Ad-hoc Study No.50

UNDERUTILISATION OF IRRIGATION POTENTIAL CREATED BY TUBEWELLS

(A Study in Narsinghpur and Morena Districts of M.P.)

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The authors thankfully acknowledge the guidance, cooperation and help rendered by following officials of the Tubewell Construction Department, Govt. of M.P.

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CHAPTER- I

I N T R O D U C T I O N

No life is possible on this planet or anywhere else without water. It is needed by human beings, animals and plants. In plants, water constitutes 3/4 of the total weight. Paucity of water supply inhibits plant growth, whereas, adequate and timely supplies vitalise the plants, enhance their growth and increase the yields.

In cultivated crops there are 3 sources of water : soil moisture, rain water and irrigation water. The cultivation of crops totally dependent on rain water is commonly known as dry farming and is practised on larger proportion of area in the country. More than 40 per cent of the cereals and over 90 per cent of pulses and oilseeds are produced on dry lands. Total dependence on (monsoon) rains, which are erratic, makes the cultivation in these areas risky.

1.1 Irrigated Area

On the other hand, there are areas which have some kind of support in the form of irrigation water in addition to rain water. In 1980-81 of the net sown area of 140.27 million hectares in the country irrigated area was 38.80 million hectaresor 27.66 per cent. Similarly, out of the gross cropped area of 173.32 million hectares, the gross irrigated area was 49.58 million hectares or 28.60 per cent. During the five year period ending 1980-81 the percentage of net irrigated area to net sown area increased by 2.46 and that of gross irrigated area increased by 2.59 (Table 1.1)

Table 1.1 Irrigated area in India 1976-77 to 1980-81

(Area-million hectares)

Year	Net sown area	Net irri-gated area	% of net crrigated area to net sown area	Gross cropped area	Gross irrigated area	% of gross irrigated area to gross cropped area
1976-77	139.46	35.15	25.20	167.34	43.55	26.02
1977-78	141.91	36.55	25.76	172.26	46.03	26.72
1978-79	143.01	38.06	26.61	174.76	48.31	27.64
1979-80	139.02	38.48	27.68	169.66	49.18	28.99
1980-81	140.27	38.80	27.66	173.32	49.58	28.61

Source : Area and Production of Principal Crops in India 1981-84, Directorate of Economics & Statistics, Ministry of Agriculture, Govt.of India, page-344

Paddy and wheat were the most important irrigated crops as they accounted for 32.95 and 31.29 per cent respectively of the gross irrigated area. Sugarcane (4.61 per cent), cotton (4.29 per cent) and pulses (4.08 per cent) were other important crops. As regards the extent of irrigation sugarcane occupied the first position. Wheat was irrigated to the extent of 69.64 per cent and barley and paddy to the extent of 50.30 and 40.69 per cent respectively. (Table 1.2)

Table 1.2 Cropped area and irrigated area in India 1980-81

(Area- thousand hectares)

Crop	Area	Percentage to gross cropped area	Irrigated area	Percentage to total	Percentage of irrigated area to total area under the crop
Paddy	40,152	23.17	16,339	32.95	40.69
Jowar	15,809	9.12	627	1.26	3.97
Bajra	11,657	6.73	639	1.29	5.48
Maize	6,005	3.46	1,195	2.41	19.90
Ragi	2,525	1.46	295	0.59	11.68
Wheat	22,279	12.85	15,516	31.29	69.64
Barley	1,807	1.04	909	1.83	50.30
Others	3,976	2.30	67	0.15	1.69
Total cereals & millets	1,04,210	60.13	35,587	71.77	34.15
Gram	6,584	3.80	1,346	2.71	20.44
Other pulses	15,873	9.15	600	1.27	3.78
Total pulses	22,457	12.95	2,026	4.08	9.02
Total foodgrains	1,26,667	73.08	37,613	75.85	29.69
Groundnut	6,801	3.92	922	1.86	13.56
Rapeseed & mustard	4,113	2.37	989	1.99	24.04
Cotton	7,823	4.51	2,129	4.29	27.21
Sugarcane	2,667	1.54	2,287	4.61	85.75
Tobacco	452	0.26	155	0.31	34.29
Others	24,797	14.66	5,490	11.09	22.13
All crops	1,73,320	100.00	49,585	100.00	28.61

Source : Area and Production of Principal crops in India 1981-84, Directorate of Economics & Statistics, Ministry of Agriculture, Govt.of India, pages 346 & 347

1.2 Importance of Irrigation

In the areas with scanty rainfall it is only with the help of irrigation that some crops can be grown. Secondly, it gives a wider choice for growing different types of crops in different seasons thereby increasing the intensity of cropping. It not only provides insurance against the failure of rains but also increases production significantly. It is an important input in itself and helps in the use of other inputs like improved seeds, fertilizers and other recommended practices. According to the estimates of the planning commission, irrigation water contributes 27 per cent increase in productivity as against 41 per cent by fertilizers, 13 per cent by improved seeds and 19 per cent by others.

Yields of principal crops always show significant variation between irrigated and unirrigated areas both at micro and macro levels. Various micro-level studies viz. farm management studies, studies of sample farms in command areas of irrigation projects and crop cutting experiments clearly indicate that irrigated crops yield more. Studies conducted for a command area beneficiary villages vs. non-beneficiary villages and also for a command area for pre-irrigation and post irrigation periods have clearly shown the advantages of irrigation. Data for yields for irrigated crops and unirrigated crops for different states have also brought out this.

Data for Madhya Pradesh for 1981-82 show that yields of paddy on irrigated areas was 44.71 per cent higher than the unirrigated areas. Similarly the yield of wheat was 97.04 per cent higher than the unirrigated crop. In the case of bajra the yield for irrigated areas was more than three times the yield of unirrigated areas. The yield of barley, rapeseed and mustard and gram

was higher by 94.09, 98.42 and 59.75 per cent higher on irrigated areas as compared to the unirrigated ones. (Table 1.3)

Table 1.3 Yields of principal crops on irrigated and unirrigated areas, Madhya Pradesh, 1981-82

(Yield- kg per hectare)

Crop	Irrigated	Un-irrigated	% increase in irrigated area over unirrigated area
Paddy	1,123	776	44.71
Wheat	1,600	812	97.04
Jowar	934	827	12.94
Bajra	1,719	397	333.00
Barley	1,444	744	94.09
Maize	1,034	995	3.92
Gram	1,008	631	59.75
Rapeseed & Mustard	754	380	98.42
Groundnut	899	734	22.48

This underlines clearly the importance of irrigation in the agricultural development. The government is also making all out efforts to increase the irrigation potential in the country. During the sixth plan an additional potential of 8.0 million hectares was proposed to be created : 1.0 million hectares under surface water and 7.0 million hectares under groundwater.

1.3 Sources of Irrigation

The main sources of irrigation are canals, tanks and wells. The sources such as nallahs, rivers etc. are grouped as "other sources". The canals are of two types i.e. govt. and private. Wells are classified into two: tube wells and other wells.

The sources of irrigation are classified in different ways. They are either protective or assured. The protective sources depend on rains, and therefore, support the crops, in the event of failure of rains, to a limited extent. Tanks and canals drawn from these come under this category. On the other hand, wells are assured sources of irrigation.

The sources of irrigation can also be classified into three, viz. major, medium and minor. The criterion of this classification is the extent of investment and the area commanded. Thus canals come under major sources of irrigation and tanks are categorised as medium sources. Wells are termed as minor irrigation sources or schemes.

Still another classification of irrigation sources could be : surface water and groundwater. As the terms clearly indicate canals and tanks come under surface water sources and the wells come under groundwater sources.

Of the total irrigated area of 38,478 thousand hectares in 1979-80, 46.30 per cent was irrigated by wells and 38.34 per cent by canals.

Thus wells form the major sources of irrigation in the country. Of the 46.30 per cent of the irrigated area under wells tubewells account for 24.18 per cent and other wells, 22.12 per cent.

Data for the five year period ending 1979-80 indicate that the proportion of irrigated area under canals remained around 39 per cent for the first four years and decreased slightly to 38.34 per cent in the last year. The proportion of irrigated area under wells, on the other hand, increased from 41.59 per cent in 1975-76 to 43.22 per cent in 1978-79. In 1979-80 it shot up significantly to 46.30 (Table 1.4).

Table 1.4 Net area irrigated by different sources in India,1975-76 to 1979-80

(Unit : Thousand Hectares)

Source	1975-76		1976-77		1977-78		1978-79		1979-80	
	Area	%	Area	%	Area	%	Area	%	Area	%
Canals										
Govt.	12,916	37.45	13,016	37.03	13,770	37.55	14,270	37.59	13,916	36.17
Private	863	2.50	845	2.40	843	2.30	838	2.21	836	2.17
Total canals	13,775	39.94	13,861	39.43	14,613	39.85	15,108	39.80	14,752	38.34
Tanks	3,986	11.56	3,901	11.10	3,901	10.64	3,918	10.33	3,482	9.05
Wells										
Tube wells	6,769	19.63	7,432	21.14	7,769	21.19	8,178	21.54	9,304	24.18
Other wells	7,577	21.96	7,655	21.78	7,896	21.54	8,232	21.68	8,513	22.12
Total wells	14,346	41.59	15,087	42.92	15,665	42.73	16,410	43.22	17,817	46.30
Other sources	2,384	6.91	2.300	6.55	2,486	6.78	2,525	6.65	2,427	6.31
Total Irrigated Area	34,491	100.00	35,149	100.00	36,665	100.00	37,961	100.00	38,478	100.00

During the sixth five year plan the groundwater got precedence over surface water. While the target for the additional irrigation potential under surface water was 1.0 million hectares- with a uniform addition of 0.2 million hectares per year- that under groundwater was 7.0 million hectares. It was 1.3 million hectares during the first two years and was to be increased to 1.4 million hectares in the third year. In the last two years of the plan the targetted potential was proposed to be 1.5 million hectares each. (Table 1.5)

Table 1.5 Physical target for irrigation for the sixth plan 1980-81 to 1984-85

(Figures- Million hectares)

Year	Additional Potential		
	Surface water	Ground water	Total
1980-81	0.2	1.3	1.5
1981-82	0.2	1.3	1.5
1982-83	0.2	1.4	1.6
1983-84	0.2	1.5	1.7
1984-85	0.2	1.5	1.7
Total	1.0	7.0	8.0

Source : Sixth Five Year Plan, 1980-85

1.4 Tubewells

Table 1.4 clearly indicates the increasing proportion of irrigated area under tubewells. The proportion was 19.63 in 1975-76 and increased marginally to 21.14, 21.19 and 21.54 in the subsequent three years. In 1979-80 it increased to 24.18 an increase of 2.64 per cent.

The table also clearly points out that this is the only source of irrigation under which the proportion of commanded irrigated area has increased uninterruptedly. There are reasons for its popularity over other sources. As mentioned earlier this source is classified as groundwater source and the groundwater has inherent advantages. Firstly, it costs absolutely nothing to store. Secondly, it is served at the doorstep of the farm and thirdly it suffers no loss due to evaporation or seepage either during storage or during transmission. Fourthly, it is easy to tap. Lastly, this source can be made available within weeks if not, in fact, in days. In contrast, the surface water is extremely difficult to store and manage. Big projects take decades to design and build, require large area of precious land for submergence and for distribution systems, are subject to serious evaporation and transmission losses, and demand stupendous outlays. They also create problems of waterlogging and drainage. Their storages are exposed to the threat of siltation. They also need large staff for maintenance.

In India minor irrigation has made very good progress during the five year plans. At the end of the fourth plan there were 68,41,000 wells, 17,52,000 diesel pumps and 24,42,000 electric pumps in the country. While the private tubewells numbered only 30,000 at the end of the first plan they increase to 7,82,000 by the end of the fourth plan. Similarly the number of state tube wells was only 7,000 at the end of first plan but increased to 21,000 by the end of fourth plan(Table 1.6).

Table 1.6 Progress of minor irrigation in India

(Number in thousands)

Item	Pre-plan	End of First plan	Second plan	Third plan	1968-69	Fourth plan
Wells in use	N.A.	3,624	4,474	5,111	5,908	6,841
Diesel pumps	66	123	230	465	721	1,752
Electric pumps	21	56	199	513	1,089	2,442
Private tubewells including filter points	21	30	49	113	246	782
State tubewells	3	7	10	13	15	21

Source : Report of the National Commission on Agriculture 1976.

During the sixth plan the target for dugwells was kept at 12 lakhs. An equal number of private tubewells were proposed to be sunk. The target for state tubewells was set at 15 thousand. (Table 1.7)

Table 1.7 Trends in utilisation of groundwater potential during the sixth plan

S.No	Item	Sixth Plan target 1980-85	1980-81	81-82	82-83	83-84	84-85
1.	Dugwells(lakh)	12.00	1.87	1.38	2.34	2.41	1.00
2.	Private tubewells (lakh)	12.00	2.44	2.10	2.14	2.32	9.00
3.	Public tubewells (No.)	15,000	2906	2147	3069	3070	21192

Source : Sixth Five Year Plan 1980-85; Mid term appraisal

1.4.1 Private Tubewells and State Tubewells

Private tubewells are owned and operated by individual farmers whereas state tubewells are the property of the Government and the operation is also done by its nominees.

Private tubewells are mostly shallow tubewells and have a discharge of about 30,000 litres per hour. These are generally run between 500 to 1,000 hours per year and irrigate between 4 to 8 hectares. The life of a private shallow tubewell is about 15 years. State tubewells generally tap deep acquifers and give on an average a discharge of about 1,35,000 litres per hour. These irrigate a gross area of 80 to 100 hectares, the net irrigated area being about 20 per cent less. These are run for 2,000 to 3,000 hours per year and have a useful life of 20 to 25 years.

Private tubewells have certain advantages over state tubewells. Firstly, in the case of private tubewells tapping of the water is controlled by individual farmer according to his needs. Secondly if any part of the equipment goes out of order, the individual farmer, who has made such a heavy investment, does not lose time to get it repaired. In the case of state tubewells, on the other hand, the operation is controlled by the government nominee and in many cases lacks timely and equitable distribution of water. In the event of a failure of an equipment inordinate delays due to departmental procedures and indifference on the part of the operator put the farmers to great losses.

Table 1.6 shows that the growth of the private tubewells has been particularly noteworthy from the third five year plan onwards. This rapid expansion came in the wake of green revolution of which adequate and timely irrigation was an essential input. Private tubewells provided this. The stepping up of the

programme of rural electrification and provision of credit facilities were other contributory factors.

1.5 Utilisation and Underutilisation of Irrigation Potential

The full utilisation of irrigation potential needs very careful planning before the commencement of the project and also requires scientific knowledge of crop planning and crop husbandry after the benefits start flowing. Instances are many in irrigation projects where full utilisation of irrigation potential is not made. Data for the years 1982-83 and 1983-84 indicate that the percentage of area actually benefitted to potential (area) created was 92.42 and 92.98 respectively. In other words the underutilisation was to the extent of 7.58 and 7.02 per cent respectively. It was also noted that the extent of underutilisation in the case of major and medium irrigation schemes was 16.49 and 15.34 per cent respectively in the two reference years. Whereas no underutilisation was observed in the case of minor irrigation schemes in both the years. (Table 1.8)

Table 1.8 Irrigation potential created and utilised in India 1982-83 & 1983-84

(Figures- Million Hectares)

Item	1982-83			1983-84		
	Potential	Utilisation	% of utilisation to potential created	Potential	Utilisation	% of Utilisation to potential created
Major and Medium schemes	29.1	24.3	83.51	30.0	25.4	84.66
Minor Schemes	34.2	34.2	100.00	35.6	35.6	100.00
Total	63.3	58.5	92.42	65.6	61.0	92.98

Source : Economic Survey, 1983-84

The reasons for underutilisation are many. It would be useful to study the extent of underutilisation of irrigation potential of a project and the reasons thereof. With these aspects in view the Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India asked the four Agro-Economic Research Centres viz. Jabalpur, Jorhat, Santiniketan, and Waltair to take up a coordinated study on "Underutilisation of Irrigation Potential created" in their respective regions. Agro-Economic Research Centre, Jabalpur was asked to conduct the study for tubewells.

1.6 Objectives

The objectives of the study are :

1. To assess the irrigation potential created by tubewells
2. To assess the extent of utilisation of irrigation potential and to know the extent of underutilisation, if any
3. To know the reasons of underutilisation, and to suggest the measures that could be taken to limit the underutilisation.

1.7 Selection of the Districts

In Madhya Pradesh the successful tubewells are mostly located in Narmada and Chambal basins. The Narmada basin consists of the districts of Mandla, Jabalpur, Narsinghpur, Hoshangabad, Khandwa, Khargone and Dhar. Chambal basin consists of the districts of Indore, Ujjain and Morena. Of the districts of Narmada basin, Narsinghpur has the largest number of tubewells and of the Chambal basin districts, Morena has so.

Therefore, Narsinghpur and Morena districts were selected for the study. The opinion of the departmental officials was also considered for the selection of the districts.

1.8 Sampling Design

The sample comprised 50 tubewell owners of each of the selected districts of Narsinghpur and Morena. Thus total sample size was 100. Narsinghpur district had two tehsils viz. Narsinghpur and Gadarwara. Therefore, 25 tubewell owners from each of the two tehsils made up the sample for Narsinghpur district. Morena district comprised 6 tehsils. Of these two tehsils had an insignificant number of tubewells and were therefore left out. The sample tubewell owners in the remaining four tehsils spread in such a way that Jaura had 18 tubewell owners, Ambah had 7, Morena had 10 and Sabalgarh had 15 making the total to 50.

This was approximately proportional to the total number of tubewells in these tehsils.

For the selection of sample tubewell owners in a tehsil lists were drawn and the concentration of tubewells was noted. The sample within the cluster of tubewell owners was drawn on random basis. As mentioned in para 1.4 above the operation of a private tube well is controlled by an individual farmer. It is he who can be credited or held responsible for utilisation or underutilisation of the tubewells. In the case of state tubewells the operation is with the employee of the govt. and therefore the utilisation of irrigation water or its underutilisation is beyond the control of individual farmer. Therefore for the present study only private tubewell owners have been selected.

1.9 Reference Years

The years for studying the impact of tubewells were two. The crop data for the year preceding the sinking of tubewell were compared with that of the data of agricultural year 1984-85.

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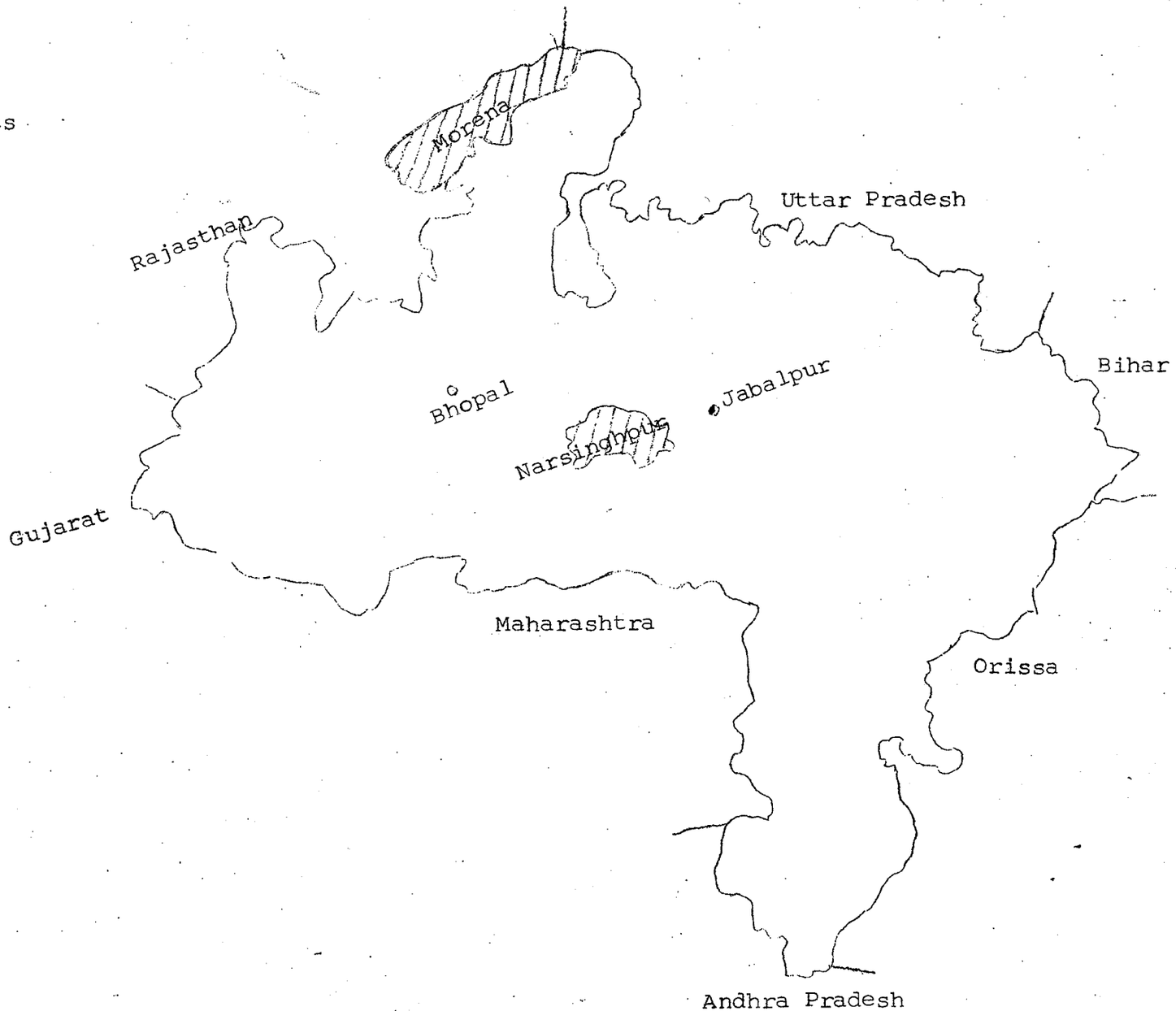
Map of Madhya Pradesh
Showing the selected districts
of
Narsinghpur & Morena



C H A P T E R II

TUBEWELL IRRIGATION IN MP

In M.P., of the total geographical area of 442.11 lakh hectares, 188.41 lakh hectares or 42.62 per cent was net area sown in 1981-82 (Also see appendix table A 2.1). Further, out of the net sown area of 188.41 lakh hectares, 24.21 lakh hectares or 12.85 per cent were irrigated. The gross irrigated area, on the other hand, was 25.11 lakh hectares or 11.54 per cent of the gross cropped area. Thus the area irrigated more than once came to 0.90 lakh hectares (Table 2.1)

Table 2.1 Irrigation Statistics of M.P., 1981-82

Item	Details
Total geographical area (lakh hectares)	442.11
Net area sown (lakh hectares)	188.41
Percentage of net area sown to geographical area	42.62
Net area irrigated (lakh hectares)	24.21
Percentage of net area irrigated to net area sown	12.85
Gross area irrigated (lakh hectares)	25.11
Percentage of gross irrigated area to gross cropped area	11.54

2.1 Irrigated Crops

Of the gross irrigated area of 2,510.8 thousand hectares, 978.8 thousand hectares or 38.98 per cent was shared by wheat and 32.88 per cent by paddy. Thus in M.P. wheat and paddy were the most important irrigated crops. Besides these, only gram commanded

a significant (7.61) percentage of irrigated area. If, however, we consider the criterion of percentage of irrigated area under a crop to its total area, sugarcane deserves the most important place as the entire area under the crop was irrigated. Spices (58.03 per cent) and vegetables (56.90 per cent) were also grown with more than half of the area under irrigation. Wheat was irrigated to the extent of 29.61 per cent and paddy 17.02 per cent. (Table 2.2)

2.2 Sources of Irrigation

Unlike the country as a whole, canals formed the most important sources of irrigation in this state as 44.99 per cent of the net irrigated area was commanded by canals. Next important sources were wells which irrigated 41.16 per cent of the net irrigated area. 'Other' sources and tanks formed only 8.28 and 5.57 per cent respectively (Table 2.3)

The proportion of area under various sources of irrigation did not vary much during the preceding five years. (see appendix table A 2.2).

