahar) and soybean crops area were also increased. The lack of adequate irrigation facility in region has adversity with more water consuming crops. Decrease in rainfall from 2005 to 2008 has shown that the cropped area has direct impact on production. Actually, the ratio of gross irrigated to total area sown of rice was only 1 percent in 1992-93 after that in 2004-05 ratios was 2 per cent and in 2008-09 it's increased up to 3 percent.

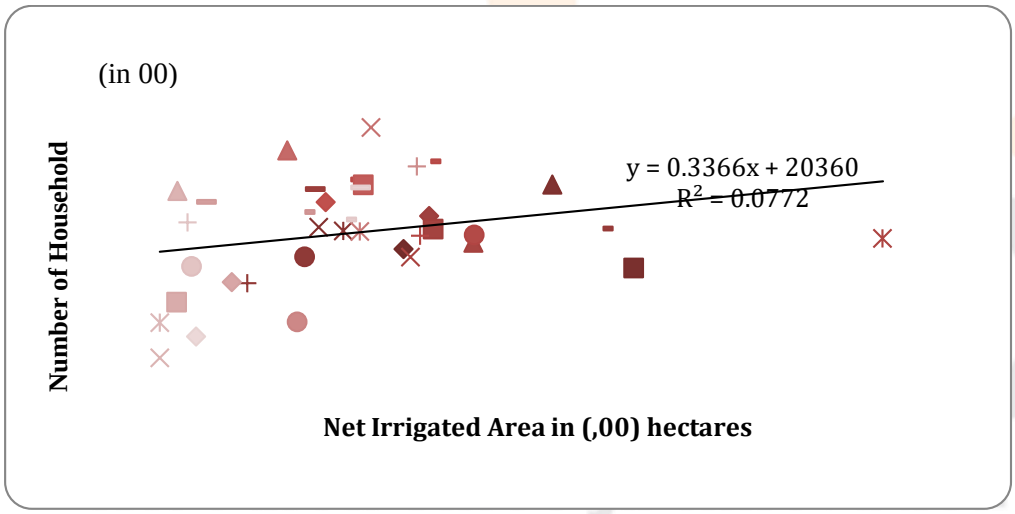


Figure 7: Correlation coefficient between numbers of household (having less than 500 Rs. average monthly incomes) to net irrigated area.

Interesting thing is that, the 12 years has made to increase one percent of paddy irrigation while in 2004 to 2009 within five years' paddy irrigation increase one percent. Proportion of total irrigated area in total cropped area of rice in 1977-78 was only 0.87 and in 1998-99 it had increased up to 1 percent.

In figure 8 Correlations between number of households (BPL) to irrigated areas in region which shows positively significant (r = 0.22). The figure demonstrates that the less irrigation area raise poverty while increasing of irrigated are is major tool of reduction of poverty.

3.5. Impact of Irrigation on Cropping Pattern

Farmer always want to maximize return from farming and therefore he uses such inputs as irrigation and fertilizers for those crops which are capable of giving commensurable returns. From this simple logic it can be deducted that the major irrigated crops should be superior crops, and that the irrigated area of only those crops increased rapidly which could raise their productivity proportionately (Jain, 1988).

Out of the total irrigated area (355.3 thousand hectares) three fourth are under only one crop wheat. While including gram and rice it moves up to 90 percent of total irrigated area. Other beneficiaries are horticulture crops (4.3 percent), barley and rapeseed & mustard. This is noteworthy that proportion of irrigated area under Fruit & vegetable, spices are several times higher than their proportion in total cropped area, as is clear from Table 3. There is marked regionalism in irrigated crops (figure 6). In the irrigated tract of the Tons and Son river basin, wheat is only major irrigated crop. In other parts, though rice is second irrigated crop, though other crops are also significant these are gram and barley in western part of Kaimur plateau and horticulture crops in Rewa, Satna, Shahdol and Sidhi districts and spices in Anuppur and Satna districts. This proves that those crops are significant in the roll of irrigated ones which have high calorific as well as market values. These crop yields are increasing tardily which enhance and endure the livelihood.