2.3 Tubewells

At the end of the year 1981-82 there were 2,333 canals 49,330 tanks, 806 reservoirs, 9,40,126 (irrigation) wells and 6,876 tubewells in the state. Indore division had the largest number (2,454) of tubewells, followed by Jabalpur (933) and Hoshangabad (785) (Table 2.4)

The number of tubewells in different districts in 1979-80 is shown in appendix table A 2.3.

The number of tubewells in the state was 2,218 in 1971-72 and increased to 5,085 in 1974-75. It decreased to 4,898 in 1975-76 but again increased from year to year to 10,645 in 1980-81. In 1981-82, however, it again decreased to 6,876. (Table 2.5)

Table 2.2 Cropping pattern and cropwise irrigated area, M.P. 1981-82

(Thousand hectares)

Crop	Area under the crop	% to total	Irrigated Area (thousand hectares)	% to total irrigated area	% of irrigated area to total area of the crop
Paddy	4,849.6	22.30	825.6	32.88	17.02
Wheat	3,305.8	15.19	978.8	38.98	29.61
Jowar	2,252.0	10.35	2.7	0.11	0.12
Maize	788.2	3.62	7.5	0.30	0.95
Barley	180.9	0.83	50.6	2.02	27.97
Other cereals	1,648.3	7.58	0.5	0.02	0.03
Total cereals	13,024.8	59.87	1,865.7	74.31	14.32
Gram	2,028.9	9.33	191.0	7.61	9.41
Peas	109.9	0.50	8.3	0.32	7.55
Lentil	301.7	1.39	12.8	0.51	4.24
Other Pulses	2,423.0	11.13	5.9	0.24	0.24
Total Pulses	4,863.5	22.35	218.0	8.68	4.48
Total food grains	17,888.3	82.22	2,083.7	82.99	11.65
Rape seed & mustard	291.3	1.34	82.4	3.28	28.29
Other oilseeds	1,754.0	8.06	12.9	0.52	0.74
Total oilseeds	2,045.3	9.40	95.3	3.80	4.66
Sugarcane	38.7	0.15	38.7	1.54	100.00
Cotton	613.5	2.82	54.2	2.16	8.33
Total fruits & Vegetables	174.0	0.80	99.0	3.94	56.90
Total spices	117.0	0.54	67.9	2.70	58.03
Other crops	889.7	4.07	72.0	2.86	8.09
Total cropped area	21,756.5	100.00	2,510.8	100.00	11.54

Source : Agricultural Statistics, M.P., 1982

Table 2.3 Net area irrigated by different sources, M.P, 1981-82

Source	Area (Thousand hectares)	Percentage to Total
Canals	1,090	44.99
Tanks	135	5.57
Wells	996	41.16
Other sources	200	8.28
Total	2,421	100.00

Source : Agricultural Statistics, M.P. 1982

Table 2.4 Distribution of tubewells in different divisions of M.P. 1981-82

Divisions	No.of tubewells
Raipur	649
Bastar	8
Bilaspur	160
Jabalpur	933
Sagar	93
Rewa	84
Indore	2,454
Ujjain	615
Morena	397
Gwalior	158
Bhopal	540
Hoshangabad	785
Total	6,876

Source : Agricultural Statistics, M.P. 1982

Table 2.5 Number of tubewells in M.P. 1971-72 to 1981-82

Year	No.of tubewells
1971-72	2,218
1972-73	3,275
1973-74	4,032
1974-75	5,085
1975-76	4,898
1976-77	5,359
1977-78	5,998
1978-79	N.A.
1979-80	8,155
1980-81	10,645
1981-82	6,876

Source : Agricultural Statistics of M.P. for different years

2.4 Progress of Tubewell Construction

In M.P., Narmada, Chambal, Sone and Tapti valleys have alluvial formations. Of these Narmada and Chambal valleys have been proved to be the most productive groundwater belts. According to the estimates of the State Irrigation Department the state can sustain 30,000 tubewells, Against this there are about 7,000 tubewells in the state. In the sixth plan period it was proposed to drill 7,000 tubewells : 4,254 Corporation tubewells and 2,746 cultivators' tubewells. It was estimated that an additional potential of 87,000 hectares would be created. (Table 2.6)

Table 2.6 Tubewell construction programme in M.P. during the sixth plan

Type of Tubewells	Proposed No. of Tubewells	Estimated potential (hectares)	Potential per well(Ha)
Corporation tubewells	4,254	66,000	15.51
Cultivators tubewells	2,746	21,000	7.65
Total	7,000	87,000	12.43

2.4.1 Exploratory Tubewells Organisation (E.T.O.)

In 1952, an exploratory Tubewell Organisation (E.T.O.) was established by the Government of India and an All India Exploratory Programme, with the help of Technical Cooperation Mission of the U.S.A., was launched due to the growing need for development of ground water. A Scheme was drawn up to sink 350 tubewells in different parts of the country where geological conditions looked promising. Out of these, 15 tubewells were allotted to Madhya Pradesh in the Narmada Valley and the number was further increased to 35 due to encouraging results. Out of these 35 tubewells 16 were found to be successful. These were taken over by the State Government in 1957-58 and were commissioned in October 1958. The civil work of these was completed by the Irrigation Department and the tubewells are still working satisfactorily.

2.4.2 Exploratory Programme by the State

In 1959, based on the results obtained in the above scheme, the State Government sanctioned a further scheme for the construction of 40 tubewells in the proved zone, 20 each in Narsinghpur and Hoshangabad districts, which was subsequently revised to

31 tubewells in Narsinghpur and 9 in Hoshangabad district as some of the area in Hoshangabad district came under the command of Tawa Project. All these wells were constructed through contractors and are doing irrigation.

2.4.3 Further Work by E.T.O.

In the third plan a scheme of 20 additional production tubewells was sanctioned and the work was entrusted to the E.T.O. The E.T.O. was also approached to do the exploration work side by side in the remaining areas of Narsinghpur and Hoshangabad districts as well as in Patan tahsil of Jabalpur district. For this, another scheme of 15 exploratory tubewells was prepared in 1961. Under these schemes, 21 tubewells in Narsinghpur, 4 in Hoshangabad and 8 in Jabalpur district were found successful. These were taken over by the Irrigation Department of Madhya Pradesh and were commissioned. (Table 2.7)

Table 2.7 Details of sucessful tubewells drilled under various schemes

Schemes	Narsinghpur	Hoshangabad	Jabalpur	Raisen	Total
Exploratory tubewells	4	9	1	2	16
Production tubewells	31	9	-	-	40
Additional tubewells	14	--	4	-	18
Exploratory tubewells	7	4	4	-	15
Total :	56	22	9	2	89

Out of these 89 tubewells, 1 in Hoshangabad district was later on found unsuccessful. The rest 88 tubewells are in operation.

2.4.4 Central Groundwater Board

1972, the Govt.of India reorganised the Exploratory Tubewell Organisation and named it as Central Groundwater Board. In M.P. the Board has completed the exploratory work in Narmada Valley and the work in Chambal and Mahanadi Basins was in progress. Earlier the Board was under the Ministry of Agriculture. Since November, 1980, it is operating under the Ministry of Irrigation.

2.4.5 Tubewell Directorate

With a view to conduct the detailed groundwater survey and to continue the drilling of tubewells, the government of Madhya Pradesh constituted a separate Directorate of Tubewells and Groundwater Survey in the Irrigation Department in January, 1968. It constructed many tubewells under Agricultural Refinance Scheme and Pilot Scheme in collaboration with the Department of Agriculture. It also drilled many wells for non-agricultural purposes for govt. departments, semi government bodies and individuals. These cases were not processed by the Department of Agriculture. The Directorate obtained advance payment from the concerned department or individuals.

This continued to work upto December, 1976.

2.4.6 Lift Irrigation Corporation

On 13th July, 1976 the State Government constituted the Madhya Pradesh Lift Irrigation Corporation Ltd.and it was decided to wind up the Directorate of Tubewells. However, the Groundwater survey unit of the Directorate was transferred to Chief Engineer, Survey and Investigation. In October, 1979 the Groundwater Survey unit was transferred under the newly created post of Chief Engineer, Groundwater Survey.

The Lift Irrigation Corporation constructed two types of tubewells.

1. Cultivators tubewells
2. Corporation tubewells

The procedure for drilling the cultivators tubewells is the same as that of the Tubewell Construction Department which is described in the subsequent paragraphs. In the case of Corporation tubewells 80% of the funds were obtained as loan from financial institutions and 20% of the cost was met by the state government. The Corporation tubewells were constructed in the eight districts of Bhind, Sidhi, Rewa, Shahdol, Durg, Rajnandgaon, Bilaspur and Satna.

The Corporation is also executing a project of exploratory tubewells in Chambal Ayacut area. This includes construction of 17 exploratory tubewells and 34 observation tubewells.

2.4.7 Tubewells Construction Department

The Tubewell Construction Department in the State is headed by the Chief Engineer, Groundwater Survey, Irrigation Department. The state is divided into two Tubewell Construction Circles located at Bhopal and Jabalpur, each headed by a Superintending Engineer. In Bhopal circle there are four Tubewell Construction Divisions located at Narsinghpur, Gwalior, Morena and Bhopal, each one headed by an Executive Engineer. In Jabalpur circle there are three Tubewell Construction Divisions at Jabalpur, Rewa and Raipur, each headed by an Executive Engineer. Each division is further divided into sub divisions, each supervised by a Sub-Divisional Officer. There are 30 sub-divisions in the State.

The Tubewell Construction Department undertakes 3 types tubewell construction.

1. Drinking Water Wells

   These are dug for Public Health Engineering Department.

2. Tubewells for Agriculture

   These are meant for irrigation. These are again grouped

into two : Those drilled for individual cultivator and the others owned by the State Government. The latter type of tubewells may be either shallow or deep. The deep tubewells had a depth of 75 metres and above.

3. Tubewells dug for industry or Cooperative Farms or Cooperative Societies

By the end of the year 1979-80 there were 7,723 tubewells constructed under different schemes by various institutions. Of these 6,444 were shallow tubewells and 195, deep tubewells. Thus a total number of 6,639 tubewells served agriculture. (Table 2.8)

Table 2.8 Distribution of tubewells under various schemes and purposes, 1979-80

	Particulars	Number
I.	Shallow tubewells	6,444
II.	Shallow tubewells under deposit works	960
III.	Tubewells for non-agricultural purposes	16
IV.	Tubewells constructed for other purposes	108
V.	Deep Tubewells	195
	Total :-	7,723

Further, of the 6,444 shallow tubewells 3,882 were successful and of these 3,462 were energised to create a potential of 34,051 hectares. Of the 195 deep tubewells drilled 129 were successful and out of these 119 were energised to create a potential of 8,493 hectares. Thus by 1979-80 the total potential created was 42,544 hectares by shallow and deep tubewells (Table 2.9)

Table 2.9 Details of deep and shallow tubewells for agricultural purposes

Particulars	Drilled (No.)	Successful (No.)	Energised (No.)	Potential created (Hectares)
Shallow tubewells	6,444	3,882	3,462	34,051
Deep tubewells	195	129	119	8,493
Total :	6,639	4,011	3,581	42,544

2.5 Procedure of Tubewell Construction for Agriculture

2.5.1 Application

The farmer submits the application for tubewell construction to the Executive Engineer, Tubewell Construction, through the Deputy Director, Agriculture, and the concerned bank, in the prescribed form. In this form the details of land to be mortgaged with the department or bank are given. An amount of Rs.15,000 is deposited along with the form or Rs.1,500 are paid as deposit in the bank. If the tubewell is declared unsuccessful an amount of Rs.1000 is forfeited and paid to the Tubewell Department. If the tubewell is declared successful the amount is adjusted in the total cost of tubewell to be paid later. A declaration from the M.P. Electricity Board is also obtained to the effect that in the case of successful tubewell the electricity connection will be provided.

2.5.2 Bank Loan

In the case of tubewell constructed on bank loan, the bank scrutinises the application and obtains the estimate of cost of the tubewell from the Tubewell Construction Department. Generally the loan amount varies between Rs.30,000 to Rs.40,000. After the loan is sanctioned a tripartite agreement between the bank, the Executive

Engineer and the farmer is signed. The bank then issues an order to the Executive Engineer to construct the tubewell in the farmer's field. The copies of the order are sent to the Deputy Director, Agriculture and the concerned farmer. The Executive Engineer fórwards the work order to the concerned Sub Divisional Officer. The S.D.O. makes the registration of the order and undertakes the construction in that sequence.

2.5.3 Selection of Site

The selection of a proper site for the tubewell is necessary. For this, soil survey or geophysical survey is undertaken. There are 8 divisional offices and in each district there are sub divisional offices of the Groundwater Survey. The details of incidence of underground water are available in the sub divisional offices. At each of the divisional offices Resistivity Units for Geophysical Survey are available and these are used for locating the most appropriate place for the tubewell in the scientific manner. The farmers can avail this facility by depositing the required sum for conducting the resistivity survey. The department conducts resistivity survey at three points and selects the most suitable point. It is necessary to keep a distance of 100 metres in rocky soils and 450 metres in sandy soils between the two wells.

While selecting the site following points should be considered-

(1) Availability of power.

(2) The site should be at a highest altitude of the field so that the water can flow to all parts by gravity.

(3) The site should be in the central part of the field to avoid lengthy water course.

2.5.4 Digging of Tubewell

After the spot is selected the tubewell construction machinery is sent to the farmer's field. Normally the digging is done to the depth of 45 metres. However, the drilling can be done to the additional depth on the application of the farmer. On the approval of the Executive Engineer the farmer is required to deposit an additional amount for the purpose. After the drilling to a desired depth is accomplished the farmer gives consent to the fitting of the pipeline.

2.5.5 Testing of the Tubewell

After this, the testing unit develops and tests the capacity of the tubewell. The development of the tubewell means the cleaning of the water sources with the help of compressors which results in obtaining pure and clear water. This process takes about 8 hours.

The capacity of the tubewell is tested by the Departmental Unit. This work is done with the help of a generator set. A submersible pump is fitted in the tubewell and is run for a definite period. With this the capacity of the tubewell is gauged and the decision regarding the horse power of the pump is taken.

After the completion of the testing a certificate from the farmer is taken in a prescribed form about the working of the pump and the well. The Sub-Divisional Officer then sends the "1st running A/c Bill" to the Executive Engineer or to the concerned Bank. After the payment of this bill the pump is fitted and the electrification is done. The second/last bill for pump fitting and electrification alongwith the certificate from the concerned farmer is sent to the Bank. The payment of this bill is made by the bank to the Tubewell Construction Department. The loan amount is recovered from the farmer in suitable instalments.

2.5.6 Pump Fitting and Electrification

After the testing of the tubewell, the concerned Sub-Divisional Officer informs the electricity department and the concerned farmer about the desirable horse power of the submersible motor pump. On the receipt of this information the officers of the Electricity Department visit the spot and get the approval for the estimated cost from the Divisional Engineer, M.P. Electricity Board. The farmer enters into an agreement with the M.P.Electricity Board. On the agreement by the Divisional Engineer, the work on providing of electricity line is initiated. The responsibility of getting the electricity line is of the concerned farmer. However, the Executive Engineer and other officials of the Tubewell Construction Department take up the issue of electrification in the district level meetings and try to coordinate the work.

On the receipt of intimation regarding the supply of electricity, the Sub Divisional Officer sets the submersible motor pump and sends the continuity test report to the M.P. Electricity Board. On the receipt of this report the meter is supplied to the farmer. Thereafter the S.D.O.arranges to connect the submersible motor pump to the meter. The farmer testifies to the proper working of motor pump and on the basis of this S.D.O. prepares and gets the payment of the second and the last bill from the bank.

2.5.7 Subsidy

Government has declared three types of subsidy :

1. Subsidy on partially or totally unsuccessful wells
2. Subsidy on high cost: this is allowed in the cases where the cost was very high due to acquifer lying at a considerable depth.
3. Subsidy on abandoned wells

1. Subsidy on partially successful or unsuccessful tubewells

An unsuccessful tubewell is one, the yield of which is 5,000 gallons per hour or less in alluvial areas and 2,500 gallons per hour or less in rocky areas but which is duly drilled, developed and tested.

The share of cost between the Government and the individual differs according to the discharge of water.

Table 2.9 Share of cost according to the discharge of the tubewell

Discharge (gallons per hour)		Govt.share (%)	Cultivator's Share(%)
Hard rock area	Alluvial area		
Less than 1,500	Less than 3,000	75	25
1,500 to 2,000	3,000 to 4,000	50	50
2,000 to 2,500	4,000 to 5,000	25	75
Over 2,500	Over 5,000	Nil	100

In the case of an unsuccessful tubewell the cultivator will have to pay Rs.1000 in case the tubewell is not completed and commissioned.

The subsidy given to the cultivator in the case of an unsuccessful tubewell applies only to drilling cost including cost of testing and developing. The cost of well assembly will be borne by the cultivator.

2. Subsidy on high cost

This is admissible according to the following slabs of cost.

	Class of cost of tubewell	Subsidy
1.	Below Rs. 10,000	Nil.
2.	From Rs. 10,000 to Rs.22,000	25 per cent of the cost exceeding Rs.10,000
3.	Above Rs. 22,000	Rs.1000 plus 50 per cent of the cost exceeding Rs.22,000 but total subsidy should not exceed Rs.5000.

3. Subsidy on abandoned wells

An abandoned well is one the drilling of which is not completed due to any reason beyond the control of the cultivator.

In such cases the cultivator is not required to pay anything and his initial deposit of Rs.1,500 is refunded to him.

2.6 Potential and Utilisation of State Tubewells

There were 149 state deep tubewells and 127 state shallow tubewells owned by the Tubewell Construction Department. For each tubewell, potential based on actual yield obtained was worked out. Assuming a tubewell is run for 20 hours per day and also assuming a depth of 0.15 m.per watering for kharif crops and 0.10m. for rabi the potential was calculated. Area actually irrigated was also recorded for each tubewell.

The potential created was 13,272.54 hectares and the actual irrigated area was 6,892.44 hectares. Thus the underutilisation was 6,380.10 hectares or 48.07 per cent. The underutilisation for kharif season was 70.34 per cent and that for rabi, 33.62 per cent (Table 2.10).

"It was observed that utilisation of potential for kharif was very meagre. This was due to following reasons.

1. In major portion of the command area paddy was not grown.
2. The water from tubewells was quite costly. Hence the farmers used it only in extreme necessities.
3. The cultivators had not adopted multiple cropping.
4. The problem of stray cattle.

In some cases, however, the irrigated area exceeded potential"[1].

1. Tubewells in Madhya Pradesh, March 19, 1981, page 142. Published by Engineer-in-Chief, Irrigation Department, M.P.

Table 2.10 Underutilisation of irrigation potential of state owned deep and shallow tube wells in M.P.

(Area- Hectares)

Crop season	Potentia created	Area irrigated	Under utilisation	% Under utilisation to potential
Kharif	5,222.65	1,549.19	3,673.46	70.34
Rabi	8,049.89	5,343.25	2,706.64	33.62
Total	13,272.54	6,892.44	6,380.10	48.07

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C H A P T E R -III

TUBEWELLS IN THE SELECTED DISTRICTS

As mentioned earlier, Narsinghpur and Morena districts were selected for this study. In this chapter the details of the tubewells in the districts have been given.

Before we narrate the details of tubewells it would be useful to have some preliminary information about the agriculture in the districts.

3.1 Narsinghpur District

Narsinghpur district is located in the centre of the State. It is bounded in the east by Seoni and Jabalpur districts, in the north by Damoh, Sagar and Raisen districts, in the west by Hoshangabad district and in the south by Chhindwara district. Its length (east to west) is 121 km. and breadth, (north to south) 64 km. The total area of the district is 513.3 thousand hectares.