Wheat, the major crop has increased its irrigated area from 2.36 lakh hectares in 1998-99 to 2.65 lakh hectares in 2008-09, marking an increase of more than 12 percent. With the increasing of percentage under wheat irrigation since 1998-99 and wheat production had increased 27 percent in 2008-09 from 1998-99. As consequences the tardily increasing of production with irrigation area because of the fact that rainfall in these districts was remarkably lower than the average which demanded expansion of irrigation. Its yield per hectare was 1003 kg in 1998-99 which come down to 953 kg in 2008-09. These two results are seen in all districts.

Gram is next to wheat sharing more than 11 per cent of total irrigated area. It's also recorded 19.4 thousand hectares in 1998-99 to 41.8 thousand hectares in 2008-09. Spices and fruit-vegetables are highly dependent on irrigation.

Table 3: Irrigated Crops, 2008-09

Crops	Proportion in Total		Irrigated area as percentage of the area of crop	Percentage change in irrigated area 1998-09
	Cropped area	Irrigated area		
Wheat	22.64	74.54	60	11.89
Rice	31	6.24	3.64	260
Gram	10.34	11.75	20.64	115.4
Fruit & vegetable	1.12	4.35	70.45	54.19
Spices	0.19	0.56	52.65	81.81
Barley	1.61	1.12	12.69	85.7
All crops	100.0	100.0	18.2	27.72

Source: Ministry of Agriculture, Government of India, 2011.

Rice is next to gram sharing 6.2 percent of the total irrigated area. As a result, very high growth 260 percent from 6.1 thousand hectares in 1998-99 to 22.2 thousand hectares in 2008-09, share of rice in gross irrigated increase rapidly from 2.2 to 6.2 per cent during this period.

Despite of this, production of rice increased by 50 percent, from 342 thousand tones to 514 thousand tones and yield rate by 44 percent, from 590 to 854 kg/ha. There are several blocks in region which witnessed increase in production and in actual rice irrigated area as well as in yield. It seems rational that development of this crop grown in rainy season depends upon other inputs such as HYV of seeds, fertilizers than on irrigation. However, in scarcity year's irrigation plays vital role (Jain, 1988). At the same time, rapid expansion of rice cropped area in northwestern and northeastern part of the region has been facilitated by the irrigation.

3.5.1 Irrigation and Adoption of Yield-raising inputs

The preceding analysis makes it clear that irrigation has played a vital role in enhancing the yield rates of the crops. At the same time, it has also influenced the adoptability of certain yield-raising inputs such as high yielding variety of seeds and fertilizers. It is see how far of these inputs co-varies temporarily and spatially with the extent of irrigated area.

a) Irrigation and Area under HYV of Seeds

It is Fact that the real benefit of irrigation comes out when improved seeds are used and it is also true that the water requirements of most of the improved varieties is much higher than local varieties (Sinha,1975, p.9). Because of this reciprocal relationship, for the application of improved seeds ensured water supply is pre-requisite (Jain, 1988, p.55).

Table 4: District-wise high yielding varieties coverage in region (Unit in Hectare)

Districts	Paddy	Maize	Jowar	Bajra	Wheat	Total
Rewa	92	0	1.5	0	126	219.5
Sidhi	56.6	30.4	3.3	0	51.9	142.1
Satna	67.4	0.3	1.2	0	98	166.9
Shahdol	55	10	0	0	30	95
Umaria	15.8	3.2	0	0	14.5	33.4
Region	286.8	43.9	6	0	320.4	656.9

Source: Department of Agriculture, Govt. of India, 2010.

In last two decades' area increased phenomenally by the end of 1998-99, area under seeds of mainly paddy was 64 thousand hectares which increases up to 80 thousand hectares in 2008-09. While wheat crop seeds cover more than 320 units per hectare in 2008-09. Rewa and Satna districts were highest in region for seeds consumption in unit hectares (table 4).

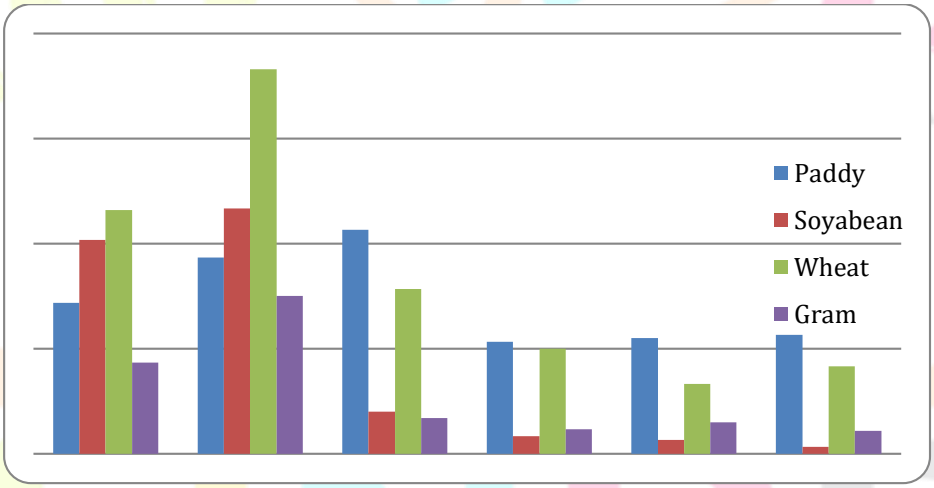


Figure 8: Distributions of Seeds (In, 00 kg)
Source: Department of Agriculture, Govt. of India, 2010

Consumption of HYV seeds has been highest in Northern part of region because this area is certainly much higher than the proportion of irrigated area. It seems that irrigation has decisive influence on the use of HYV of seeds. Other districts such as Shahdol, Anuppur and Umaria were low irrigation facilities also have little area under HYV of seeds.

b) Irrigation and Uses of Fertilizers

Modern agriculture relies on adequate and supplies of inputs fertilizer being a key input, directly effects agricultural production and development of rural areas. Consumption of fertilizers is affected by a number of factors, the most

important of which are unusual and unfavourable weather, non-availability of adequate water, input-output relationship, non-availability of the right type of fertilizers at the place away from rail-heads and markets, absence of transport facilities, inadequacy or absence of credit facilities (Jain, 1988, p.78).

Consumption of fertilizers has recorded an increase of more than 48 percent; from 492 tonnes in 1991-92 to 728 tonnes in 2008-09. Annual average of use of fertilizer per hectare increased from 28.3 in 1991-92 to 30.8 kg per hectare in 2008-09. The growth of irrigated area is much higher than growth of fertilizer consumption. There is wide variation in spatial pattern of use of fertilizers. It ranges between 7 kg/ha in Shahdol and 54 kg/ha in Rewa in 1991-92. There are two areas of concentration, first Ton basin of Rewa and Satna districts and mid- eastern part of the region comprising Sidhi and some part of the Shahdol districts.

Table 5: Consumption of Fertilizers, 1991-2009)

Year	(In 00 Tonnes)				kg/ha.			
	Nitrogen	Phosphate	Potash	Total (NPK)	N	P	K	Total
1991-92	297.15	191.45	3.20	491.80	17.1	11.0	0.1	28.3
1996-97	407.35	180.23	4.57	592.15	20.7	9.2	0.23	30.2
2001-02	322.30	238.36	6.85	567.52	14.6	10.84	0.3	25.7
2006-07	426.93	268.85	11.2	706.99	17.5	11.29	0.49	29.3
2008-09	457.40	260.10	10.70	728.20	19.1	11.2	0.48	30.8