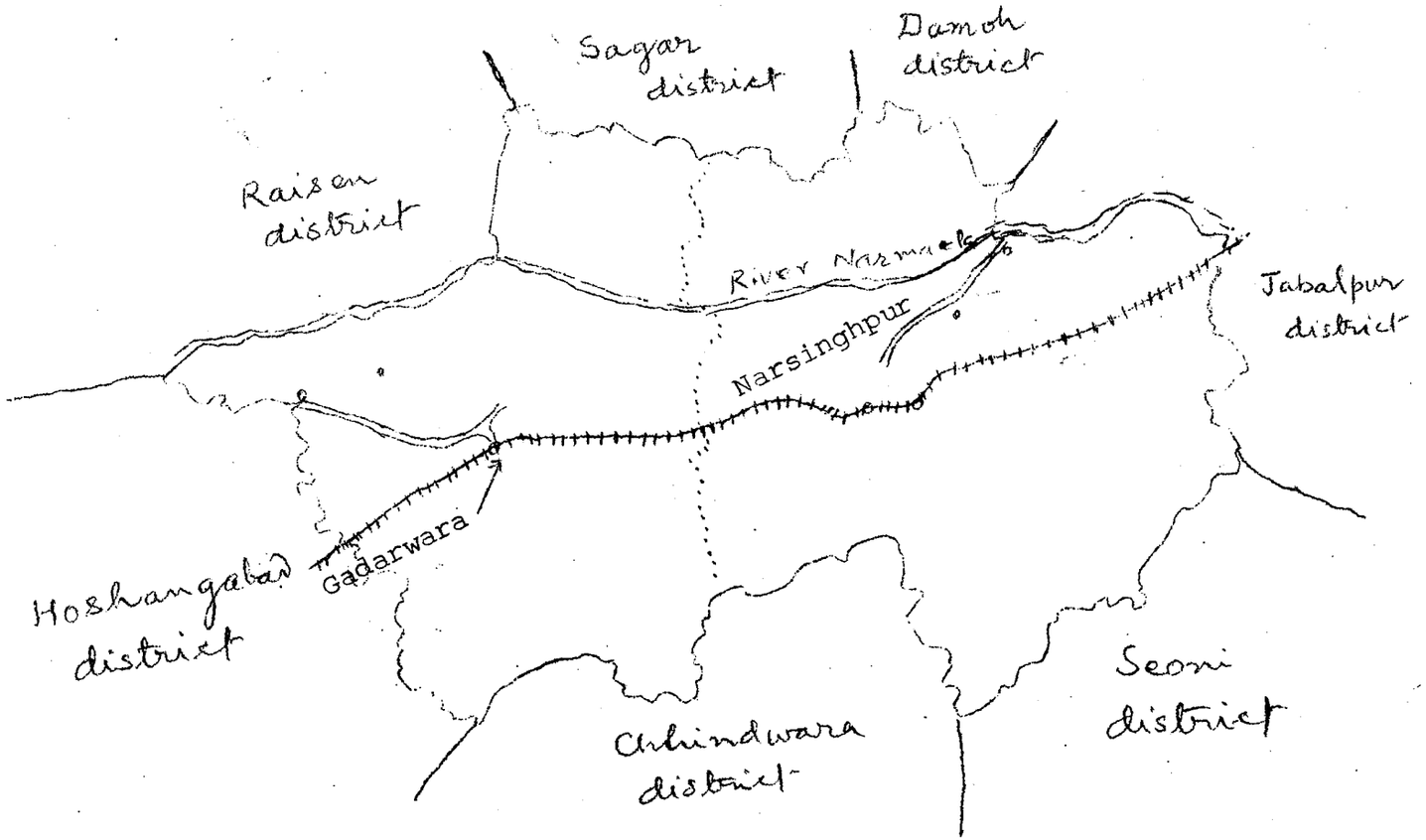
Of the total area, 136.2 thousand hectares or 26.53 per cent was under forests and slightly more than 50 per cent of the total area was net area sown. (Table 3.1)

Table 3.1 Land utilisation, Narsinghpur district, 1981-82

Particulars	Area	
	Thousand Hectares	%
Forests	136.2	26.53
Land not available for cultivation	23.4	4.56
Other uncultivated land excluding fallow	31.2	6.08
Cultivable waste land	29.2	5.69
Fallow land	19.0	3.70
Net area sown	274.3	53.44
Total area	513.3	100.00

MAP :

DISTRICT - NARSINGHPUR



The district can be divided into three regions on the basis of topography.

1. Slopes of Vindhya and Satpura ranges
2. Plateau of Vindhya and Satpura ranges
3. Narmada Valley

Narmada valley is agriculturally the most productive region of the district. Narmada river flows from east to west and has a total length of 160 km in the district. The Narmada basin is 32 to 48 km in breadth. The district receives an average rainfall of 1,250 mm.

3.1.1 Crops Grown

The district is well known for pulse production. Of the gross cropped area of 290.5 thousand hectares 99.1 thousand hectares or 34.11 per cent was under gram. This was more than the area under all the cereals taken together. Other pulses of importance were pea (9.85 per cent), tur (6.54 per cent) and teora (4.13 per cent). Lentil, moong and urd occupied 2.75, 2.45 and 2.45 per cent of the gross cropped area respectively. The area under total pulses was 2.29 times the area under cereals indicating clearly their importance over cereals. Among cereals wheat was the most important occupying 11.94 per cent. Jowar (5.99 per cent) and paddy (5.48 per cent) were other important cereals.

Of the crops grown wheat, gram, moong, sugarcane, fruits and vegetables and spices were irrigated. While the entire area under sugarcane was irrigated, wheat was irrigated to the extent of 47.26 per cent. Although gram was the most important crop it was irrigated to the extent of only 2.02 per cent (Table 3.2)

Table 3.2 Crops grown and irrigated crops, Narsinghpur district, 1981-82

Crop	Area (Thousand hectares)	%to total	Irrigated area (thousand hectares)	%to total irri-gated area	%of irrigated area to total area of the crop
Paddy	15.9	5.48	-	-	-
Wheat	34.7	11.94	16.4	72.57	47.26
Jowar	17.4	5.99	-	-	-
Kodo-Kutki	8.9	3.06	-	-	-
Other cereals	2.3	0.79	-	-	-
Total cereals	79.2	27.26	16.4	72.49	20.71
Gram	99.1	34.11	2.0	8.85	2.02
Tur	19.0	6.54	-	-	-
Urd	9.1	2.45	-	-	-
Moong & moth	7.1	2.45	0.3	1.33	4.23
Teora	12.0	4.13	-	-	-
Pea	28.6	9.85	-	-	-
Lentil	8.0	2.75	-	-	-
Other pulses	0.3	0.10	-	-	-
Total pulses	181.2	62.38	2.3	10.18	1.27
Groundnut	0.2	0.07	-	-	-
Sesamum	11.5	3.96	-	-	-
Linseed	1.3	0.45	-	-	-
Niger	0.9	0.31	-	-	-
Soybean	6.2	2.13	-	-	-
Total Oilseeds	20.1	6.92	0.1	0.44	0.50
Sugarcane	2.4	0.82	2.4	10.62	100.00
Sunhemp	0.5	0.17	-	-	-
Fodder	4.3	1.48	-	-	-
Total Fruits & Vegetables	2.0	0.69	1.2	5.37	27.91
Total Spices	0.4	0.14	0.2	0.88	10.00
Others	0.4	0.14	-	-	-
Total	290.5	100.00	22.6	100.00	7.78

3.1.2 Sources of Irrigation

The main sources of irrigation in the district were wells: open wells and tubewells. These commanded as high as 89.82 per cent of the irrigated area in the district. "Other sources" irrigated 8.41 per cent of the area and the remaining 1.77 per cent of the irrigated area was under canals. (Table 3.3)

Table 3.3 Sourcewise irrigated area, Narsinghpur district, 1981-82

Source	Area (Thousand hectares)	Percentage to total
Open wells & tubewells	20.3	89.82
Canals	0.4	1.77
Other sources	1.9	8.41
Total :	22.6	100.00

There were 8 tanks in the district which had water all through the year. Some tanks were created by damming small rivers and rivulets. There were 5 such tanks in the district. A big tank was also created 8 km. north east of Tendukhera by damming the river Vira.

The irrigation in the district is accomplished by 752 tubewells, besides 5 canals, 3 reservoirs and 7,361 open wells.

3.2 Tubewells in Narsinghpur district

The tubewell drilling in this district started around 22nd June, 1968 under pilot scheme. Most of the tubewells were drilled by the Government agencies, namely, the Exploratory Tubewell Organisation, the Tubewell Directorate, the Lift Irrigation Corporation and the Tubewell Construction Department. Some tubewells have also been drilled by private agencies.

Narsinghpur was one of the 7 Tubewell Construction Divisions of the State. It was headed by an Executive Engineer, Tubewells, and comprised 6 sub divisions, each under the charge of an Assistant Engineer.

There were two types of tubewells: deep tubewells and shallow tubewells. There were in all 82 deep tubewells in the district and all of them were located in Gadarwara sub-division. They were drilled by the Central Groundwater Board. Besides, there were 752 shallow tubewells in the district: 285 in Narsinghpur sub division and 467 in Gadarwara sub division. Since 1972 the tubewell construction has been taken over by the Tubewell Construction Department. Of the total tubewells 512 or 68.09 per cent were working and 186 or 24.73 per cent were unsatisfactory. The remaining 54(7.18 per cent) tubewells were abandoned. (Table 3.4)

Table 3.4 Shallow tubewells in Narsinghpur district

Particulars	Narsinghpur		Gadarwara		Total	
	No.	%	No.	%	No.	%
Working tubewells	154	54.04	358	76.66	512	68.09
Unsatisfactory tubewells	98	34.39	88	18.84	186	24.73
Abandoned tubewells	33	11.58	21	4.50	54	7.18
Total :	285	100.00	467	100.00	752	100.00

The maximum number of tubewells dug in a year was 157 in 1972. Fairly large number (132) were dug in 1975 and also (120) in 1971. The minimum number (4) was dug in 1979. If only working tubewells were taken into account it was observed that highest number of 114 working tubewells were dug in 1975 and about equal number of 101 working tubewells were dug in 1972. The number in 1971 was 89. (Table 3.5)

Table 3.5 Tubewells in Narsinghpur district dug in different years

Year	Total tubewells		Working tubewells	
	No.	%	No.	%
1968	2	0.27	1	0.20
1969	19	2.53	9	1.76
1970	50	6.65	35	6.84
1971	120	15.96	89	17.38
1972	157	20.88	101	19.73
1973	33	4.39	20	3.91
1974	72	9.57	58	11.32
1975	132	17.55	114	22.26
1976	51	6.78	41	8.01
1977	18	2.39	14	2.73
1978	9	1.20	8	1.56
1979	4	0.53	2	0.39
1980	27	3.59	7	1.37
1981	24	3.19	13	2.54
1982	34	4.52	-	-
Total	752	100.00	512	100.00

The classification and analysis of the tubewells that follow refer to 512 working tubewells only.

Of the 512 working tubewells the highest number (191 or 33.30 per cent) had a depth between 50 to 60 metres. Another 164 (32.03 per cent) were 40 to 50 metres deep and 108 (21.10 per cent) had a depth of over 60 metres (Table 3.6)

Table 3.6 Drilling depth in metres, selected working tubewells, Narsinghpur district

Drilling Depth in metres	Working tubewells	
	No.	%
Below 30	8	1.56
30 - 40	41	8.01
40 - 50	164	32.03
50 - 60	191	37.30
60 & above	108	21.10
Total	512	100.00

As regards discharge of water per minute, it was noted that the maximum number (187 or 36.52 per cent) of tubewells had a discharge of 760 litres per minute. The second highest number of tubewells (153 or 29.88 per cent) had a discharge of 947 litres per minute. Another 79 tubewells (15.43 per cent) had a discharge of 570 litres per minute (Table 3.7)

Table 3.7 Discharge in litres per minute, selected working tubewells, Narsinghpur district

Discharge (Litres per minute)	Working tubewells	
	No.	%
380	25	4.88
570	79	15.43
606	2	0.39
680	3	0.59
760	187	36.52
834	1	0.20
910	17	3.32
947	153	29.88
960	10	1.95
1138	11	2.15
1139 & above	24	4.69
Total	512	100.00

As regards the horse power of the pumps it was observed that the largest number of 123 pumps (24.02 per cent) were of 11 horse power and 98 pumps (19.14 per cent) were of 9 horse power. Fifty four pumps (10.55 per cent) were of 6.50 horse power and 51 (9.96 per cent) of 7 horse power. Pumps of 8 and 8.5 horse power were 44 (8.59 per cent) and 40 (7.81 per cent) respectively. (Table 3.8)

Table 3.8 Horse power of pumps of tubewells in Narsinghpur district

Horse power	Number of pumps	
	No.	%
3	1	0.20
4.5	1	0.20
5.0	19	3.71
6.0	12	2.34
6.5	54	10.55
7.0	51	9.96
7.5	12	2.34
8.0	44	8.59
8.5	40	7.81
9.0	98	19.14
9.5	27	5.27
10.0	3	0.59
11.0	123	24.02
12.0	4	0.78
14.0	2	0.39
20.0	1	0.20
Others	20	3.91
Total	512	100.00

One of the difficulties faced by the tubewell owners was that it took very long time between the completion of the drilling of the tubewell and the energisation of the pump. The data indicated that 193 pumps (37.70 per cent) were energised within a period of one year but quite a large number of 152 tubewells (29.69 per cent) could be energised only between 1 to 2 years time. Another 66 (12.89 per cent) could be energised between 2 to 3 years of drilling and the rest 101 (19.72 per cent) took 3 years and more for energisation. (Table 3.9)

Table 3.9 Duration between drilling and energisation of tubewells, Narsinghpur district

Period	Number of tubewells	
	No.	%
Upto 1 year	193	37.70
1 to 2 years	152	29.69
2 to 3 years	66	12.89
3 to 4 years	26	5.08
4 years and more	75	14.64
Total	512	100.00

3.3 Morena District

Morena district is located in the north west corner of the state and lies between 25°15' and 26°15' North latitude and 76°22' and 78°42' east longitude. It is bounded by Kota district in south west, Sawai Madhopur and Bharatpur, all belonging to Rajasthan in the north west, Agra district of Uttar Pradesh in the north, Bhind in north-east and Gwalior and Shivpuri in the south-east.

In shape the district resembles a gourd. The district has two distinct physical features viz.(1) area covered by plains, criss crossed by rivers and ravines and (ii) the other covered with forests. While Ambah, Morena and Jaura tehsils are plain full of Chambal and Kuari river ravines, Bijaypur and Sheopur tehsils have hills and forests. The district is subjected to extremes of climate, the maximum and minimum temperatures reaching 48°C and 4°C in summer and winter respectively. The average rainfall varied between 635mm. and 889 mm. being less in Morena and Ambah tehsils and heavier in Bijeypur and Sheopur tehsils.

The total area of the district was 1168.3 thousand hectares. The remarkable feature of the land utilisation of the district was that only about one third (32.95 per cent) of the geographical area was net area sown and as high as 23.25 per cent of the area was not available for cultivation. This was due to preponderence of ravines. Forests also occupied a significant (27.30 per cent) proportion of the geographical area (Table 3.10)

MAP :
DISTRICT MORENA

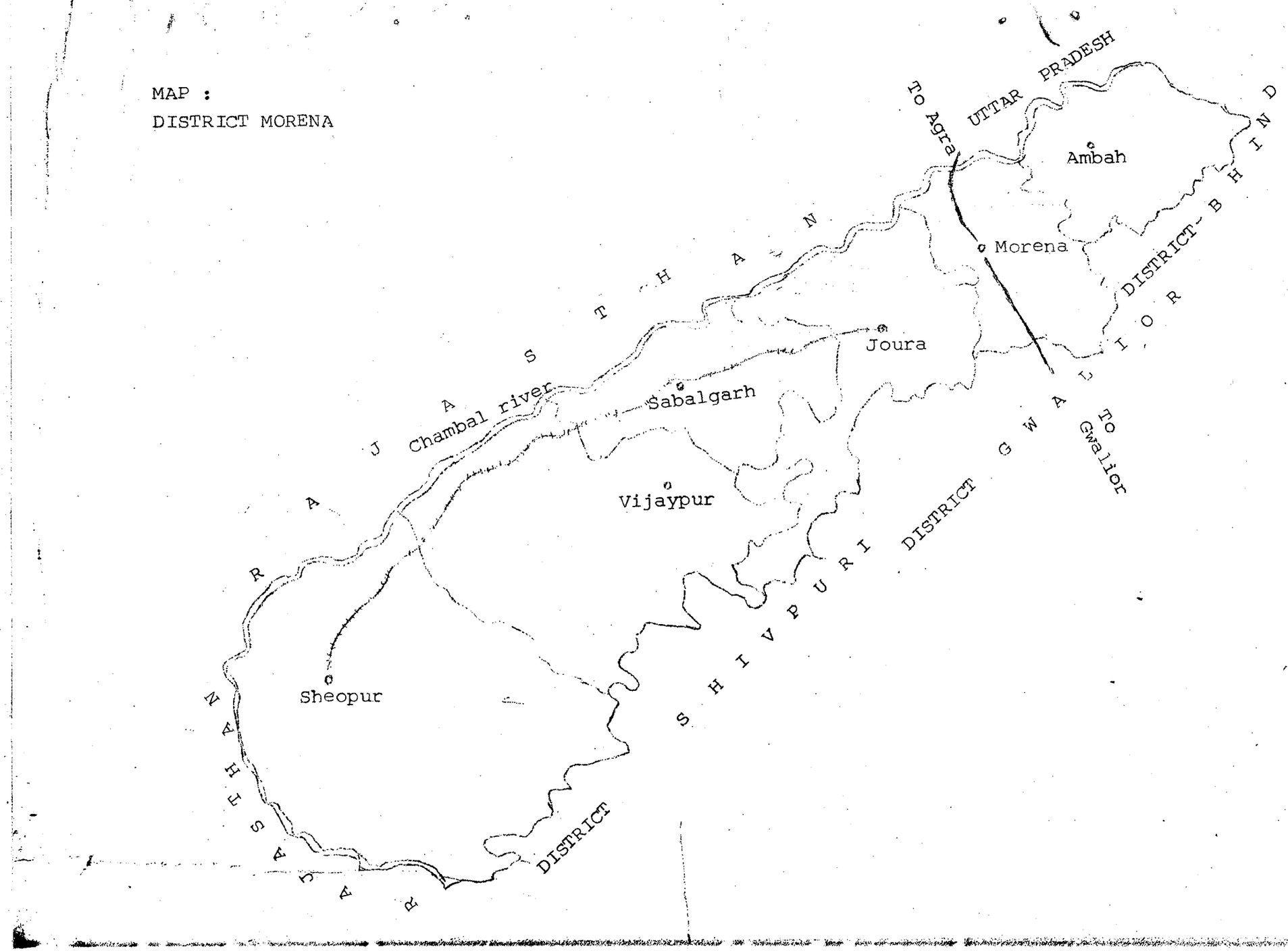


Table 3.10 Land utilisation, Morena district, 1981-82

Particulars	Area (Thousand hectares)	Area %
Forests	324.8	27.80
Land not available for cultivation	271.6	23.25
Other uncultivated land excluding fallow	69.2	5.92
Cultivable waste land	91.0	7.80
Fallow land	26.7	2.28
Net area sown	385.0	32.95
Total	1,168.3	100.00

3.3.1 Crops Grown

Rapeseed and mustard are the most important crops of the district and occupied nearly one fourth (24.86 per cent) of the cropped area. Wheat was next important occupying 22.05 per cent of the area. Gram was another important rabi crop occupying 10.85 per cent. Thus the district was mainly rabi crops growing area with 57.76 per cent cropped area under these. The kharif crops of importance were bajra (14.56 per cent), jowar (6.62 per cent) and arhar (3.97 per cent) aggregating 25.15 per cent of the gross cropped area. Of the crops grown, paddy, wheat, barley, gram, peas, lentil, mustard, linseed, fruits and vegetables, sugarcane and spices were irrigated. While sugarcane was entirely irrigated wheat was irrigated to the extent of 86.1 per cent and rapeseed and mustard 61.7 per cent. Gram was irrigated to the extent of 43.4 per cent. Although paddy, barley, peas and fruits and vegetables and spices had significant proportion

of area under irrigation, the total area under the crops itself was not significant. (Table 3.11)

Table 3.11 Crops grown and irrigated crops, Morena district, 1981-82

Crops	Area (thousand hectares)	% to total	Irrigated area (thousand hectares)	% to total irrigated area	% of Irrigated area to total area of the crop
Paddy	2.3	0.55	1.9	1.08	82.6
Wheat	91.6	22.05	78.9	44.70	86.1
Jowar	27.5	6.62	-	-	-
Maize	2.2	0.53	-	-	-
Bajra	60.5	14.56	-	-	-
Barley	7.1	1.71	3.5	1.98	49.3
Total cereals	191.2	46.02	84.3	47.76	44.1
Gram	45.1	10.85	19.6	11.10	43.4
Tur	16.5	3.97	-	-	-
Urad	0.7	0.17	-	-	-
Moong-moth	6.6	1.59	-	-	-
Peas	0.3	0.07	0.1	0.06	33.3
Masoor	1.4	0.34	0.1	0.06	7.1
Total Pulses	70.6	16.99	19.8	11.22	28.0
Groundnut	0.3	0.07	-	-	-
Sesamum	13.2	3.18	-	-	-
Rape seed & Mustard	103.3	24.86	63.7	36.09	61.7
Linseed	4.7	1.13	0.6	0.34	12.8
Soybean	0.1	0.02	-	-	-
Others	13.0	3.13	0.5	0.28	3.8
Total oil seed	134.6	32.39	64.8	36.71	48.1
Sugarcane	2.3	0.55	2.3	1.30	100.00
Sunhemp	0.1	0.02	-	-	-
Fodder	2.9	0.70	-	-	-
Total Fruits & Vegetables	1.5	0.36	1.3	0.74	86.7
Total Spices	2.0	0.48	1.4	0.79	70.0
Others	10.3	2.49	2.6	1.48	25.2
Total	415.5	100.00	176.5	100.00	42.5

3.3.2 Sources of Irrigation

The main sources of irrigation were canals and wells, including tubewells. Canals commanded 66.23 per cent of the irrigated area whereas, wells, 16.94 per cent. (Table 3.12)

The district received irrigation from 12 canals, 30 reservoirs, 103 tanks, 14,335 open wells and 421 shallow tubewells.

Table 3.12 Sourcewise irrigated area, Morena district, 1981-82

Source	Area (Thousand Hectares)	% to total
Open Wells & Tubewells	29.9	16.94
Canals	116.9	66.23
Tanks	2.7	1.53
Other sources	27.0	15.30
Total	176.5	100.00

3.4 Tubewells in Morena district

The tubewell construction in this district started in September, 1970 under the Agricultural Refinance Corporation Scheme. Most of the tubewells were drilled by Government agencies. Morena is one of the seven tubewell construction divisions of the state. The division was headed by an Executive Engineer, Tubewells. and had 8 adjoining districts under its jurisdiction. Each district comprise one sub division and is headed by an Assistant Engineer. In Morena district apart from the subdivisional office at Morena there are offices at Ambah, Jaura, Sabalgarh and Sheopur tehsil towns under the charge of a Junior Engineer each. However, workshop and machinery depot are located at Morena for the Morena sub-division.

Deep tubewells in the district were under construction on both the sides of the Ambah canal under World Bank Scheme. It was planned to construct 108 such deep tubewells in the district and the water would be lifted from these wells and put in the canal. The deep tubewell water would not be available to the farmers directly but through the canals.

Shallow tubewells in the district numbered 421. These were concentrated in four of the six tehsils viz. Jaora, Morena, Ambah and Sabalgarh. Work in Sheopur tehsil was started only recently. No tubewell irrigation work existed in Bijeypur tehsil.

The largest number of tubewells (151) was in Jaora tehsil followed by Sabalgarh (114). Ambah and Morena tehsils had 92 and and 64 tubewells respectively. However, it may be mentioned that of the total tubewells 285 or 67.70 per cent were working and 93 or 22.09 per cent were unsatisfactory. The remaining 43 or 10.21 per cent tubewells were abandoned. (Table 3.13)

Table 3.13 Shallow tubewells in Morena district

Particular	Jawara		Morena		Ambah		Sabalgarh		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Working tubewells	111	73.51	51	79.69	69	75.00	54	47.37	285	67.70
Unsuccessful tubewells	32	21.19	8	12.50	13	14.13	40	35.09	93	22.09
Abandoned tubewells	8	5.30	5	7.81	10	10.87	20	17.54	43	10.21
Total	151	100	64	100	92	100	114	100	421	100

The years 1973, 1974 and 1975 were the important years as far as the tubewell construction activity was concerned. In these years 99, 95 and 97 tubewells constituting 23.52, 22.57 and 23.04 per cent tubewells were constructed respectively. In 1972, 57 or 13.54 per cent and in 1976, 55 or 13.06 per cent of the total tubewells were constructed. The picture appears about same even if we take into consideration only the working tubewells. (Table 3.14)

Table 3.14 Tubewells in Morena district dug in different years

Year	Total tubewells		Working tubewells	
	No.	%	No	%
1970	8	1.90	8	2.81
1971	10	2.38	10	3.51
1972	57	13.54	41	14.39
1973	99	23.52	65	22.81
1974	95	22.57	71	24.91
1975	97	23.04	62	21.75
1976	55	13.06	28	9.82
Total	421	100.00	285	100.00

For further analysis only working tubewells were considered.

The distribution of tubewells according to the depth of drilling indicated that half (49.12 per cent) of the tubewells had a depth ranging between 50 to 60 metres and the one fourth (25.61 per cent) had a depth between 60 to 70 metres. The tubewells with a depth of 40 to 50 metres were 14.74 per cent (Table 3.15)

Table 3.15 Drilling depth in metres, working tubewells, Morena district

Drilling depth in metres	Working tubewells	
	No.	%
Below 30	1	0.35
30 - 40	8	2.81
40 - 50	42	14.74
50- 60	140	49.12
60 - 70	73	25.61
70 - 80	9	3.16
80 - 90	8	2.81
90 & above	4	1.40
Total	285	100.00

About half (49.13 per cent) of the tubewells had a discharge of 910 litres per minute. Further, 15.79 per cent tubewells had a discharge of 947 litres per minute. Tubewells with a discharge of 760 & 834 litres per minute constituted 13.68 per cent each. Thus most of the tubewells had a discharge ranging between 760 to 947 litres per minute. (Table 3.16)

Table 3.16 Discharge in litres per minute, working tubewells, Morena district

Discharge (Litres per minute)	No.	%
380	1	0.35
570	9	3.16
606	10	3.51
680	1	0.35
760	39	13.68
834	39	13.68
910	140	49.13
947	45	15.79
960	-	-
1138	1	0.35
1139 & above	-	-
Total	285	100.00

The distribution of tubewells according to horse power indicated that the largest number (240 or 84.20 per cent) had 11 horse power motor each. Ten tubewells (3.51 per cent) had 6.5 horse power motor. (Table 3.17)

Table 3.17 Horse power of pumps of tubewells in Morena district

Horse power	Number of pumps	
	No.	%
5.0	2	0.70
5.5	6	2.11
6.5	10	3.51
7.0	8	2.81
8.0	7	2.46
9.0	2	0.70
9.5	7	2.46
10.0	3	1.05
11.0	240	84.20
Total	285	100.00

It had been the endeavour of the tubewells construction department and the Electricity Board to energise the tubewell as early as possible. Any delay in energisation of a tubewells after it is tested causes loss to the farmer. In Morena about half (49.26 per cent) of the tubewells were energised within a year's time. However, others took more time. About one fourth (28.73 per cent) took between 1 to 2 years and the remaining 59 (22.01 per cent) tubewells required more than two years. (Table 3.18)

Table 3.18 Duration between drilling and energisation of tubewells, Morena district

Period	Number of tubewells	
	No.	%
Upto 1 year	132	49.26
1 to 2 years	77	28.73
2 to 3 years	32	11.94
3 to 4 years	16	5.97
4 years & more	11	4.10
Total	268*	100.00

*In the case 17 tubewells date of energisation was not available.

3.5 Underutilisation of Irrigation Potential

Irrigation department of the State Government, in 1979, estimated the irrigation potential for each deep and shallow tube-well owned by it. At the time of estimation there were no state deep tubewells in Morena. Further, there were no shallow tubewells owned by the state in both the districts. Therefore, we have the estimates of underutilisation of state deep tubewells for Narsinghpur district only. It was observed that in Narsinghpur district of the potential of 6,055.53 hectares the area irrigated was 3,437.93 hectares resulting in the underutilisation to the extent of 2,617.60 hectares. Thus the percentage of underutilisation was 43.23. For kharif season the percentage was quite higher (67.95) than that of rabi (27.12) (Table 3.19)

Table 3.19 Underutilisation of irrigation potential of state owned deep tubewells, Narsinghpur district.

(Area - Hectares)

Crop season	Potential created	Area irrigated	Under utilisation	% of under-utilisation to potential
Kharif				
Kharif	2388.95	765.70	1623.25	67.95
Rabi	3666.58	2672.23	994.35	27.12
Total	6055.53	3437.93	2617.60	43.23

Source - Tubewells in Madhya Pradesh by Engineer-in-chief, Irrigation Department, M.P. March 81.

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C H A P T E R IV

UNDERUTILISATION OF TUBEWELL IRRIGATION POTENTIAL

As mentioned earlier, 50 tubewell owners of Narsinghpur district and an equal number in Morena district were selected for farm level data. Before we study the underutilisation it would be useful to know some details of the selected tubewells such as year of drilling, horse power, etc.

As many as 79 per cent of the selected tubewells were drilled between 1971 and 1975. In Narsinghpur tehsil 3 tubewells were sunk in 1976 and one each in 1977 and 1984. In Gadarwara tehsil 13 tubewells were drilled during this period. In addition 5 were drilled in 1980 and 6 in 1981. In Ambah and Joura tehsils 2 tubewells were dug in 1970 and one in 1976. (Table 4.1)

Table 4.1 Year of drilling of selected tubewells

Year	Narsinghpur		Morena		Total
	Narsinghpur	Gadarwara	Ambah & Joura	Morena & Sabalgarh	
1968	-	-	-	-	-
1969	1	-	-	-	1
1970	-	-	2	-	2
1971	6	4	3	-	13
1972	5	5	5	2	17
1973	1	-	5	10	16
1974	-	2	8	7	17
1975	7	2	1	6	16
1976	3	-	1	-	4
1977	1	-	-	-	1
1978	-	-	-	-	-
1979	-	-	-	-	-
1980	-	5	-	-	5
1981	-	6	-	-	6
1982	-	-	-	-	-
1983	-	1	-	-	1
1984	1	-	-	-	1
Total	25	25	25	25	100

As regards the depth of tubewells it was observed that 83 per cent tubewells had a depth ranging between 40 to 70 metres with highest percentage of 32 having the depth between 50 to 60 metres. (Table 4.2)

Table 4.2 Depth in metres, selected tubewells

Depth of tubewell in metres	Narsinghpur		Morena		Total
	Narsinghpur	Gadarwara	Ambah & Joura	Morena Sabalgarh	
30 - 40	1	5	-	1	7
40 - 50	7	9	6	4	26
50 - 60	9	6	7	10	32
60 - 70	8	3	7	7	25
70 - 80	-	2	1	1	4
80 & above	-	-	4	2	6
Total	25	25	25	25	100

Slightly more than half (53 per cent) of the tubewells had an output between 900 to 990 litres per minute. Ten per cent had an output of 758 litres and 8 per cent had 777 litres. Of the 25 tubewells of Narsinghpur tehsil as many as 7 had output below 570 litres (Table 4.3).

Table 4.3 Output in litres per minute, selected tubewells

Out-put in litres per minute	Narsinghpur		Morena		Total
	Narsinghpur	Gadarwara	Ambah & Jaora	Morena & Sabalgarh	
Below 570	7	-	-	-	7
570	2	2	-	-	4
607	1	-	-	-	1
682	1	-	-	-	1
698	-	1	-	-	1
758	3	3	2	2	10
760	3	-	-	-	3
777	2	6	-	-	8
796	1	-	1	-	2
834	-	1	3	-	4
872	1	-	2	1	4
910	1	-	7	16	24
948	2	11	7	3	23
986	-	1	2	3	6
Above 986	1	-	1	-	2
Total	25	25	25	25	100

Pumps with 11 horse power were highest (30 per cent) in number followed by those (26 per cert) with more than 11 horse power. Nine pumps had 9 horse power pumps and pumps with 6.5 horse power and 8 horse power numbered 8 each. There were 5 pumps with 5 horse power (Table 4.4)

Table 4.4 Horse power of pumps on selected tubewells

Horse power	Narsinghpur		Morena		Total
	Narsinghpur	Gadarwara	Ambah & Jaora	Morena & Sabalgarh	
Below 5	1	-	-	-	1
5.0	2	2	1	-	5
5.5	-	-	1	-	1
6.0	1	-	-	-	1
6.5	3	5	-	-	8
7.0	1	1	-	-	2
7.5	-	-	-	-	-
8.0	2	5	1	-	8
8.5	2	1	-	-	3
9.0	4	4	1	-	9
9.5	-	3	-	1	4
10.0	1	-	1	-	2
10.5	-	-	-	-	-
11.0	8	-	-	22	30
Above 11	-	4	20	2	26
Total	25	25	25	25	100

Duration between drilling and energisation ranged between 6 months and 2 years in the case of 79 per cent of the tubewells. Ten tubewell owners were lucky enough to get the tubewells energised within 6 months of drilling (Table 4.5).

Table 4.5 Duration between drilling and energisation of selected tubewells

Duration	Narsinghpur		Morena		Total
	Narsingh-pur	Gadarwara	Ambah & Jaora	Morena & Sabalgarh	
Below 6 months	-	2	3	5	10
6 to 12 months	2	16	8	9	35
12 to 18 months	5	5	8	-	18
18 to 24 months	12	2	2	10	26
24 to 30 months	1	-	3	-	4
30 to 36 months	1	-	-	1	2
36 to 42 months	3	-	-	-	3
42 to 48 months	1	-	-	-	1
48 and above	-	-	1	-	1
Total	25	25	25	25	100

4.1 Underutilisation in Narsinghpur District

Underutilisation in two selected districts is described separately as there were peculiar reasons for underutilisation in these districts.

The description for Narsinghpur district follows.

4.1.1 Location of Selected Tubewells

Narsinghpur district has 2 tehsils: Narsinghpur and Gadarwara. Therefore, a sample of 25 tubewell owners was selected from each tehsil. It was noted that in both the tehsils the tubewells were concentrated in the northern half of the tehsils specifically, between the railway line and the river Narmada.

The selected tubewell owners were spread in 13 villages. Actually Rampura village-one of those villages where tubewell irrigation in the district started way back in 1962 had 12 sample owners (Table 4.6).

Table 4.6 Frequency distribution of selected tubewell owners by number of selected owners per village, Narsinghpur district.

Frequency of tubewell owners per village	No.of villages	Total Number of sample owners
1	4	4
2	2	4
3	1	3
4	1	4
5	2	10
6	1	6
7	1	7
12	1	12
Total	13	50

4.1.2 Castes and Education of Farmers

The caste wise composition of the selected tubewell owners (hereafter termed as farmers) indicated that the largest number (18) belonged to Lodhi caste followed by 12 belonging to Kirar caste. Among other castes brahmins were 5 and Chouksey and Agrawal 3 each (Table 4.7)

Table 4.7 Castewise distribution of selected tubewell owners, Narsinghpur district

Caste	No.of tubewell owners
Lodhi	18
Kirar	12
Brahmin	5
Choksey	3
Thakur	3
Agrawal	3
Jat & Kayasth (2 each)	4
Gujar & Sahu (1 each)	2
Total	50

The educational status of the farmers was such that about half (26) of the farmers were educated upto class VII. Eleven farmers were educated upto class X. Significantly enough, 7 were matriculates and the remaining 6 were graduates (Table 4.8)

Table 4.8 Educational status of the selected farmers

Educational level	No.of farmers
Up to IV	13
V to VII	13
VII to X	11
Matriculation & above	7
Graduation & above	6
Total	50

4.1.3 Size of holding and Irrigation

The total area of the selected 50 farmers was 758.60 hectares. In other words the average size of holding was 15.17 hectares. Of the total area of 758.60 hectares the area irrigated was 432.21 hectares which gave the percentage of irrigated area to total area to be 56.95.

It is well known that the farmers owning tubewells are big and well off. Evidently this is proved from our study. As against the average size of holding of 3.6 hectares for the district, the one for the selected farmers was 15.17 hectares. Similarly, while the percentage of irrigated area to net area sown was 8.2 for the district as a whole, that for the selected farmers was as high as 56.95. Tubewells contributed 86.33 per cent to the irrigated area. Other sources contributed 6.88 per cent and wells, 6.79 per cent (Table 4.9)

Table 4.9 Sourcewise irrigated area on sample farms, Narsinghpur district

Source	Area (Hectares)	%
Tubewells	373.13	86.33
Wells	29.34	6.79
Others	29.74	6.88
Total	432.21	100.00

4.1.4 Impact of Tubewell Irrigation on Cropping Pattern

Impact was naturally, studied for the command area of the tubewells. Such area was 373.13 hectares.

The impact of tubewell irrigation on the types of crops grown and the proportion of area under them underwent a significant change. Firstly, the area under crops increased from 398.82 hectares to 480.78 hectares. Thus the intensity of cropping increased from 107 per cent to 129 per cent. While kodo-kutki and the mixture of jowar and arhar lost ground after the introduction of irrigation, soybean, sugarcane, summer moong and summer vegetables were the new crops cultivated with the new irrigation facilities. Among the crops grown both before and after the irrigation was introduced, jowar, arhar, urd, moong, teora, batri pea and lentil had a decrease in area whereas paddy, wheat, gram and groundnut had an increase in area (Table 4.10)

Table 4.10 Change in crops and area under crops after irrigation, selected farms, Narsinghpur district

Crop	Pre Tubewell		Post Tube-well		% increase (+) or decrease(-) in post tubewell over pre tubewell
	Area (hect)	% to total	Area (hect)	% to total	
Jowar	82.15	20.60	13.96	2.90	- 75.70
Paddy	3.24	0.81	14.57	3.03	+ 349.69
Wheat	27.11	6.80	122.83	25.54	+ 353.08
Kodo-Kutki	4.65	1.17	-	-	- 100.00
Arhar	73.25	18.37	30.55	6.35	- 58.29
Urd	2.83	0.71	1.82	0.38	- 35.69
Moong	2.63	0.66	0.81	0.17	- 69.20
Gram	139.01	34.86	179.89	37.42	+ 29.41
Teora	20.24	5.07	4.45	0.93	- 78.01
Batri	6.07	1.52	5.67	1.18	- 6.59
Pea	12.75	3.20	11.33	2.36	- 11.14
Lentil	6.27	1.57	1.01	0.21	- 83.89
Groundnut	0.81	0.20	1.21	0.25	+ 49.38
Til	6.48	1.62	5.46	1.14	- 15.74
Arhar + Jowar	11.33	2.84	-	-	- 100.00
Soybean	-	-	66.69	13.87	-
Sugarcane	-	-	9.11	1.89	-
Summer moong	-	-	5.67	1.18	-
Summer Vegetables	-	-	5.75	1.20	-
Total	398.82	100.00	480.78	100.00	

4.1.5 Underutilisation of Tubewell Irrigation Potential

Tubewells are the perennial sources of irrigation with a uniform discharge of water in all the seasons of the year. The cent per cent utilisation of the tubewells, and in turn, cent per cent utilisation of its potential means its running for all the twenty four hours of the day for all the days of the year/ and maximum use of discharge. Any amount of non-working or non-utilisation of the water output be termed as underutilisation.

4.1.6 Methods of Estimating Underutilisation

There are two ways of estimating the underutilisation -

1. Estimate the number of hours the tubewell had been working during the whole year as against the optimum hours for which it should run.

2. Estimate the potential area the tubewell could irrigate looking to the local conditions such as the capacity of tubewell, the type of soil, the types of crops grown and their water requirements and restrictions such as topography of the soil, location of the tubewell, pausity of electricity supply etc. Against this, estimate the area actually irrigated for different crops in different seasons. The difference between the potential and the actual area irrigated should give the underutilisation.

The second method was followed in the study. The reasons are many :

The first method gives only the extent of non-operation of the tubewell. It will not give the extent of underutilisation of the resultant water output. The utilisation of the water output will depend upon many factors (some of them have been listed above).

From the farming point of view the second method proves to be better, as it directs one to the limitations in utilisation of full irrigation potential and also brings forth the solutions to the problem of underutilisation in the given situation.

In this study the potential has been estimated by asking the farmer the area that his tubewell could command in three seasons of kharif, rabi and summer with the possible crops that could be grown by him and by his neighbours to whom he could benefit by the surplus potential. Against this potential, the present command area under different crops on his and for the farms to whom he had extended the benefit is noted. The difference between these two for each crop season gives the extent of underutilisation.

4.1.7 Extent of Underutilisation on Selected Farms

On the selected farms the irrigation potential in all the three seasons of kharif, rabi and summer came to 1,026.05 hectares. Against this the utilisation was 522.67 hectares resulting in the underutilisation to the extent of 503.38 hectares. The underutilised area formed 49.06 per cent of the potential indicating that only half of the potential area was actually utilised. The percentage of underutilisation varied in different seasons. The maximum underutilisation was in summer season (81·15 per cent). It may, however, be mentioned that the potential in summer was also very meagre i.e. only 5.90 per cent of the total potential. In kharif season the underutilisation was 45.50 per cent and it was lowest (43.12 per cent) in rabi season. The important crops for which underutilisation was reported were summer moong, summer vegetables, paddy, soybean and wheat (Table 4.11)

Table 4.11 Potential, utilisation and underutilisation of tubewell irrigated area, selected farms, Narsinghpur district

(Area- hectares)

Season/Crop	Potential	Utilisation	Under-utilisation	% of under-utilisation to potential
Kharif				
Paddy	55.85	17.00	38.85	69.56
Jowar	27.93	27.93	13.97	50.02
Urad	2.23	1.82	0.41	18.39
Arhar	35.00	30.55	4.45	12.71
Moong	2.23	2.02	0.21	9.42
Soybean	186.67	68.92	117.75	63.08
Groundnut	2.43	1.21	1.22	50.21
Til	6.00	5.46	0.54	9.00
Sugarcane	14.98	10.73	4.25	28.37
Total kharif	333.32	151.67	181.65	54.50
Rabi				
Wheat	295.64	144.68	150.96	51.06
Gram	301.51	190.01	111.50	36.98
Pea	17.20	13.76	3.44	20.00
Batri	8.50	5.67	2.83	33.29
Teora	7.28	4.45	2.83	38.87
Lentil	2.02	1.01	1.01	50.00
Total Rabi	632.15	359.58	272.57	43.12
Summer				
Moong	37.23	5.67	31.56	84.77
Vegetables	23.35	5.75	17.60	75.37
Total Summer	60.58	11.42	49.16	81.15
Total Cropped area	1026.05	522.67	503.38	49.06

4.1.8. Reasons of Underutilisation

The reasons of underutilisation can be categorised into two :

1. Non-working of the tubewells
2. Non-utilisation of the entire output of water.

4.1.8.1 Non-working of Tubewells

The non-working of tubewells was due to following reasons.

1. Non-operation by the tubewell owners voluntarily
2. Non-working of the tubewells due to mechanical troubles.
3. Non-working due to paucity of electricity supply.

Non Operation by the Tubewell Owners Voluntarily

Voluntary non-operation occurs during the period when the owner does not need tubewell irrigation or he does not use the tubewell although he might have used it.

Reasons for voluntary non-operation vary from one crop season to another. These are being described for kharif, rabi and summer seasons in the following pages.

Voluntary Non-operation in Kharif

As mentioned earlier, Narsinghpur got an average rainfall of 1250mm. This rainfall was sufficient enough for kharif crops like paddy and soybean and, therefore, not much irrigation was needed in kharif season. These crops needed irrigation only during the latter stages of ripening.

Incidentally, Narsinghpur had a very small area under kharif crops. Table 3.2 indicated that paddy (5.48 per cent) Jowar (5.99 per cent) and arhar (6.54 per cent) occupied together only 18.01 per cent of the gross cropped area. Whereas rabi

crops like gram (34.11 per cent), wheat (11.94 per cent), teora (4.13 per cent) and pea (9.85 per cent) dominated the cropping pattern occupying 60.03 per cent of the area.

On the selected farms the cropping pattern for the tube-well command area was such that gram occupied 37.42 per cent of the gross cropped area and wheat, 25.54 per cent. These totalled up to 62.96 per cent. The kharif crops of importance were soybean (13.87 per cent), arhar (6.35 per cent) and paddy (3.03 per cent) totalling 23.25 per cent only. (Table 4.10).

It may be mentioned that not all soils and areas were suitable for growing paddy. This crop was grown only in the low lying areas of the district where sandy soil occured. It also involved additional expenditure on inputs like fertilizers, labour etc. which the farmers had hitherto not incurred.

Sugarcane, another crop which can utilise a significant amount of tubewell water requires rich soil. This occurs in the patch between Kareli and Bohani. With the installation of sugar-mills in the adjoining Hoshangabad district the scope of sugarcane cultivation might increase. Some of the selected farmers did show interest in its cultivation.

Soybean is a newly introduced crop of kharif season, and would catch up in the near future. Farmers have shown keen interest in this crop. However, rabi crop taken after soybean yields lower than the one taken after kharif following. Another reason for not growing soybean was lack of finance as it required heavy dozes of fertilizers. Yet another limitation for growing soybean is water logging. Some opined that there was not enough

period left to prepare a field for rabi after the harvest of soybean.

In other words kharif fallowing succeded by a rabi crop like gram or wheat is a common practice of the district. There are reasons for kharif fallowing. Firstly, the fields remain waterlogged in kharif and no kharif crop suitable to such conditions has yet been introduced. Secondly, gram, pea and wheat are cash crops and are taken care of immensely. To sow these crops in time requires that they are not preceded by a kharif crop which might require postponement of the sowing of a rabi crop. This might result in considerable loss. Lastly, the farmers have a conviction that a kharif crop preceding the rabi cash crop lowers the yield of the latter.

Further, due to no good market in and around the district, there is little scope for vegetable cultivation. Moreover, inaccessibility to even district and tehsil headquarters restrains the farmers from growing vegetables.

In many cases it was noted that the soil was not fertile enough to practise double cropping. Alternatively the preference is for rabi crop preceded by a kharif fallow.

Voluntary non-operation in Rabi

1. Table 4.11 indicated that the underutilisation was least (43.12 per cent) in rabi. As has been mentioned earlier, Narsinghpur district is mainly a rabi crop area growing wheat gram and pea. With the introduction of tubewell irrigation there has been a sharp increase in wheat area and also a shift from gram to wheat. Since new H.Y. varieties of wheat can take up to 5-6 irrigations with a striking increase in yield with the increased number of irrigations,

no farmer would afford to allow the tubewell to remain under-utilised in this season. The cases of underutilisation were noted when the farmers after fully utilising the tubewell water on their farms could not use the spare capacity for others.