Source: Madhya Pradesh Krishi Kalyan and Welfare department, M.P Govt., 2011

If the area of these districts compare with map of irrigated area, it shows that the highly irrigated areas have high use of fertilizer concentration. Further, in Kharif season fertilizer is lesser popular as comparison to Rabi seasons. The high percentage uses of fertilizer is mainly in Rabi season on northern part of the region, which is pre-dominantly of Rabi crop especially wheat and gram (table 5). However, correlation coefficient between irrigated area and use of fertilizers is highly significant (r = 0.89). This correlation method provides attraction on irrigation which is increasing with the help of modern techniques. To improve and sustain livelihood the water supply for agriculture is a prominent method (Figure 10).

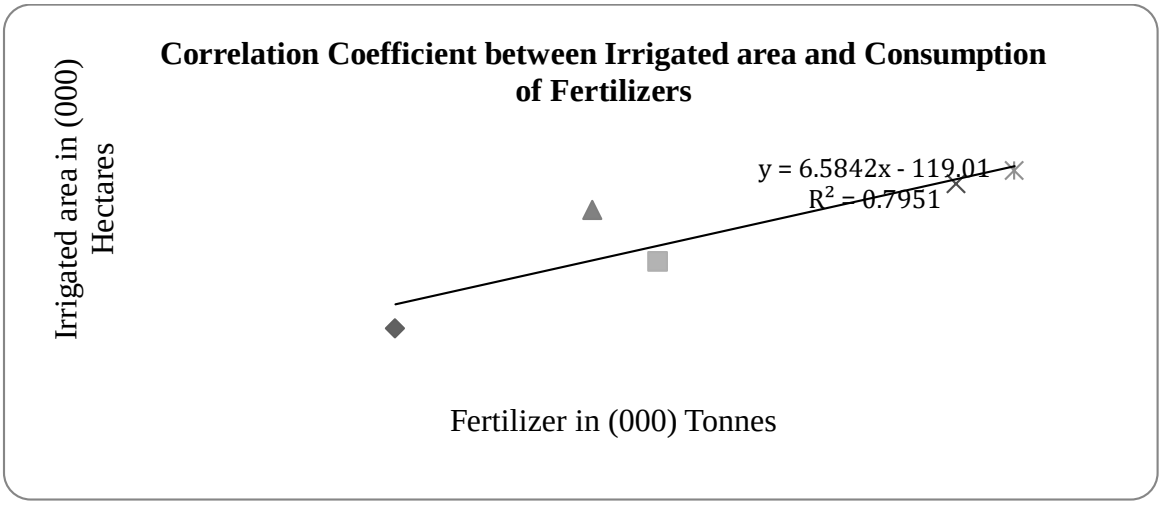


Figure 9: Coefficient of Correlation between Irrigated area and Fertilizer Consumption

Picture 2 : Mustard crop in Sirmour, Rewa

Picture 1: Gram crop cultivation in Majhgawan,

3.7 CONCLUSION

The percent of irrigation has been increasing steadily over the years this is especially seen that the foot tapping of ground water for irrigation is increasing exponentially. Irrigation through reservoirs needs to be more developed because of this development increases less dependency on tube well irrigation. The rainfall is only source of recharging river, pond, tank and ground water resource, so when years get more rain this effects on irrigation intensity through secondary sources. Kharif and Rabi crops wheat, rice, soyabean etc. and these crops cover more than three-fourth of total irrigation. The raising of modern inputs in agriculture plays a vital role in increasing cropped area. So we can say that water is a key position in the development of agriculture where the region's three-fourth people linked to the livelihood. Only one-fourth of water has been extracted from ground water into use of total water availability in the region. The culturable waste lands and fallow lands percentage is highly concentrated so it can be made productive by improving it. In case of water deficiency, the alternative system must come in function, therefore, the system will have compensation from the irrigation when shortage of rainfall during the Kharif

season. It can be concluded that expansion in net area irrigation owes to other factors facilitating and necessitating expansion of cropped area rather than to increasing irrigation facilities.

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