There are reasons for this.

a) The neighbour did not need the spare capacity

b) There was no practice of selling irrigation water in many areas

c) The owner of the tubewell did not want to help his neighbour

d) The neighbour had his own source of irrigation

On the selected farms the cropped area irrigated of the neighbours' fields came to 41.89 hectares or only 8.72 per cent of the owned cropped area.

Voluntary non-operation in Summer

The underutilisation was highest (81.15 per cent) in summer. The summer season is of intense heat. From about the end of February the temperature begins to increase rapidly till May, which is the hottest month. The mean daily temperature in May is about 41°C and the mean daily minimum about 25°C. The heat is intense and hot dust laden winds in the latter part of the summer season (locally called loo) add to the discomfort. On some days the maximum temperature may go up to about 46°C or 47°C. The humidity in the afternoons of this season is less than 20 per cent.

The reasons of underutilisation are following.

1. Due to high temperature and low humidity the water requirement of the crops grown is very high and in some cases increases to the point of becoming uneconomical. The supervision of irrigation and guarding of crops also become very difficult in hot

afternoons.

2. Added to these is the problem of guarding the crops against stray cattle. Village properietors, before the abolition of malguzari system, used to have large grass reserves. On the abolition of proprietary rights these lands reserved for fodder crops were lost. The grazing lands in the villages were most insufficient. There was no significient area under fodder crops as the farmers could hardly afford cultivation of these in competition with food and cash crops. In the haveli tract, during the monsoon the working cattle are sent to forest area for grazing where they are kept for five to six months. Green grass is available in sufficient quantity in latter part of rainy season and also in winter. Besides grass, jowar stalks, paddy straw and other crop residues are used as fodder for cattle. In summer, dried grass, jowar stalks and straw are used as fodder. In this season scarcity of fodder is felt intensely and the cattle are left free for grazing. Thus cattle in groups, small and large, grazing in the open fields is a common sight in hot summer. If they come across a green patch of land they would tread and romp and devour the crop at the slightest carelessness of the guard whether it be a day or night.

This restricted the farmers from growing any crop during summer season. Driving away of intruding cattle by force and inflicting injuries to them had invited quarrels and fighting from the stray cattle owners, the farmers reported.

3. As has been mentioned earlier the tubewell owners are big farmers and eventually the harvested produce of rabi crops is quite enormous for post harvest operations such as threshing, winnowing,

cleaning and marketing. The farmers pay great attention to these as delay might result in the spoiling of the produce due to untimely pre-monsoon showers. They, therefore, do not favour mixing of operations of other crops at that time.

4. On the heels of these operations is the marriage reason and the farmers have to move out to other villages and towns in this connection. They play hoststo others. Incidentally, this is the season when they get respite and need some rest.

5. There is alsc an element of complecency. After a good harvest of rabi crops the big farmers do not want to bother themselves with a summer crop which they do not consider economically attractive.

6. The preparatory cperations for the kharif as well as rabi crops begin with the ploughing and harrowing by the middle or third week of May. Farmers did not want these operations to be hindered by standing summer crops.

Voluntary Non-operation-other reasons

1. Lack of scope for vegetable cultivation

Vegetable cultivation could be thought of as a means of utilising the tubewell water. However, there is an important reason for a very meagre area under vegetables in the district i.e. inaccessibility within the district due to lack of good roads and the large terrain being criss crossed by rivers and rivulets etc. The second reason is non-existence of a ready market for vegetables in or outside the district within a reasonable distance. Among the selected farms vegetable cultivation was more popular in Narsinghpur than Gadarwara.

2. Inefficiency due to fragmentation

Undoubtedly, the tubewell owners were big farmers. However, with the passage of time between the sinking of the tubewells and as of now subdivision and fragmentation of the holdings had taken place and thereby the area commanded by a tubewell and owned by an individual had shrunk to a smaller contiguous piece. This had two effects. Firstly, the operation of tubewell was done by more than one individual creating operational problems and secondly, the command area decreased to only contiguous pieces leaving the far flung pieces remaining unirrigated thereby compelling the owner to allow the tubewell remain idle if there was no buyer of water.

3. Undulating Fields

Land levelling and other developments did not precede the construction of a tubewell. Hence the flow of water was not easy in the entire (supposedly) command area resulting thereby under-utilisation. Undulating land restricts flow of water.

4. Labour Shortage

As has been mentioned earlier, the tubewell owning farmers are big farmers and depend to a very large extent on permanent farm servants and casual labourers. Labour shortage is particularly experienced during rabi season, the most busy agricultural season of the district. It is also experienced in summer when the labourers move out due to social obligations and are unwilling due to unsatisfactory working conditions of hot summer. In frosty winter nights the agricultural labour is a problem. This restricts the big farmers from using the entire cultivable area and thus resulting in underutilisation of tubewells.

5. Difficulty in management of far off fields

Fields far away from residence are difficult to manage and irrigate particularlly during frosty winter nights when electricity is supplied only in the nights. These were also difficult to manage with respect to guarding of the crops.

6. Insufficient output

Insufficient output of tubewell is another reason for underutilisation. In many tubewells the output was far below the estimated output due to different reasons. In some cases the water was a mixture of sand and gravel and was not fit for irrigation resulting in the underutilisation. It also results in frequent breakdowns. A few farmers reported a fall in water table in the past few years and the resultant insufficient water output.

7. A peculiar case

There was an isolated case of a family involved in a criminal suit. The active male members of the family were engaged in legal complexities of the case and could not devote enough time for farming activities. The sprinkler was lying idle and the tube well was not run to full capacity. The restricted agricultural activities were done under fear. Although there is no intention of generalising, it might be noted that such sociological factors do affect agricultural operations including the utilisation of tubewell irrigation potential.

8. Defective water channels

As the water channels were kutcha there was a considerable loss due to seepage and in turn underutilisation. It also resulted in loss of labour for upkeep.

Non Working due to mechanical troubles

Although the cases reporting underutilisation due to mechanical troubles were very few it should be appreciated that repair of tubewell is a specialised jcb and in the absence of an efficient repairing service in the remote areas the loss due failure of pump in peak rabi season is invaluable. Some of the selected farmers complained of water cutput mixed with sand. This restricted the full capacity utilisation.

Paucity of Electricity Supply

From the tubewell irrigation point of view rabi season is the peak season. As mentioned earlier more than 60 per cent of the gross cropped area is under rabi crops. Gram, wheat and pea which bring in cash are cared utmost and are therefore provided timely and regular irrigations. Any amount of hindrance in the supply of irrigation water results in great losses. There is, therefore, a great demand for electricity supply. Supply falls short of demand and it needs to be restricted by rationalising it. The areas are demarcated and supplies are regulated during the definite hours of the day.

This results in :

1. Short supply of water,
2. Intermittant and irregular supply of water
3. Water supply during night hours.

All these affect the crop growth adversely. Gram needs 3 irrigations and high yielding varieties of wheat need 5 to 6 irrigations . Short supply of electricity resulting in shortage of irrigation water affects plant growth and restricts farmers from using full doses of fertilizers.

Intermittant and irregular supply also means uncertainty of interculture operations.

Shortage of electricity supply compels the authorities to supply it in some areas during night hours. This affects the utilisation due to :

a) Exterme cold weather during rabi season nights

b) Darkness resulting in difficulties in irrigating fragmented plots.

December and January are the coldest months of the year with daily maximum temperature at about 25°C and the mean daily minimum at about 9°C. In these months cold waves passing across North India affect the district and the minimum temperature may go down to about freezing point. One can imagine the difficulties the farmers have to face in irrigating the fields in such an inclement weather. Frosty weather and cold water make it difficult. Darkness prevents proper supervision of labour and supplies to fields. It is more difficult where the plots are fragmented and scattered. It is also unsafe. Some pockets in the district have criminal records. Two of our selected farmers reported under-utilisation due to scare of enemies.

4.1.8.2 Non Utilisation of Entire Output of Water

This included the incidents when the tubewell is in running condition but the output of water is not used optimally. It included following cases ;

1. The output of the pump was less than the estimated calculated output.
2. Loss of water due to defective channels.
3. Non-optimum use due to non-levelling of land.
4. Losses due to non-fitting of efficiency increasing equipments like sprinklers.

4.2 Underutilisation in Morena District

In the following pages underutilisation in Morena district is described.

4.2.1 Location of Selected Tubewells

In Morena district there were six tehsils. Of these two tehsils had an insignificant number of tubewells and were, therefore, not represented in the sample. The selected 50 tubewells spread over 16 villages. Village Hatipura of Sabalgarh tahsil had the largest number of 9 tubewells whereas village Bacchimi of Jaura tehsil and village Datehra of Morena tehsil had 7 tubewells each. (Table 4.12)

Table 4.12 Frequency distribution of selected tubewell owners by number of selected owners per village, Morena district

Frequency of tubewell owners per village	No.of villages	Total tubewell owners
1	8	8
2	1	2
3	2	6
5	1	5
6	1	6
7	2	14
9	1	9
Total	16	50

4.2.2 Castes and Education of Farmers

The largest number (28) of selected farmers belonged to Thakur caste. Brahmins were 8 in number and Dhakad 5. There were 2 muslim farmers and the remaining 7 farmers belonged to a caste each. (Table 4.13)

Table 4.13 Castewise distribution of selected tubewell owners, Morena district

Caste	No.of tubewell owners
Thakur	28
Brahmin	8
Dhakad	5
Muslim	2
Jatav	1
Nai	1
Paliwal	1
Gurjar	1
Baghel	1
Kachhi	1
Karanveer	1
Total :-	50

This clearly indicated the predominance of higher caste farmers among the tubewell owners.

The educational status was such that 9 farmers were illiterate and another 8 were educated upto IV standard. The maximum number (12) had education between V to VII standard and 11 had between VIII to X standard (Table 4.14).

Table 4.14 Educational status of the selected farmers, Morena district

Educational Status	No.of farmers
Illiterate	9
Upto IV	8
V to VII	12
VIII to X	11
Matriculation and above	6
Graduation & above	4
Total	50

4.2.3 Size of Holdings and Irrigation

In Morena district the total area of the selected farmers was 583.88 hectares or 11.68 hectares per farmer. Of the total area of 583.88 hectares, 423.53 hectares were irrigated giving the percentage of irrigated area as 72.53.

The average size of holding and the percentage of irrigated area for the district was 2.40 hectares and 43.9 per cent respectively indicating that the tubewell owning farmers had a considerably higher status as far as farm assets were concerned.

Further, of the total irrigated area 308.79 hectares (or 72.91 per cent) were commanded by tubewells and 88.43 hectares (20.88 per cent) were irrigated by canals (Table 4.15).

Table 4.15 Sourcewise irrigated area on sample farms, Morena district

Source	Area (Hectares)	% to total area
Tubewells	308.79	72.91
Wells	26.31	6.21
Canals	88.43	20.88
Total	423.53	100.00

4.2.4 Impact of Tubewell Irrigation on Cropping Pattern

There was a remarkable change in the cropping pattern from the pretubewell irrigation period to post tubewell period. Firstly, the gross cropped area increased from 255.77 hectares to 326.44 hectares or an increase of 27.63 per cent. Secondly, new crops like paddy, soybean, sugarcane, til, kharif fodder, kharif vegetables, rabi vegetables, berseem, and summer crops like moong, vegetables, and fodder were grown in post tubewell period. Thirdly, there was a tremendous increase in area under wheat, a phenomenon also noticed in Narsinghpur district. The other important rabi crop to benefit was mustard. Lastly, due to assured and adequate water supply from the tubewells the farmers could dispense with more than a dozen crop mixtures both in kharif and rabi (Table 4.16)

Table 4.16 Changes in crops and area under crops after irrigation, Morena district

(Area -Hect.)

Crop	Pre-tubewell		Post tubewell		% increase (+) or decrease(-) is post tube-well over pre-tubewell
	Area	%	Area	%	
KHARIF					
Paddy	-	-	0.81	0.25	-
Jowar	4.86	1.90	4.86	1.49	-
Bajra	25.50	9.97	54.23	16.60	+ 112.67
Moong	2.02	0.79	0.61	0.19	- 69.80
Urd	1.21	0.47	4.05	1.24	- 234.71
Arhar	1.21	0.47	0.81	0.25	- 33.06
Soybean	-	-	1.82	0.56	-
Sugarcane	-	-	34.70	10.62	-
Bajra + Moong	-	-	3.24	0.99	-
Bajra + Til	-	-	1.21	0.37	-
Jowar + Arhar	7.28	2.85	-	-	-
Urd + Arhar	-	-	0.81	0.25	-
Urd + Til	-	-	2.83	0.87	-
Mixtures of Bajra + Other cereals, pulses & Oil seeds numbering 11	110.49	43.20	4.05	1.24	- 60.90
Til	-	-	3.64	1.12	-
Fodder	-	-	1.62	0.50	-
Vegetables	-	-	1.01	0.31	-
Total Kharif	152.57	59.65	120.30	36.85	- 21.16
RABI					
Wheat	4.86	1.90	88.54	27.15	+1723.87
Gram	40.87	15.98	5.46	1.67	- 86.64
Mustard	38.45	15.04	105.42	32.30	+ 174.17
Linseed	4.86	1.90	-	-	-
Vegetables	-	-	0.81	0.25	-
Fodder	3.04	1.19	0.30	0.09	- 90.13
Gram + Cereals/ Oilseeds	11.12	4.34	-	-	-
Lentil	-	-	0.61	0.19	-
Berseem + Mustard	-	-	0.40	0.12	-
Total Rabi	103.20	40.35	201.64	61.77	+ 95.39
SUMMER					
Moong	-	-	3.25	1.00	-
Vegetables	-	-	1.00	0.30	-
Fodder	-	-	0.25	0.08	-
Total Summer	-	-	4.50	1.38	-
Gross Cropped Area	255.77	100.00	326.44	100.00	+ 27.63

4.2.5 Extent of Underutilisation on Selected Farms

Of the 50 selected tubewell owners 7 reported that their tubewells were not working from duration ranging between 1 to 5 years. Among the reasons for non-working, three reported admixture of sard, and one reported saline water discharge. Slipping of motor down the well, burning of motor and the theft of transformer were reported by 1 each tubewell owner.

In Morena district the irrigation potential on the selected farms was 936.48 hectares. Against this, the utilisation was 437.07 hectares resulting in the underutilisation to the extent of 499.41 hectares. The potential thus underutilised formed 53.33 per cent. This was 4.27 per cent more than on Narsinghpur farms. The seasonswise underutilisation followed a trend similar to that of Narsinghpur farms. The maximum underutilisation was in summer (92.29 per cent). In kharif season the percentage of underutilisation was 61.19 per cent and in rabi it was lowest i.e. 51.27 per cent (Table 4.17). The crops for which the underutilisation was remarkable were summer vegetables, soybean, summer moong, sugarcane and gram.

Table 4.17 Potential, utilisation and underutilisation, selected farms, Morena district

(Area-Hectares)

Crop	Potential	Utilisation	Under utilisation	% of under utilisation to potential
KHARIF				
Sugarcane	6.28	2.83	3.45	54.78
Vegetables	0.20	0.20	-	-
Soybean	2.63	-	2.63	100.00
Fodder	0.81	0.81	-	-
Total Kharif	9.92	3.84	6.08	61.19
RABI				
Wheat	423.11	200.12	222.99	52.70
Mustard	360.79	195.67	165.12	45.77
Rape	0.61	0.61	-	-
Gram	31.57	8.70	22.87	72.44
Lentil	0.61	0.61	-	-
Vegetables	6.48	0.81	5.67	87.50
Sugarcane	58.48	22.97	35.51	60.72
Fodder	0.20	0.20	-	-
Berseem	0.10	0.10	-	-
Total Rabi	881.94	429.79	452.15	51.27
SUMMER				
Moong	29.75	1.32	28.43	95.56
Sugarcane	9.31	2.02	7.28	78.20
Vegetables	5.46	-	5.46	100.00
Fodder	0.10	0.10	-	-
Total Summer	44.62	3.44	41.18	92.29
Total Cropped Area	936.48	437.07	499.41	53.33

4.2.6. Reasons of Underutilisation

The reasons of underutilisations can be grouped into two as in Narsinghpur district.

The reasons for voluntary non-operation in different seasons are given below.

Voluntary Non-operation in Kharif

Morena district received an average rainfall of about 700mm. which was quite inadequate for paddy. The soil was also not suitable for paddy. Therefore the kharif crops were mainly bajra, jowar and arhar. These crops did not require much of irrigation. Moreover, as indicated in table 3.11 these together accounted for only one fourth of the gross cropped area. Whereas the rabi crops accounted for 57.76 per cent of the cropped area.

For the selected farms the cropping pattern for the tubewell command area was such that rabi crops occupied 61.77 per cent and kharif crops, 36.85 per cent. Of the kharif crops sugarcane was the most important from the point of view irrigation and it also commanded a significant 10.62 per cent of the 36.85 per cent area under kharif crops. Thus kharif irrigation on the selected farms was limited to only sugarcane crop . Bajra, another important kharif crop occupying 16.60 per cent was not irrigated.

The extent of underutilisation in kharif season on the selected farms was 61.19 per cent.

Kharif fallowing succeded by rabi crops like mustard, wheat and gram occupying 32.30, 27.15 and 1.67 per cent of gross cropped area respectively was most common. There were many reasons for this (kharif fallow, rabi) rotation.

The above mentioned rabi crops are cash crops and are cultivated with utmost care.

Mustard, particularly needs minimum inputs such as soil preparation, fertiliser and irrigation. Against these, the returns from this crop were quite high due mainly to high price it fetches.

These rabi crops have to be sown in time and if a kharif crop precedes these there would be likelihood of delay in the sowing of these crops. Farmers did not want to risk this. The farmers also believed that if these crops were grown on the pieces of land occupied by a kharif crop these would yield less than when grown on land kept fallow in kharif.

Growing of these high return crops results not only in allowing the land to remain fallow in kharif but also makes the growers complacent towards the summer crops.

Better utilisation of irrigation potential in kharif could be achieved by growing vegetables.

However, caste, social and economic status of the tubewell owners came in the way. As indicated earlier tubewells were owned by large farmers (average size 11.68 hectares) belonging to higher castes such as thakur, brahmin, gujar, yadav etc. These farmers avoided cultivation of kharif vegetables.

The farmers belonging to lower castes with small size holdings grew kharif vegetables and earned good returns. But this was not done by tubewell owning large farmers belonging to higher castes.

Another reason for underutilization during kharif was silting. The problem in some areas was so acute that it resulted in waterlogging in kharif season.

Still another reason for not growing kharif crops was that the inputs such as seed, fertilizers and perticides were neither available timely nor in adequate quantities. Some of the farmers also complained of the absence of extension activities of the state government which could induce the farmers to grow new kharif crops.

Valuntary Non Operation in Rabi

As mentioned earlier rabi season was the most important crop season even from the irrigation point of view. Therefore, of all the three seasons, underutilisation was least (51.27 per cent) in rabi season. Among different crops it was highest for vegetables (87.50 per cent), followed by gram (72.44 per cent) The reasons for not cultivating vegetables have already been elaborated. In the case of sugarcane it was observed that fertile soil did not exist everywhere. In the case of gram and mustard the underutilisation was due to the fact that these crops needed only 2-3 irrigations. Actually, wheat was the crop that could utilise the tubewell irrigation water to the optimum as the H.Y.Vs of wheat required upto 5 irrigations. The farmers knew of this and accordingly increased the area under wheat to the highest extent.

The reasons for underutilisation in rabi were thus inherent in the crops which needed less number of irrigations (mustard and gram) or farmers' inability to irrigate their entire land or their disinterest in allowing the surplus water to be used by neighbours.

Voluntary non-operation in Summer

As in Narsinghpur the underutilisation was highest (92.29 per cent) in summer in Morena. The summer season of this northern most district is of extreme heat as the mean maximum temperature reaches 47.7°C. Not only the temperature is very high the sand laden winds blowing in the afternoon make the condition worse.

Due to high temperature and other adverse climatic conditions the irrigation requirements of the summer crops increase sharply and irrigating the land having low water holding capacity becomes uneconomical.

As has been mentioned earlier the tubewell owing farmers were large land holders belonging to higher castes. They would not like to take up hard jobs needing intensive labour and close supervision of irrigation in hot summer season. For them this was the season of respite, after hectic rabi season cultivation spared for social activities like visiting the relatives far and near, attending marriages, making purchases etc.

The important crops of summer season were vegetables and as mentioned earlier these farmers with large size holdings belonging to higher castes attached social stigma to vegetable cultivation.

A large number of tubewell owners owned tractors and trolleys. In summer season they earned handsomely by hiring these for transporting men and material for marriages, visiting , construction and transporation of fertilizers and produce to the markets. These kept them very busy throughout the summer season and left very little time to look after agriculture.

An element of complacency was also visible. After a good harvest of cash crop like mustard or wheat they did not have urge

to grow the subsequent summer crop which involved hard work.

As mentioned earlier there was a problem of silting and the farmers' experience was that if a summer crop was grown it became very difficult to grow subsequent kharif crop due to silting caused by summer irrigation. Similar problem was faced wherever the tubewells pumped out saline water.

As in Narsinghpur, stray cattle menace during the summer season existed in Morena district. After the harvesting of rabi crop the cattle roamed the open fields scratching through the dry grass and stubbles of rabi crops. Many a times the cattle moved in herds and were difficult to control. The farmers therefore avoided growing summer crops.

Voluntary Non Operation- Other Reasons

1. Allied economic activities

Most of the tubewell owners had allied economic activities like trade, grain marketing, middlemanship, transport, etc. These were more profitable than the agriculture and therefore such farmers had little time to spare for agricultural activities including the optimum tubewell operation. In some cases the non-agricultural occupation had become more sizeable than agriculture and the owners had very little interest in agricultural activities.

2. Dacoit menace

The dacoit menace in the district restricted the activities of the tubewell owners and other big landholders. In busy rabi crop season when electricity was provided only during the night hours it was very risky for the tubewell owners to venture out in dark nights to manage and supervise irrigation and guard the standing crops. This was particularly risky when the fragment lay far away from village.

It was common to see the double storied pump houses with the upper storey manned by guards and gunmen.

3. Fragmentation of holdings

As in Narsinghpur, this problem was observed in Morena. The fragments located far away from the tubewell remained un-irrigated as the channels had to be dug though others' fields and this was objected to by others. Even if the channels could be dug the expenditure was enormous and the loss of water, high.

This problem got compounded when there existed fractions or groups based on castes and politics.

In many cases the obliging farmers who allowed the tubewell owners to construct irrigation channels through their fields got their fields irrigated at concessional rates or even free of cost resulting in the under-utilisation by the owner farmers.

4. Lack of knowledge of soil and water management

Twin problems of salinity and silting affected farming in some areas. Due to lack of knowledge of managing the soils in such situations farmers incurred losses due to not growing crops in all the seasons.

5. Disconnected tubewells

Due to non-payment of electricity charges many tubewells were disconnected. The owners opted for alternative source of irrigation rendering the underutilisation of tubewells.

6. Alternative Sources of Irrigation

Canal irrigation was also prevalent in some of the tube-well command areas. Borewells were also in operation. Farmers opined that irrigation by these sources was cheaper than tubewell

irrigation. This, particularly, affected the sale tubewell water, resulting in underutilisation.

7. Lower output of water

As in Narsinghpur, some cases of low water output were reported in Morena. Some were genuine but some were reported to seek a certificate to that effect in order to avoid the repayment of loan amount.

In some cases the cutput was low because of admixture of sand in water. This not only affected the soil but also endangered the pump. Underutilisation is the result.

Non Working due to Mechanical Troubles

The reason for mechanical trouble commonly mentioned was the output with the admixture of sand . Whatever be the reason, the mechanical trouble resulted in underutilisation and financial loss to the farmer. It may be mentioned that the facilities for repairing were available only at Morena and this caused waste of time and energy on the part of the tubewell owner.

Paucity of Electricity Supply

This phenomenon has been elaborated while describing reasons in Narsinghpur district. Additional dimension of this problem in Morena was the bribing of the persons doing the jobs of repairing the electrical faults and replacing the damaged transformers etc. Repairing of electrical faults posed same problesm as those of mechanical faults.

4.3 The Possible Solutions

4.3.1 Narsinghpur District

1. For better utilisation in kharif, soybean cultivation should be encouraged. It was catching up and proved to be a profitable crop. With the readily available market and the sturdiness of the crop there was a good scope for this crop. Among the selected farmers there was a desire to increase the area under it and the non-growers intended to grow it in future. The crop required less input cost and less care, including guarding, as compared to other crops. However, waterlogging was a constraint in its cultivation. It was expressed by some that a rabi crop preceded by soybean yielded lower than a crop taken after kharif fallowing. This was a common complaint and a solution to this should be found out by agronomists. Our consultation with the agronomists revealed that the use of balanced fertilizers was the answer.

2. Although sugarcane was a promising crop in view of the sugarmills coming up in Narsinghpur district and in the adjoining district of Hoshangabad, the stray cattle problem cropped in summer season.

There were cases where the farmers gave up growing sugarcane due to this menace. But many were keen to grow it on a limited scale (on fertile patchaes) to begin with. We suggest financing by banks for wire fencing in such cases.

3. Groundnut was tried by some of the selected farmers for a few years but it failed in one particular year miserably and was substituted by soybean. Efforts be made to encourage its cultivation.

4. Cultivation of short duration paddy varieties should be encouraged in sandy soils.

5. Agricultural Extension Services should guide those farmers who are not able to go in for double cropping due to poor fertility of soils, although, they had enough tubewell water. Testing of soils and taking up measures to apply suitable manures and fertilizers might help to grow kharif crops also.

6. In rabi, the underutilisation due to non-operation was on account of non utilisation of spare capacity for others. Block Development Authorities who do the crop planning should pursuade the tubewell owners to make available the spare water for their less fortunate neighbours.

7. The main problem in summer season, as narrated earlier, was stray cattle. This menace could be overcome if all the tubewell owners in a village resolved to grow summer crops and guard them collectively. But the prerequisit for summer crops was barbed wire fencing of the fields. This was a costly affair and the farmers expressed that a loan with a suitable subsidy be granted. This is a genuine demand and should be considered by the financial institutions. Some farmers were keen to grow summer moong and vegetables provided the cattle was contained.

8. Underutilisation in summer was also due to preoccupation of big farmers in post harvest operations of rabi, marriages, preparatory operations of kharif, besides, complecency. It is suggested that they should be pursuaded to fence a small piece of land near the tubewell and grow summer crops. If they can not do it by themselves they should give it to the less privileged persons on share cropping basis.

9. Sprinkler irrigation is a boon to the farmers possessing tubewells. It conserves and regulates water more efficiently and the losses due to seepage are minimised. It also allows irrigation of undulating land. It helps to irrigate scattered fragments without digging channels through neighbours' fields. The efficiency of irrigation is more than doubled with the use of sprinklers. Sprinkler irrigation should be encouraged.

10. Sale of irrigation water is one way of optimising utilisation. This practice should be encouraged by organising meetings of panchayats.

11. Losses due to seepage were enormous because the channels were kutcha. Such losses could be plugged if financing for construction of pucca channels or lining of kutcha channels could be liberalised.

12. Uninterrupted and timely supply of electricity is very important, specially in rabi season, to achieve full utilisation. This problem should be looked into by the Departments of Agriculture, Tubewell Directorate, the M.P.Electricity Board and the Rural Electrification Corporation.

13. The levelling of land is a must for proper distribution of irrigation water. The Soil Conservation Department should look into such cases.

14. The twin problem of lower output than the estimated and the output with the admixture of sand should be looked into by the Tubewell Directorate.

4.3.2 Morena District

1. Underutilisation in Morena district was due to the fact that there was no kharif crop suitable to the climate and soil. Sugarcane held some promise. Efforts should, therefore, be made to popularise this crop by adding suitable manures and fertilizers to enrich the soils.

2. The most common rotation was kharif fallow succeded by rabi. This needed to be changed by introducing short duration kharif crops responsive to irrigation. Soybean is one. Looking to the shortage of pulses and oilseeds in the country efforts be made to popularise soybean and research be conducted to find out any other pulse, oilseed or vegetable crop. Extension agencies should convince the tubewell owners to grow vegetables also.

3. The problems of silting and salinity should be taken up by the soil scientists and engineers.

4. The tubewell owners complained that the supplies of seed, fertilizers and pesticides were not timely and in sufficient quantities. Tubewell owners being big land holders, require these inputs in large quantities. Officials of the agriculture and cooperative departments and banks should look into these problems and find out the sclutions so that the precious national water resource does not remain unutilised.

5. In rabi season the underutilisation was highest for vegetables. The measures to correct this have already been given above. High Yielding Wheat was the crop which could utilise the available irrigation water to the maximum extent. But this was a capital intensive crop and needed proper management and supply of inputs in time. The cooperation of the concerned departments can resolve this problem.

6. The reasons for underutilisation in summer seem to be genuine. The intense heat is the real problem. Similarly the stray cattle menace is also not easy to contain. However, it is posible for a tubewell owner to lease out a part of his land near tubewell to a person interested in growing summer vegetables. Fencing of limited area jointly by the tubewell owner and the lessee may not be difficult.

7. The problems of underutilisation due to fragmentation of holdings and paucity of electricity supply are not localised to this area. These need to be tackled at the national level.

8. The problems of low output of water due to admixture of sand and other mechanical troubles should be looked into by the Directorate of Tubewells.

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C H A P T E R V

SUMMARY AND CONCLUSIONS

Water is essential for human beings, annimals and plants. The three sources of water for plants are : soil moisture, rain water and irrigation.

5.1.1 In India, in 1980-81, 27.66 per cent of the net sown area was irrigated. The percentage of irrigated area to gross irrigated area in the same year was 28.61. Paddy and wheat were the most important irrigated crops as they accounted for 32.95 and 31.29 per cent of the gross irrigated area respectively. Sugarcane, cotton and pulses were other important irrigated crops. As regards extent of irrigation sugarcane topped the list with 85 per cent area under irrigation. Wheat was irrigated to the extent of 69.54 per cent and barley and paddy, 50.30 and 40.69 per cent respectively.

5.1.2 The yields of irrigated crops are remarkably higher than the unirrigated crops. In M.P., during 1981-82, the yield of irrigated paddy was 44.71 per cent higher than the unirrigated one. For irrigated wheat the yield was 97.04 per cent higher than the unirrigated crop. This was also true in the the case of crops like bajra, barley, rapeseed, mustard and gram.

5.1.3 The sources of irrigation are canals, tanks and wells. The nalas, rivers etc. are grouped as "other sources". In 1979-80, out of the total irrigated area of 38,478 thousand hectares 46.3 per cent was irrigated by wells and 38.34 per cent by canals. Of the 46.30 per cent area under the command of wells, tubewells accounted for 24.18 per cent and other wells, 22.12 per cent.

Data for the five year period ending 1979-80 indicated that the proportion of irrigated area under canals remained around

38 to 39 per cent. The proportion of irrigated area under wells, on the other hand, increased gradually till 1978-79 and shot up to 46.30 per cent in 1979-80.

During the seventh five year plan, the additional surface water potential to be created was fixed at 1.0 million hectares with a uniform addition of 0.2 million hectares per year. Where as additional groundwater potential was fixed at 7.0 million hectares with increasing potential in different years.

5.1.4 Tubewells have definite advantages over other sources. Firstly, it costs absolutely nothing to store. Secondly, it is served at the doorstep of the farm. Thirdly, it suffers no loss due to evaporation or seepage either during storage or transmission. Fourthly it is easy to tap and lastly, this source can be created within weeks, if not, infact, within days.

5.1.5 Private tubewells are owned and operated by individual farmers. They are mostly shallow tubewells and have a discharge of 30,000 litres per hour. These irrigate between 4 to 8 hectares. State tubewells are the property of the Government and are deep tubewells. The discharge is about 1,35,000 litres per hour. These have the potential to irrigate between 80 to 100 hectares.

5.1.6. Data for the years 1982-83 and 1983-84 indicated that the underutilisation of irrigation schemes was 7.58 and 7.02 per cent respectively. The underutilisation in major and medium irrigation schemes was 16.49 and 15.34 per cent respectively, whereas, there was no underutilisation in minor irrigation schemes.

5.1.7 The objectives of the study were :

1. To assess the irrigation potential created by tubewells
2. To assess the extent of utilisation of irrigation potential and to know the extent of underutilisation, if any
3. To know the reasons of underutilisation, and to suggest the measures that could be taken to limit the under-utilisation.

5.1.8 In Madhya Pradesh the successful tubewells are mostly located in Narmada and Chambal basins. Therefore, for this study, Narsinghpur district from among the districts of Narmada basin and Morena district from those of the Chambal basin were selected. Officials of the Directorate of Tubewells were consulted for the purpose.

5.1.9 The sample comprised 50 tubewell owners of each of the selected districts making the total to 100. In Narsinghpur there were two tehsils, Narsinghpur and Gadarwara. Therefore, 25 tubewell owners from each tehsil made up the sample. In Morena the sample of 50 tubewell owners was spread is four tehsils in proportion to the number of tubewells in those tehsils. For the selection of sample within a tehsil the clusters of tubewell owners were noted and the random sample was drawn from a cluster.

The years of studying the impact were two. The crop data for the year preceding the sinking of tubewells were compared with that of the data of agricultural year 1984-85.

5.2.1 In Madhya Pradesh, in 1981-82, 12.85 per cent of the net sown area was irrigated. The percentage of gross irrigated area was 11.54. The most important irrigated crops were paddy and

wheat. Unlike the country as a whole, canals formed the most important sources of irrigation commanding 44.99 per cent of the net irrigated area. Next important sources were wells which irrigated 41.16 per cent of the net irrigated area.

5.2.2 At the end of the year 1981-82 there were 6,876 tubewells in the State . Indore division had largest number(2,454) of tubewells followed by Jabalpur (933) and Hoshangabad (785). In the sixth plan period it was proposed to drill 7,000 tubewells : 4,254 Corporation Tubewells and 2,746 cultivators tubewells. It was estimated that an additional potential of 87,000 hectares would, thus, be created.

5.2.3 The tubewell construction work in the state started with the establishment of Exploratory Tubewell Organisation(E.T.O.) by the Government of India in 1952. Under this scheme 35 tubewells were dug in the Narmada valley. Of these 16 were found successful. In 1959 the state Govt. sanctioned a scheme for the construction of 40 tubewells in Narsinghpur and Hoshangabad districts. These were constructed through contractors. In the third plan period 18 additional tubewells were dug and in 1961 a scheme of 15 more tubewells was prepared and implemented. Thus the number of tubewells increased to 89. In 1972, the Govt. of India reorganised the Exploratory Tubewell Organisation and named it as Central Ground water Board. Previously the Board operated under the Ministry of Agriculture. Since 1980 it is operating under Ministry of Irrigation. In January 1968, the Government of M.P. constituted the Directorate of Tubewells and Ground water Survey. It continued till December 1976. In July 1976 the Government constituted the Lift Irrigation Corporation Ltd.

5.2.4 The Tubewell Construction Department in the State is headed by a Chief Engineer, Groundwater Survey, Irrigation Department. There were 2 Tubewell Construction circles at Bhopal and Jabalpur, each headed by a Superintending Engineer. Bhopal circle had 4 Tubewell Construction Divisions at Narsinghpur, Gwalior, Morena and Bhopal each headed by an Executive Engineer, Jabalpur had 3 Tubewell Construction Divisions at Jabalpur, Rewa and Raipur, each headed by an Executive Engineer, The Tubewell Construction Department undertook 3 types of tubewells : Drinking water tubewells, tubewells for Agriculture and tubewellsfor industries, cooperative farms and cooperative societies.

5.2.5 By the end of the year 1979-80, there were 6,444 shallow tubewells and 195 deep tubewells serving agriculture. Of the 6,444 shallow tubewells, 3,882 were successful and of these 3,462 were energised to create a potential of 34,051 hectares. Of the 195 deep tubewells 129 were successful and of these 119 were energised to create a potential of 8,493 hectares. Thus the total potential created was 42,544 hectares.

5.2.6 As regards the procedure of tubewells construction, the farmer submitted the application to the Executive Engineer through Deputy Director of Agriculture and the concerned bank. In the case of bank loan, the bank scrutinised the application and obtained the estimate from the Tubewell Construction Department. After the loan is sanctioned the bank issued an order to the Executive Engineer to construct the tubewell.

5.2.7 The Tubewell Construction Department had 149 deep tubewells and 127 shallow tubewells under it. For each such tube-tubewell, the irrigation potential and the area actually irrigated were recorded by the Department. Thus the potential created was

13,272.54 hectares and the area actually irrigated was 6,892.44 hectares. Thus the underutilisation was 6,380.10hectares or 48.07 per cent. The underutilisation in kharif season was 70.34 per cent and that for rabi, 33.62 per cent.

5.3.1 The selected Narsinghpur district was located in the centre of the state. It is well known for pulse production. As high as 34.11 per cent of the gross cropped area was under gram. Other important pulses were, pea (9.85 per cent), arhar (6.54 per cent), and teora (4.13 per cent). However, these were not important from irrigation point of view. Sugarcane was entirely irrigated, whereas, wheat was irrigated to the extent of 47.26 per cent. Gram was irrigated to the extent of only 2.02 per cent.

5.3.2 Wells (open wells and tubewells) commanded as high as 89.82 per cent of the irrigated area.

5.3.3 There were two types of tubewells: deep tubewells and shallow tubewells. There were 82 deep tubewells and 752 shallow tubewells. Of the 752 shallow tubewells 512 or 68.09 per cent were working. The remaining tubewells were either unsatisfactory or abandoned. The highest number of working tubewells (114) were dug in 1975 and about equal number (101) were dug in 1972. Further, it was noted that 191 or 33.30 per cent tubewells had a depth between 50 to 60 metres. Another 32.03 per cent tubewells were 40 to 50 metres deep and 21.10 per cent had a depth of over 60 metres. As regards discharge of water it was observed that 36.52 per cent tubewells had a discharge of 760 litres per minute. Another 29.88 per cent had a discharge of 947 litres per minute. Tubewells with the discharge of 570 litres per minute were 15.43 per cent. With regard to horse power it was noticed that 24.02 per cent of the pumps were of 11 horse power each and 19.14 per

cent were of 9 horse power. Another 10.55 per cent had 6.50 horse power. The time taken between the completion of drilling and the energisation varied from one tubewell to another. Data showed that 37.70 per cent of the tubewells were energised within a period of one year. But29.69 per cent could be energised only between 1 to 2 years' time. Others took more than 2 years for energisation.

5.3.4 Another selected district (Morena) is located in the north west corner of the State. Rapeseed and mustard were the most important crops of the district and occupied nearly one fourth (24.86 per cent) of the gross cropped area. Wheat was next important occupying 22.05 per cent of the area. Gram, another important crop, occupied 10.85 per cent.Thus, the district was mainly rabi crops growing 57.76 per cent area under these. The kharif crops of importance were bajra (14.56 per cent) and jowar (6.62 per cent). While sugarcane was entirely irrigated, wheat was irrigated to the extent of 86.1 per cent and rapesed and mustard 61.7 per cent.

5.3.5 Canals were the most important sources of irriga tion commanding 66.23 per cent of the irrigated area. Wells, including tubewells, commanded 16.94 per cent.

5.3.6 At the time of this survey there were no deep tubewells in the district. These were under construction on both the sides of Ambah canal under world Bank Scheme. Shallow tubewells numbered 421 and were concentrated in four of the six tehsils. Of the 421 tubewells only 285 or 67.70 per cent were working. The remaining tubewells were either unsatisfactory or abandoned. As high as 69.13 per cent of the tubewells were constructed during

the three year period 1973-75. Nearly half (49.12 per cent) of the tubewells had a depth ranging between 50-60 metres and another one fourth (25.61 per cent) had a depth between 60 to 70 metres. As regards output, half (49.13 per cent) of the tubewells had a discharge of 910 litres per minute. Another 15.79 per cent had a discharge of 947 litres per minute and the tubewells with a discharge of 760 and 834 litres constituted 13.68 per cent each. As far as horse power is concerned, 11 horse power motor was preferred by as many as 84.20 per cent tubewells owners. Further, about half (49.26 per cent) of the tubewells were energised within a years time. However, another one fourth (28.73 per cent) took between 1 to 2 years and the rest, more than two years.

5.3.7 Irrigation Department of the State Government, in 1979, estimated the irrigation potential and utilisation of each tubewell owned by it. At that time there were neither deep nor shallow tubewells owned by State Govt.in Morena district. It owned only deep tubewells in Narsinghpur district. Thus, of the selected two districts, we have the estimates for deep tubewells of Narsinghpur district only. According to the state Govt. estimates the percentage of underutilisation to potential was 43.23. It was 67.95 for kharif and 27.12 per cent for rabi.

5.4.1 Fifty tubewell owners of Narsinghpur district and an equal number in Morena district were selected for the study. Of the 100 tubewells 79 were drilled between 1971 and 1975. However, in Gadarwara tehsil of Narsinghpur district as many as half of the 25 tubewells were dug from 1980 to 1983. Further, as high as 83 per cent tubewells had a depth ranging between 40 to 70 metres. Of these 32 had the depth between 50 to 60 metres. As regards output, 53 per cent of the tubewells

had an output between 900 to 990 litres per minute. Another ten per cent had 777 litres per minute. The largest percentage of tubewells (30) had 11 horse power pumps and 26 per cent had more than 11 horse power pumps. Nine pumps were of 9 horse power and 8 had 6.5 horse power. In the case of 79 per cent of the tubewells the duration between drilling and energisation ranged between 6 months and 2 years. Ten tubewell owners were lucky to get their tubewells energised within 6 months of drilling. Thirty five got their pumps energised between 6 to 12 months and 26 per cent between 18 to 24 months.

5.4.2 In Narsinghpur district 18 out of 50 tubewell owners belonged to Lodhi caste followed by 12 belonging to Kirar caste. The average size of holding was 15.17 hectares as aganist 3.60 hectares for the district. The percentage of irrigated area to total area was 56.95, as against the district average of 8.2 per cent. Tubewells commanded 86.33 per cent of irrigated area. The first impact of tubewells was that the area under the crops increased from 398.82 hectares to 480.78 hectares : an increase of 22 per cent in the intensity of cropping. Secondly, kodo-kutki and the mixture of jowar and arhar lost ground to the crops like soybean, sugarcane, summer moong and summer vegetables. Area under crops such as jowar, arhar, urd, moong, teora, batri, pea and lentil decreased while that under paddy, wheat, gram and groundnut increased.

5.4.3 The 100 per cent utilisation of tubewells means its running for all the twenty four hours of the day for all the days of the year and maximum use of discharge. Any amount of non-working or non-utilisation of water output be termed as under utilisation.

5.4.4 On the selected farms of Narsinghpur district the potential in all the three seasons of kharif, rabi and summer came to 1,026.05 hectares. Against this the utilisation was 522.67 hectares resulting in underutilisation to the extent of 503.38 hectares or 49.06 per cent. The maximum underutilisation was in summer (81.15 per cent). In kharif season the underutilisation was 45.50 per cent and that in rabi, 43.12 per cent. The crops for which underutilisation was reported were summer moong, summer vegetables, paddy, soybean and wheat.

5.4.5 The reasons of underutilisation were of two types: 1. Non working of tubewells 2. Non-utilisation of the entire output of water. Further, non working of tubewells could be due to-1. Non operation by the tubewell owners 2. Non working of tubewells due to mechanical troubles, and, 3. Non-working due to paucity of electricity supply.

5.4.6 Non operation of tubewells by owners in kharif was due to the fact that the district received, on an average, 1,250 mm of rainfall which was sufficient for growing a kharif crop. Moreover, Narsinghpur had a very small area (18.01 per cent) under kharif crops. Tubewell water in kharif was required only for soybean, sugarcane and paddy, in later stages of monsoon. But these crops had a small area under them. Kharif fallow followed by rabi crops like gram or wheat was the common practice. Voluntary non-operation in rabi was least as Narsinghpur was predominantly rabi crops growing district and therefore utilisation was quite high in that season. Actually there was a shift from gram to wheat with twin goals of utilising additional irrigation potential and profitability. The underutilisation was noticed in the cases where the

farmers, after wing the maximum potential for their own farms did not use the spare capacity for their neighbours. The underutilisation was highest (81.15 per cent) in summer. The main reason for underutilisation was intense heat due to which supervision of irrigation and guarding of crops became very difficult. Another problem in summer was that of stray cattle which roamed, in groups, in search of stubbles of rabi crops. Not all farmers had irrigation facilities to grow summer crops. They kept the land fallow during summer and since majority of farmers did so there was no crop to guard. The stray cattle, therefore, were attracted towards the patches of summer crops and devoured them. Still another reason for underutilisation was that the tubewell owners were big farmers and the produce of rabi crops was big enough to keep them busy in post harvest operations even in summer. They were also required to attend social ceremonies and needed rest after hectic rabi season.

5.4.7 Among other reasons for underutilisation the first was the lack of scope for vegetable cultivation. This in turn, was due to inaccessibility within the district due to bad roads and lack of ready markets. The second reason was the inefficiency due to fragmentation. Among other reasons were labour shortage during peak season, insufficient output of water, defective water channels and paucity of electricity supply.

5.4.8 The reasons for underutilisation of output of water of a running tubewell included, the defective construction of channels, the lower output than the estimated, the non-levelling of land and non-fitting of sprinklers.

5.4.9 In Morena district 28 of the selected 50 farmers belonged to Thakur caste. Brahmins were 8 in number and Dhakad,

5, indicating the predominance of higher castes. Further, 12 of the selected farmers had education between V to VII standard. Nine farmers were illiterate and 8 were educated upto class IV. The average size of holding was 11.68 hectares as compared to 2.40 hectares of the district. The percentage of irrigation was 72.52 on the selected holdings as against 43.9 for the district as a whole. Of the total irrigated area 72.91 per cent was commanded by tubewells and 20.88 per cent by canals.

5.4.10 With the introduction of tubewell irrigation the gross cropped area increased by 27.63 per cent. Secondly, new crops like paddy, soybean, sugarcane, til, kharif fodder, kharif vegetables, rabi vegetables, berseem and summer crops like moong, vegetables and fodder were introduced. Thirdly, there was a tremendous increase in the area of wheat and a significant increase in mustard area. The farmers also did away with a dozen crop mixtures, both is kharif and rabi.

5.4.11 In Morena the irrigation potential created on the selected farms was 936.48 hectares and the utilisation was 437.07 hectares. Thus the underutilisation was to the extent of 499.41 hectares or 53.33 per cent. The maximum underutilisation was in summer (92.29 per cent). In kharif it was 61.19 per cent and in rabi 51.27 per cent. The underutilisation was remarkable in crops like summer vegetables, soybean, summer moong, sugarcane and gram.

5.4.12 The main reason for non-operation of tubewells in kharif season was the absence of crop like paddy or soybean. Since the rainfall was only 700 mm and the soils were not suitable for paddy, crops like jowar, bajra and arhar were grown. These crops did not require much of irrigation. Morever, these a accounted for

only one fourth of the gross cropped area. Only sugarcane was important from the irrigation point of view. Kharif fallowing succeded by rabi cash crops like mustard, wheat and gram was most common. The reasons were two : Firstly, the rabi crops were cash crops and were cultivated with utmost care. If kharif crop was grown in the patch where rabi crop was to be subsequently grown the former might cause delay in the sowing of latter and the result would be low yield. Secondly, in the absence of judicious use of fertilizers, farmers opined that a rabi crop sown after the harvest of a kharif crop would yield less. Vegetable cultivation was possible but the big landholders belonging to upper castes avoided vegetable growing. Another reason was silting of soil. Still another reason was the heavy investment that would be needed on fertilizers, pesticides etc. and the management of these inputs. Underutilisation in rabi was least. It was mainly in vegetables, gram and mustard. The reasons for vegetables have been noted above. Gram and mustard needed only two to three irrigations and therefore there was some underutilisation. The surplus water was not lent to neighbours. The nonoperation in summer, as in Narsinghpur, was due to intense heat. Moreover, the big farmers had tractors and trolleys and preferred to do the work of transportation of men and material during summer, which incidentally, was quite profitable. Complacency was another factor. Lastly, as in Narsinghpur, stray cattle menace existed in Morena also.

Among other reasons of voluntary nonoperation were :

1. Allied economic activities like trade, grain marketing, transport, etc. which detracted their attention out of agriculture.
2. Dacoit menace restricted the irrigation activities especially during nights, as in many areas, in winter, electricity was available only in the night. 3. Fragmentation of holdings, and

4. Lower output of water due to admixture of sand. Underutilisation was also caused due to non-working of pumps due to mechanical troubles and paucity of electricity.

5.4.13 The possible solutions to the problem of under-utilisation in Narsinghpur district were:

1. Soybean cultivation should be encouraged in kharif.
2. Cultivation of sugarcane, groundnut and paddy should also be encouraged in pockets where the conditions were favourable.
3. Agricultural Extension Services should guide those farmers to go in for double cropping who were not able to do so because of poor fertility of soil.
4. The Block Development authorities should pursuade the farmers to make available the spare capacity of tubewells to their neighbours.
5. The menace of stray cattle can be contained by financing for barbed wire fencing.
6. Sprinkler irrigation should be popularised. The M.P. Electricity Board and Rural Electrification Corporation should jointly tackle the problem of shortage of electricity.

5.4.14 The possible solutions for Morena district were 1. Popularising of sugarcane after enriching the soils by adding suitable manures and fertilizers 2. Soybean and vegetable cultivation should be popularised. 3. The problems of silting and salinity should be solved by engineers and soil scientists 4. Wheat cultivation has the maximum potential of utilising tubewell water but it requires timely and adequate supplies of fertilizers and pesticides. This aspect should be dealt by the officials of cooperative and agriculture departments and Bank authorities. 5. The problem of low output of water due to admixture of sand be tackled by the Directorate of Tubewells.

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Appendix table A 2.1 Land use classification of M.P., 1981-82

Particulars	Area (Thousand hectares)	Percentage to geographical area
Forests	14,034.0	31.74
Land not available for cultivation	4,570.6	10.34
Other uncultivated land excluding fallow	2,996.8	6.78
cultivable waste land	1,835.9	4.15
Fallow land	1,932.5	4.37
Net area sown	18,841.0	42.62
Total	44,210.8	100.00

Appendix table A 2.2 Net area irrigated by different sources in M.P., 1977-78 to 1981-82

(Area-thousand hectares)

Source	1977-78		1978-79		1979-80		1980-81		1981-82	
	Area	%	Area	%	Area	%	Area	%	Area	%
Canals	972	45.2	1,065	46.0	915	42.8	1,035	44.4	1,090	45.0
Tanks	143	6.6	140	6.1	140	6.5	136	5.8	135	5.7
Wells	858	39.8	943	40.7	921	43.1	986	42.3	996	41.1
Others	180	8.4	167	7.2	163	7.6	175	7.5	200	8.2
Total :-	2,153	100.00	2,315	100.00	2,139	100.00	2,332	100.00	2,421	100.00

Appendix table A 2.3 Details of tubewells in different districts of M.P., 1979-80

District	Shallow Tubewells				Deep Tubewells				Shallow tube-wells under deposit work	Non-Agri-cultu-ral uses	others	TOTAL
	Drilled	Success-ful	Ener-gised	Poten-tial created (Hect.)	Drilled	Success-ful	Ener-gised	Poten-tial created (Hect.)				
Balaghat	9	4	2	12	-	-	-	-	2	-	-	11
Bastar	53	26	24	480	-	-	-	-	--	8	-	61
Betul	35	11	9	54	-	-	-	-	-	-	8	43
Bhind	499	400	357	3654	28	5	5	495	46	-	-	573
Bhopal	229	121	102	822	-	-	-	-	51	-	-	280
Bilaspur	164	69	45	318	69	27	17	238	48	-	--	281
Chhatarpur	20	7	7	42	-	-	-	-	1	-	-	21
Chhindwara	24	-	-	-	-	-	-	-	-	-	-	24
Damoh	44	20	18	108	-	-	-	-	-	-	-	44
Datia	22	16	14	90	-	-	-	-	3	-	-	25
Dewas	113	42	41	270	-	-	-	-	2	-	-	115
Dhar	85	29	26	172	-	-	--	-	1	-	-	86
Durg	316	188	139	1664	-	-	-	-	21	-	33	370
Guna	6	2	1	6	-	-	-	-	1	-	-	7
Gwalior	85	59	48	480	-	-	-	-	90	-	-	175
Hoshangabad	914	701	675	6788	-	-	-	-	163	-	-	1077
Indore	323	147	143	900	-	-	-	-	13	-	-	336
Jabalpur	443	269	250	2728	14	13	13	1040	85	-	-	542
Jhabua	10	-	-	-	-	-	-	-	-	-	-	10

Cont....2/-

Appendix table A 2.3 continued

Khandwa	26	3	3	18	-	-	-	-	1	-	-	27
Kharqone	100	35	32	192	-	-	-	-	5	-	-	105
Mandla	14	3	2	12	-	-	-	-	5	-	-	19
Mandsaur	35	7	6	44	-	-	-	-	55	-	-	90
Morena	438	337	303	3114	-	-	-	-	14	-	12	464
Narsinghpur	662	491	491	5158	82	82	82	6560	25	-	7	776
Panna	23	6	5	30	-	-	-	-	-	-	-	23
Raigarh	62	34	34	600	-	-	-	-	3	-	-	65
Raipur	198	89	83	554	-	-	-	-	82	-	33	313
Raisen	401	256	197	1586	2	2	2	160	7	-	-	410
Rajgarh	16	2	2	12	-	-	-	-	21	-	-	37
Rajnandgaon	84	45	35	523	-	-	-	-	1	-	-	85
Ratlam	104	48	47	282	-	-	-	-	3	-	-	107
Rewa	105	71	31	466	-	-	-	-	32	-	1	138
Sagar	50	22	19	114	-	-	-	-	3	2	3	58
Satna	88	47	34	204	-	-	-	-	18	6	-	112
Sehore	197	106	98	694	-	-	-	-	19	-	-	216
Seoni	15	-	-	-	-	-	-	-	5	-	1	21
Shahdol	29	14	7	42	-	-	-	-	71	-	-	100
Shajapur	64	13	12	74	-	-	-	-	1	-	-	65
Shivpuri	24	8	8	48	-	-	-	-	5	-	-	29
Sidhi	85	50	34	904	-	-	-	-	42	-	10	137
Surguja	58	23	22	440	-	-	-	-	2	-	-	60
Tikamgarh	29	13	13	78	-	-	-	-	-	-	-	29
Ujjain	104	36	35	226	-	-	-	-	10	-	-	114
Vidisha	39	12	8	48	-	-	-	-	3	-	-	42
Total of MP	6444	3882	3462	34051	195	129	119	8493	960	16	108	7723

Appendix Table 4.1

Land Use classification in Madhya Pradesh
1950-51 to 1975-76
Area Under Forest and Land Put to Non- Agricultural User

(For Index Base year 1952-53=100)

	Area Under Forest			Land Put to Non-Agricultural User		
	Area Thousand Hec.	Index	Percentage	Area Thousand Hec.	Index	Percentage*
1950-51	9573.39	70.37	22.22	1309.20	86.15	3.04
1951-52	12446.60	93.94	28.10	1422.52	93.60	3.21
1952-53	13249.89	100.00	31.45	1518.43	100.00	3.60
1953-54	13604.61	102.68	31.36	2231.72	146.84	5.14
1954-55	13628.14	102.85	31.40	1961.84	129.09	4.52
1955-56	13552.82	102.29	31.1	1899.05	124.96	4.4
1956-57	13534.45	102.15	31.1	1923.32	126.55	4.4
1957-58	13795.03	104.11	31.4	1912.64	125.85	4.4
1958-59	13868.90	104.67	31.6	1863.47	122.62	4.3
1959-60	13878.22	104.74	31.7	1901.06	125.75	4.3
1960-61	13826.93	104.36	31.6	1914.30	125.96	4.3
1961-62	16165.54	122.01	31.6	2004.78	131.91	4.6
1962-63	14348.90	108.29	32.6	2002.41	131.76	4.5
1963-64	14579-45	110.03	30.0	2004.16	131.87	4.5
1964-65	14438.27	108.94	32.6	2045.51	134.59	4.6
1965-66	14610.01	110.26	33.0	2022.64	133.09	4.6
1966-67	14702.56	110.96	33.2	2040.99	134.30	4.6
1967-68	14695.82	110.91	33.1	2075.89	136.59	4.7
1968-69	14609.04	110.26	33.0	2086.52	137.29	4.7
1969-70	14437.00	108.96	32.6	2064.00	135.81	4.7
1970-71	14459.00	109.12	32.7	2073.00	136.40	4.7
1971-72	14440.00	108.98	32.6	2092.00	137.65	4.8
1972-73	14432.00	108.92	32.6	2029.00	133.51	4.6
1973-74	14330.00	108.15	32.4	2084.00	137.13	4.7
1974-75	14310.00	108.00	32.3	2130.00	140.15	4.8
1975-76	14480.00	109.28	32.6	2150.00	141.47	4.8
Linear Growth Rate	-	0.69	-	-	1.29	

* Percentage to total Geographical Area.

Appendix Table 4.2

Land Use classification in Madhya Pradesh
1950-51 to 1975-76
Barren and Unculturable Land and Pastures and Grazeing Land

(For Index Base year 1952-53 = 100)

	Barren and unculturable land			Permanent Patures and other grazing land		
	Area Thousand Hec.	Index	Percentage*	Area Thousand Hec.	Index	Percentage*
1950-51	4021.11	106.56	9.33	959.14	92.65	2.23
1951-52	3882.16	102.88	8.76	958.73	92.61	2.16
1952-53	3764.63	100.00	8.94	1035.22	100.00	2.46
1953-54	2432.44	64.46	5.61	2489.56	240.48	5.74
1954-55	2637.34	69.89	6.08	2455.19	237.16	5.66
1955-56	2751.34	72.91	6.3	2597.09	250.87	6.0
1956-57	2793.05	72.96	6.3	2896.51	279.79	6.7
1957-58	2547.49	67.51	5.8	3472.83	335.47	7.9
1958-59	2421.34	64.16	5.5	3617.30	349.42	8.3
1959-60	2367.30	62.73	5.4	3525.09	340.51	8.0
1960-61	2294.37	60.80	5.2	3900.11	376.74	9.0
1961-62	2197.98	58.25	5.1	3922.06	378.86	9.0
1962-63	2090.08	55.39	4.8	4071.58	393.30	9.3
1963-64	2146.30	56.88	4.9	4106.41	396.67	9.3
1964-65	2452.81	65.00	5.5	4200.38	405.75	9.5
1965-66	2417.22	64.06	5.4	4310.71	416.40	9.7
1966-67	2269.05	60.13	5.2	3585.11	346.31	8.9
1967-68	2227.23	59.02	5.0	3368.92	325.43	7.6
1968-69	2228.23	59.05	5.0	3278.93	316.74	7.4
1969-70	2362.00	62.59	5.3	3110.00	300.42	7.0
1970-71	2321.00	61.51	5.2	3222.00	311.24	7.3
1971-72	2306.00	61.11	5.2	3202.00	309.30	7.2
1972-73	2285.00	60.55	5.2	3147.00	303.99	7.1
1973-74	2309.00	61.19	5.2	3080.00	297.52	7.0
1974-75	2320.00	61.48	5.2	3170.00	306.21	7.2
1975-76	2280.00	60.42	5.1	3080.00	297.52	6.9
Linear Growth Rate	-	- 1.21	-	-	6.04	-

* Percentage to Total Geographical Area.

Appendix Table 4.3

Land Use Classification in Madhya Pradesh
1950-51 to 1975-76

Area Under Trees and Groves and Culturable Waste

	Area Under Misc Tree Crops and graves not included in net area sown			Culturable Weste		
	Area Thousand Hec.	Index	Percentage*	Area Thousand Hec.	Index	Percentage*
1950-51	4813.80	496.09	11.17	5478.88	124.58	12.72
1951-52	2126.61	219.16	4.80	5592.69	127.17	12.62
1952-53	970.34	100.00	2.30	4397.71	100.00	10.44
1953-54	422.38	43.53	0.97	4373.34	99.44	10.08
1954-55	419.01	43.18	0.97	4392.75	99.89	10.12
1955-56	397.76	40.99	0.9	4334.55	98.56	9.9
1956-57	374.89	38.63	0.9	4177.17	94.98	9.6
1957-58	347.27	35.79	0.8	3395.61	77.21	8.7
1958-59	345.52	35.61	0.8	3651.16	83.02	8.3
1959-60	330.77	34.09	0.8	3414.43	77.64	7.8
1960-61	330.47	34.06	0.8	3214.34	73.09	7.3
1961-62	476.55	49.11	1.1	2845.47	64.70	6.5
1962-63	529.82	54.60	1.2	2655.12	60.37	6.0
1963-64	366.32	37.75	0.8	2436.55	55.40	5.5
1964-65	108.01	11.13	0.2	2474.48	56.27	5.6
1965-66	78.99	8.14	0.2	2336.24	53.12	5.3
1966-67	106.13	10.94	0.4	2323.86	52.84	5.2
1967-68	87.91	9.06	0.2	2296.87	52.23	5.2
1968-69	79.24	8.16	0.2	2285.35	51.97	5.2
1969-70	209.00	21.54	0.5	2240.00	50.93	5.1
1970-71	130.00	13.40	0.2	2108.00	47.93	4.8
1971-72	139.00	14.32	0.3	2052.00	46.66	4.6
1972-73	143. 00	14.74	0.3	2065	46.96	4.7
1973-74	145.00	14.94	0.3	2123.00	48.27	4.8
1974-75	140.00	14.43	0.3	1980.00	45.02	4.5
1975-76	120.00	12.37	0.3	2020. 00	45.93	4.5
Linear Growth Rate	-	-7.27	-	-	-3.08	-

*Percentage to Total Geographical Area.

Appendix Table 4.4

Land Use classification in Madhya Pradesh
1950-51 to 1975-76

Fallow Land

(For Index Base year 1952-53=100)

	Area Under current Follows			Area Under other fallow Lands		
	Area Thousand Hec.	Index	Percentage*	Area Thousand Hec.	Index	Percentage*
1950-51	707.01	122.42	1.64	2254.85	118.09	5.23
1951-52	641.85	111.14	1.45	2931.46	153.53	6.62
1952-53	577.51	100.00	1.37	1909.32	100.00	4.53
1953-54	1063.93	184.23	2.45	1573.85	82.43	3.63
1954-55	947.21	164.02	2.18	1506.19	78.88	3.47
1955-56	998.45	172.89	2.3	1379.69	72.26	3.2
1956-57	826.73	143.15	1.9	1534.19	80.35	3.5
1957-58	1099.93	190.46	2.5	1608.57	84.25	3.7
1958-59	799.47	138.43	1.8	1595.56	83.56	3.6
1959-60	792.38	137.21	1.8	1626.03	85.16	3.7
1960-61	781.52	135.33	1.8	1416.80	74.20	3.2
1961-62	815.48	141.21	1.9	1223.49	64.08	2.8
1962-63	812.46	140.68	1.8	1203.91	63.05	2.7
1963-64	748.74	129.65	1.7	1211.08	63.42	2.7
1964-65	695.18	120.37	1.6	1084.80	56.81	2.5
1965-66	893.11	154.65	2.0	1114.72	58.38	2.5
1966-67	956.82	165.68	2.2	1123.06	58.82	2.5
1967-68	735.70	128.08	1.7	1030.98	54.00	2.3
1968-69	737.35	127.68	1.7	889.46	46.58	2.0
1969-70	685.00	118.61	1.6	848.00	44.41	1.9
1970-71	715.00	123.81	1.6	858.00	44.94	1.9
1971-72	682.00	118.09	1.6	864.00	45.25	2.0
1972-73	747.00	129.35	1.7	892.00	46.72	2.0
1973-74	754.00	130.56	1.7	899.00	47.08	2.0
1974-75	810.00	140.26	1.8	910.00	47.66	2.1
1975-76	880.00	152.38	2.0	750.00	39.28	1.7
Linear Growth Rate	-	-0.47	-	-	-2.94	-

* Percentage to total Geographical Area.

Appendix Table 4.5

Land Use Classification in Madhya Pradesh
1950-51 to 1975-76

Net Area Sown

(For Index Base year 1952-53 =100,)

	Net Area Sown			Total Gegraphical Area	
	Area Thousand Hec.	Index	Percentage	Area Thousand Hec.	Index.
1950-51	1369.33	95.01	32.42	43087.00	
1951-52	14294.59	97.22	32.27	44297.00	
1952-53	14703.32	100.00	34.90	42126.00	
1953-54	15192.21	103.32	35.02	43384.00	
1954-55	15456.06	105,12	35.61	43403.73	
1955-56	15615.08	106.20	35.9	43526.00	
1956-57	15520.88	105.56	35.6	43541.00	
1957-58	15243.28	103.67	34.8	43827.00	
1958-59	15696.82	106.76	35.8	43860.00	
1959-60	16007.92	108.87	36.5	43853.00	
1960-61	16104.03	109.53	36.8	43782.00	
1961-62	16252.01	110.53	37.4	43475.00	
1962-63	16353.94	111.23	37.1	44068.00	
1963-64	16521.57	112.37	37.4	44121.00	
1964-65	16734.58	113.81	37.9	44234.00	
1965-66	16528.82	112.42	37.3	44312.00	
1966-67	17205.30	117.02	38.8	44313.00	
1967-68	17797.47	121.04	40.2	44321.00	
1968-69	18074.43	122.93	40.8	44269.00	
1969-70	18283.00	124.35	41.3	44238.00	
1970-71	18351.00	124.81	41.8	44237.00	
1971-72	18460.00	125.55	41.7	44237.00	
1972-73	18497.00	125.80	41.8	44237.00	
1973-74	18560.00	126.23	41.9	44284.00	
1974-75	18510.00	125.89	41.8	44280.00	
1975-76	18720.00	125.89	42.1	44480.00	
Linear Growth Rate	-	1.26	-	-	

* Percentage to total Geographical Area.

Appendix Table 4.6

Net Area sown and Gross Cropped Area of Madhya Pradesh
1950-51 to 1975-76

(For Index Base year 1952-53=100)

	Net Area Sown	Area Double Cropped			Gross Cropped area	
	Area Thousand Hec.	Area Thousand Hec.	Index	Percentage*	Area Thousand Hec.	Index
1950-51	13969.33	1376.25	84.10	9.85	15345.60	93.90
1951-52	14294.59	1585.59	96.89	11.09	15880.18	87.17
1952-53	14703.32	1636.47	100.00	11.13	16341.85	100.00
1953-54	15192.21	1622.20	99.13	10.68	16814.41	102.89
1954-55	15456.06	1704.42	104.15	11.03	17160.48	105.01
1955-56	15651.08	1945.56	118.89	12.48	17560.64	107.46
1956-57	15520.88	2112.86	129.11	13.61	17633.73	107.90
1957-58	15243.28	1338.10	81 .77	8.78	16580.90	101.46
1958-59	15696.82	2034.40	124.32	12.96	17730.70	108.50
1959-60	16007.92	2176.20	132.98	13.59	18183.50	111.27
1960-61	16104.03	2090.40	127.74	12.98	18194.40	111.34
1961-62	16252.01	2255.20	137.81	13.88	18506.80	113.25
1962-63	16353.94	2053.30	125.47	12.56	18406.60	112.63
1963-64	16521.57	2221.80	137.77	13.45	18743.30	114.70
1964-65	16734.58	2228.40	136.17	13.32	18962.90	116.04
1965-66	16528.82	1257.20	76 .82	7.61	17786.00	108.84
1966-67	17205.30	1130.50	69.08	6.57	18335.80	112.20
1967-68	17797.47	1855.30	113.37	10.42	19652.80	120.26
1968-69	18074.43	1837.80	112.30	10.17	19912.20	121.85
1969-70	18283.00	2015.00	123.13	11.02	20298.00	124.21
1970-71	18351.00	2210.00	135.05	12.04	20561.00	125.82
1971-72	18460.00	2428.00	148.37	13.15	20888.00	127.82
1972-73	18497.00	2246.00	137.25	12.14	20743.00	126.93
1973-74	18560.00	2652.00	162.06	14.29	21212.00	129.80
1974-75	18510.00	2000.00	122.21	10.80	20510.00	125.51
1975-76	18720.00	2640.00	161.32	14.10	21360.00	130.71
Linear Growth Rate	-	-	1.71	-	-	1.32

* Percentage to Net Area Sown.

Appendix Table 4.7

Trend Equations of Shifts in Crop Acreage in Madhya Pradesh (1956-57 to 1972-73)

Y = a + bx where Y = index of crop area (base 1956-57 = 100)
x = Years

Crop	Rice Zone	Wheat Zone	Rice - Wheat Zone	Cotton-Jowar Zone	Jowar-Wheat Zone
Paddy	Y= 83.71+0.16x	Y=108.73+1.25x	Y=56.67 + 4.50x	Y= 95.32 + 0.11x	Y=100.74 + 1.03x
Jowar	Y =101.65+0.08x	Y=146.84+2.86x	Y=53.84 + 6.24x	Y=108.60 +1.95x	Y=115.42 + 1.53x
Maize	Y =114.25+0.02x	Y=101.50+1.08x	-	Y= 98.88 + 3.68x	-
Wheat	Y = 96.48 +0.01x	Y= 99.30-3.10x	Y=44.49+3.88x	Y= 87.54 + 1.26x	Y=91.90 + 2.05x
Gram	Y = 88.11 +0.007x	Y= 84.14-1.03x	Y=61.08 + 5.50x	Y= 86.37 - 0.06x	Y=105.14 +0. 64x
Linseed	Y= 90.52 +0.004x	Y= 79.84+1.20x	Y=41.19 + 4.92x	Y= 79.31 - 1.51x	-
Tur	-	Y=104.41+5.53x	-	-	Y= 92.38 +3.49x
Teora	Y= 109.03 +28.115x	-	-	-	
Sugarcane	-	-	Y=53.04 + 8.66x	-	Y= 99.24 -2.14x
Kodo-kutki	-	-	Y=48.98 + 3.42x	-	-
Mustard	-	-	-	-	Y= 73.49 +7.75x
Cotton	-	-	-	Y=106.52 -0.88x	-

Source - Dynamics of cropping Pattern in M.P. (1956-57 to 1972-73), Technical Bulletin No.AEC/4/1977, JNKVV, Jabalpur, M.P. (Mimeographed)

Appendix Table 4.8

Intensity of Cropping in Madhya Pradesh
1950-51 to 1975-76

(Area in thousand Hectares)

Years	Net Area Sown	Area sown more than-over	Gross Cropped Area	Intensity of cropping*
1950-51	13969.33	1376.25	15345.60	109.85
1951-52	14294.59	1585.59	15880.18	111.09
1952-53	14703.32	1636.47	16341.85	111.14
1953-54	15192.21	1622.20	16814.41	110.68
1954-55	15456.06	1704.42	17160.48	111.03
1955-56	15615.08	1945.56	17560.64	112.46
1956-57	15520.88	2112.86	17633.73	113.61
1957-58	15243.28	1338.10	16580.90	108.78
1958-59	15696.82	2034.40	17730.70	112.96
1959-60	16007.92	2176.20	18183.50	113.59
1960-61	16104.03	2090.40	18194.40	112.98
1961-62	16252.01	2255.20	18506.80	113.87
1962-63	16353.94	2053.30	18406.60	112.55
1963-64	16521.57	2221.80	18743.30	113.45
1964-65	16734.58	2228.40	18962.90	113.32
1965-66	16528.82	1257.20	17786.00	107.61
1966-67	17205.30	1130.50	18335.80	106.57
1967-68	17797.47	1855.30	19652.80	110.42
1968-69	18074.43	1837.80	19912.20	110.17
1969-70	18283.00	2015.00	20298.00	111.02
1970-71	18351.00	2210.00	20561.00	112.04
1971-72	18460.00	2428.00	20888.00	113.15
1972-73	18497.00	2246.00	20743.00	112.14
1973-74	18560.00	2652.00	21212.00	114.29
1974-75	18510.00	2000.00	20510.00	110.80
1975-76	18720.00	2640.00	21360.00	114.10

*Percentage to total Geographical Area.

Appendix Table 4.9

District-wise Normal and Average Rainfall and Coefficient of Variation of Rainfall in Madhya Pradesh

S.No.	Name of the District	Normal Rainfall (M.M.)	Average Rainfall (18 Yrs. Average)	Coefficient of variation of Rainfall
1.	Sagar	1235.0	1103.00	28.21
2.	Damoh	1224.5	1285.5	22.82
3.	Jabalpur	1274.1	1251.2	25.93
4.	Mandla	1569.6	1376.7	23.00
5.	Hoshangabad	1294.5	1267.1	31.22
6.	Narsimhapur	1300.8	1223.0	25.64
7.	East-Nimar(Khandwa)	880.0	938.9	30.51
8.	Balaghat	1623.2	1495.5	26.18
9.	Betul	1083.9	1059.2	34.09
10.	Chhindwara	1324.0	1065.3	26.20
11.	Seoni	1384.5	1221.6	25.32
12.	Durg	1270.1	1238.3	23.75
13.	Raipur	1384.9	1269.6	25.54
14.	Bilaspur	1391.7	1324.2	25.37
15.	Surguja	1493.2	1383.3	23.71
16.	Raigarh	1619.7	1498.5	30.53
17.	Bastar	1532.2	1412.2	13.50
18.	Bhind	668.3	861.3	48.43
19.	Morena	720.3	793.6	29.51
20.	Gwalior	751.2	938.8	26.82
21.	Shivpuri	816.3	860.8	25.09
22.	Guna	1052.5	999.2	27.41
23.	Vidisha	1133.8	1176.5	29.43
24.	Rajgarh	1100.8	976.3	28.30
25.	Shajapur	977.2	970.3	35.79
26.	Ujjain	892.2	920.8	33.62
27.	Ratlam	895.9	934.1	35.59
28.	Mandsaur	824.5	830.9	28.80
29.	Dewas	1083.2	1109.6	33.61
30.	Indore	974.9	986.7	40.53
31.	West Nimar (Khargone)	831.5	745.3	48.93
32.	Dhar	833.1	913.8	34.48
33.	Jhabua	828.0	787.5	36.55
34.	Rewa	1235.6	1084.3	28.16
35.	Satna	1099.9	1021.9	30.79
36.	Sidhi	1248.3	1071.2	24.23
37.	Shahdol	1396.8	1134.4	10.85
38.	Datia	739.9	776.4	26.85
39.	Tikamgarh	1001.1	1017.5	23.52
40.	Chhatarpur	1074.9	987.3	25.17
41.	Panna	1176.4	1151.9	31.22
42.	Sehore	1244.8	1311.6	18.66
43.	Raisen	13330.4	1177.0	25.27
44.	Madhya Pradesh	1135.3	1106.9	19.50

Appendix Table 4.10 Rainfall in East Madhya Pradesh - 1952-53 to 1975-76

(Unit -MM.)

Year	South West Monsoon 1st June to 30th Sept.			Past Monsoon Period Ist Oct. to 31 Dec.			Winter Monsoon 1st Jan. to Last Feb.			Pre Monsoon period 1st March to 31st May.			Total Actual Rain fall
	Actual	Normal	Percentage Departure	Actual	Normal	Percentage Departure	Actual	Normal	Percentage Departure	Actual	Normal	Percentage Departure	
1952-53	1118	1110	- 7	56	104	- 45	23	38	- 35	33	79	- 57	1230
1953-54	1334	1204	+ 11	81	104	- 21	3	36	- 95	33	79	- 57	1451
1954-55	11759	1204	- 2	36	104	- 66	8	36	- 76	61	79	- 23	1284
1955-56	1181	1204	- 2	209	104	+102	6	37	- 83	81	78	+ 4	1477
1956-57	1382	1203	+ 15	145	97	+ 50	21	39	- 45	98	68	+ 45	1646
1957-58	1010	1197	- 16	38	97	- 61	26	39	- 34	57	68	- 16	1131
1958-59	1107	1197	- 7	151	97	+ 56	34	39	+ 14	45	68	- 34	1337
1959-60	1320	1197	+ 10	117	97	+ 20	29	39	- 27	86	68	+ 28	1552
1960-61	964	1197	- 19	111	97	+ 14	47	39	+ 21	68	68	+ 1	1190
1961-62	1520	1197	+ 27	104	97	+ 7	33	39	- 17	89	68	+ 33	1746
1962-63	919	1197	- 23	62	97	- 36	17	39	- 58	99	68	+ 46	1097
1963-64	1011	1215	- 17	71	91	- 22	24	41	- 41	84	63	+ 33	1190
1964-65	1021	1218	- 16	63	90	- 30	20	41	- 51	88	62	+ 42	1192
1965-66	799	1251	- 37	14	84	- 84	22	44	- 51	40	56	- 29	866
1966-67	864	1231	- 30	65	82	- 21	2	44	- 96	126	56	+123	1057
1967-68	957	1231	- 22	47	84	- 44	22	43	- 49	80	57	+ 40	1106
1968-69	981	1230	- 20	49	82	- 40	9	44	- 79	55	56	- 2	1094
1969-70	1130	1224	- 8	43	82	- 47	55	44	+ 24	92	56	+ 64	1320
1970-71	1335	1229	+ 9	10	82	- 88	50	44	+ 12	111	56	+ 99	1506
1971-72	1354	1231	+ 10	92	82	+ 13	18	44	- 60	26	56	- 54	1490
1972-73	1057	1231	- 14	98	82	+ 19	47	44	+ 5	15	56	- 72	1217
1973-74	1174	1231	- 5	166	82	+ 102	15	44	- 65	22	53	- 59	1377
1974-75	891	1202	- 26	76	80	- 4	22	45	- 52	36	53	- 33	1025
1975-76	1373	1206	+ 14	110	79	+ 38	12	46	- 74	48	53	- 10	1543
Coefficient of Variation (%	16.88			57.09			61.16			45.60			16.52

Sorce - 1. Estimates of Area and Production of Principal Crops
2. Indian Agricultural Statistics.

Appendix Table 4.11 Rainfall in West Madhya Pradesh - 1952-53 to 1975-76

(Unit-M.M.)

	South-West Monsoon (1st June to 30th Sept.)			Past Monsoon period (1st Oct. to 31 Dec.)			Winter Monsoon (1st Jan to Last Feb)			Pre Monsoon Period (1st March to 31st May)			Total Actual Rainfall
	Actual	Narmal	Percentage Departure	Actual	Narmal	Percentage Departure	Actual	Normal	Percentage Departure	Actual	Normal	Percentage Departure	
1952-53	818	996	- 18	10	71	- 87	10	25	- 62	13	33	- 59	851
1953-54	848	996	- 15	25	71	- 65	20	25	- 16	13	33	- 59	906
1954-55	1135	980	+ 16	5	74	- 93	38	25	+ 54	15	33	- 56	1193
1955-56	1163	980	+ 19	139	75	+ 86	2	24	- 92	66	34	- 95	1370
1956-57	1023	982	+ 4	129	55	+ 134	18	19	- 6	49	26	+ 91	1219
1957-58	811	975	- 17	11	54	- 79	10	19	- 49	7	26	- 71	839
1958-59	982	976	+ 1	32	55	+ 49	38	19	+ 101	42	26	+ 64	1094
1959-60	1105	975	+ 13	72	55	+ 31	32	19	+ 73	27	25	+ 5	1236
1960-61	919	975	- 6	79	55	+ 43	36	19	+ 92	19	25	- 23	1053
1961-62	1271	975	+ 30	143	55	+ 160	33	19	+ 75	32	25	+ 29	1479
1962-63	972	975	- 3	44	55	- 20	19	19	- 1	16	26	- 37	1051
1963-64	871	970	- 10	63	57	+ 11	20	20	0	26	25	+ 4	980
1964-65	861	969	- 11	60	57	+ 5	16	20	- 20	28	25	+ 12	965
1965-66	522	960	- 46	15	59	- 75	9	21	- 57	15	25	- 47	561
1966-67	671	963	- 30	33	59	- 45	1	21	- 98	49	25	+ 94	754
1967-68	790	963	- 18	35	59	- 41	15	21	- 29	26	25	+ 4	866
1968-69	889	962	- 8	19	60	- 68	11	21	- 48	48	25	- 70	926
1969-70	1009	959	+ 5	50	60	- 16	39	21	+ 89	29	25	+ 13	1127
1970-71	1089	962	+ 13	6	60	- 90	14	21	- 34	27	26	+ 5	1136
1971-72	1045	974	+ 7	56	58	- 3	5	21	- 75	3	25	- 87	1109
1972-73	753	965	+ 22	32	57	- 44	14	20	- 32	5	25	- 82	804
1973-74	1367	965	+ 42	32	57	- 44	2	21	- 89	13	23	- 44	1414
1974-75	853	935	- 9	99	56	+ 76	14	21	- 36	9	23	- 63	975
1975-76	1017	933	+ 9	58	54	+ 7	16	22	- 27	24	23	+ 1	1115
Coefficient of Variation (%)	1952	-	-	76.81	-	-	65.00	-	-	65.91	-	-	20.37

Source:- 1. Estimates of Area and Production of Principal Ceops. 2. Indian Agricultural Statistics.

Appendix Table 4.12 Annual Rainfall and its Seasonal Breakup in Madhya Pradesh 1956-57 to 1975-76

(Unit -m.m.)

Year	Monsoon		Past Monsoon		Winter		Pre Monsoon		Total	
	Rainfall m.m.	No. of days	Rainfall	No. of days	Rainfall	No. of days	Rainfall	No. of days	Rainfall	No. of days.
1956-57	1055.1	37	94.4	5	60.4	6	17.0	2	1226.9	50
1957-58	863.3	40	19.5	1	29.9	3	6.6	1	919.3	44
1958-59	1101.2	51	98.8	5	35.7	3	4.6	2	1240.3	62
1959-60	1147.1	50	51.1	5	51.2	4	13.0	1	1262.4	60
1960-61	965.0	46	78.9	5	46.3	4	24.4	3	1114.6	58
1961-62	1147.1	50	72.1	5	51.2	4	13.0	1	1283.4	60
1962-63	911.4	43	13.6	1	46.9	4	20.4	2	992.3	50
1963-64	957.1	44	53.2	3	10.7	1	6.2	1	1027.2	49
1964-65	1014.1	44	25.7	1	17.1	2	7.3	3	1064.2	50
1965-66	622.5	29	8.6	1	20.1	1	7.5	-	658.7	27
1966-67	717.2	36	29.3	2	45.8	3	5.5	-	797.8	41
1967-68	1058.5	45	4.3	-	112.5	7	55.0	-	1180.3	53
1968-69	850.7	37	22.5	2	9.5	1	13.9	1	896.6	38
1969-70	1088.1	44	39.8	1	71.4	5	11.0	1	1210.3	51
1970-71	1107.9	44	7.4	1	28.8	2	19.4	2	1163.5	49
1971-72	1165.1	44	71.3	3	26.3	1	19.3	2	1282.0	50
1972-73	852.3	32	32.7	2	47.3	1	1.7	1	934.0	36
1973-74	1216.4	44	73.9	3	10.5	1	10.9	1	1312.2	49
1974-75	794.6	36	79.4	4	16.4	2	0.3	1	890.7	43
1975-76	1096.5	47	74.4	3	10.6	1	18.1	2	1199.6	53
1976-77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Coefficeient of variation	15.99		63.26		66.47		59.08		16.85	

Appendix Table 4.13 Cropwise Averages of Area Affected and Losses in Out turn per year in Madhya Pradesh (Average Calculated on 18 years data)

Crops	Insufficent rains		Excessive rains		Floods	
	Area	Loss of out turn in tons	Area	Loss of Out turn in tons	Area	Loss of Out turn in tons
Paddy	473675.38	203126.77	4949.00	764.72	1378.28	421.94
Wheat	45014.17	8402.78	23373.44	3251.67	-	-
Jowar	138369.67	37510.56	68570.50	11036.67	1583.61	797.83
Maize	37785.83	7558.89	27972.78	6659.94	492.94	176.44
Kodon-kutki	158359.11	17460.94	1815.28	124.94	549.67	32.28
Gram	27257.72	4740.61	6280.22	1829.11	-	-
Tur	18532.89	7542.89	3777.33	1398.72	323.83	179.17
Teora	11975.83	1560.50	3471.72	911.67	-	-
Cotton	62811.17	27389.94	49170.33	1822.22	1500.56	216.44
Groundnut	29895.83	11001.39	16972.67	4426.17	167.56	75.06
Linseed	16897.50	1481.33	4804.33	328.94	-	-
Sesamum	16142.44	2355.22	1570.28	151.50	224.28	31.56
Total Kharif	1086939.06	331966 .50	174468.56	1754.53	6892.72	2203.39
TotalRabi	116605.56	18841.22	48012.78	8136.89	6.78	1.50

Appendix Table 4.13 Contd.....

Crops	Hail		Cold waves		Insects, pest and diseases	
	Area	Loss of Out turn in tons	Area	Loss of Out turn in tons	Area	Loss of Out turn in tons
Paddy	95.67	28.33	10.00	2.89	53978.70	5555.66
Wheat	25481.78	7179.22	87124.72	13390.33	6917.33	1162.89
Jowar	456.50	115.28	11.22	3.55	2512.17	435.28
Maize	-	-	-	-	3933.56	609.28
Kodon-kutki	141.44	23.33	1.11	0.055	63.61	8.89
Gram	17970.39	3804.61	72167.50	13254.39	36084.17	6755.67
Tur	2760.67	416.94	14169.44	6356.72	-	-
Teora	3723.55	845.39	1703.78	254.17	11947.66	1344.28
Cotton	294.89	483.83	9922.17	343.06	1738.28	133.78
Groundnut	-	-	-	-	384.39	89.89
Linseed	5457.78	829.89	11253.44	1322.61	1061.33	119.44
Sesamum	0.72	0.39	16.94	2.39	354.00	61.50
Total Kharif	14495.28	1421.72	24185.67	6840.28	66039.33	8329.72
Total Rabi	59472.28	14122	206734.67	35381.06	66100.11	10877.06

Appendix Table 4.14

Area Irrigated by Different sources in Madhya Pradesh (1950-51 to 1975-76)- (for Index Base year 1952-53 =100)

(Area in thousand Hectares)

	Area Irrigated by Canals			Area Irrigated by Tanks		
	Area	Index	Percentage*	Area	Index	Percentage *
1950-51	354	93.40	39.8	235	188.00	26.4
1951-52	358	94.45	44.8	149	119.20	18.7
1952-53	379	100.00	47.2	125	100.00	15.5
1953-54	360	94.98	43.4	161	128.80	19.4
1954-55	381	100.52	45.5	135	108.00	16.1
1955-56	370	97.62	44.9	119	95.20	14.4
1956-57	390	102.90	47.1	109	87.20	13.2
1957-58	401	105.80	40.6	244	195.20	24.7
1958-59	388	102.37	46.3	114	91.20	13.6
1959-60	432	113.98	46.6	135	108.00	14.6
1960-61	441	116.36	47.7	122	97.60	13.2
1961-62	457	120.58	48.3	125	100.00	13.2
1962-63	463	122.16	45.4	174	139.20	17.0
1963-64	495	130.60	47.8	140	112.00	13.5
1964-65	543	143.27	50.4	127	101.60	11.9
1965-66	461	121.64	47.2	118	94.40	12.1
1966-67	470.	124.01	43.1	196	156.80	18.0
1967-68	559	147.49	48.9	129	103.20	11.3
1968-69	627	165.44	47.7	177	141.60	13.5
1969-70	669	176.52	46.8	175	140.00	12.2
1970-71	710	187.33	48.0	130.	104.00	8.8
1971-72	766	202.11	46.6	154	123.20	9.4
1972-73	779	205.54	45.9	145	116.00	8.5
1973-74	772	203.69	44.6	127	101.60	7.3
1974-75	679	179.16	41.5	153	122.40	9.3
1975-75	801	211.35	44.4	132	105.60	7.3
Linear Growth Rate	-	4.94	-	-	0.44	-

* Percentage to Net Irrigated Area.

Appendix Table 4.15

Area Irrigated by Different Sources in Madhya Pradesh (1950-51 to 1975-76) (for Index Base year (1952-53 = 100)

(Area in thousand Hectares)

	Area Irrigated by Wells			Area Irrigated by Other Sources		
	Area	Index	Percentage*	Area	Index	Percentage*
1950-51	249	93.61	28.0	52	144.44	5.8
1951-52	244	91.72	30.6	47	130.55	5.9
1952-53	266	100.00	32.9	36	100.00	4.4
1953-54	268	100.75	32.3	41	113.88	4.9
1954.55	282	106.01	33.7	39	108.33	4.7
1955-56	298	112.03	36.1	38	105.55	4.6
1956-57	294	110.53	35.5	36.	100.00	4.2
1957.58	299	112.41	30.4	42	116.67	4.3
1958.59	300	112.78	35.8	37	102.77	4.3
1969-60	321	120.68	34.7	38	105.56	4.1
1960-61	324	121.80	35.1	37	102.77	4.0
1961-62	328	123.31	34.8	34	94.44	3.7
1962-63	342	128.57	33.5	82	227.77	4.1
1963-64	362	136.08	35.0	38	105.55	3.7
1964-65	364	136.84	33.8	44	122.22	3.9
1965-66	345	129.70	33.3	52	144.44	5.4
1966-67	370	139.10	34.0	53	147.22	4.9
1967-68	411	154.51	36.0	44	122.22	3.8
1968-69	461	173.30	34.4	59	163.88	4.4
1969-70	511	192.10	35.7	76	211.11	5.3
1970-71	562	211.28	38.0	78	216.66	5.2
1971-72	621	233.46	37.3	103	286.11	5.2
1972-73	644	242.10	37.9	130	361.11	7.7
1973-74	693	260.53	40.0	141	391.67	8.1
1974-75	647	243.23	39.7	156	433.33	9.5
1975-76	700	263.16	38.8	171	475.00	9.5
Linear Growth Rate -		6.75	-		11.40	-

* Percentage to Net Irrigated Area.

Appendix Table 4.16

Cropwise Irrigated Area in Madhya Pradesh (1950-51 to 1975-76)

(For Index Base year 1952-53 =100)

	Rice			Maize		
	Irrigated Area (Hec.)	Index	Percentage to Gross Area	Irrigated Area(Hec.)	Index	Percentage to Gross Area
1950-51	552600	127.21	61.03	1404	24.63	0.16
1951-52	465800	107.23	56.93	1500	26.32	0.18
1962-53	434400	100.00	52.65	5700	100.00	0.69
1953-54	504500	116.14	59.75	1200	21.05	0.14
1954-55	461100	106.15	53.98	2000	35.09	0.23
1955-56	425600	97.97	50.84	1600	28.07	0.19
1956-57	440800	101.47	52.54	1300	22.81	0.15
1957-58	596400	137.29	59.66	4600	80.70	0.46
1958-59	430000	98.99	50.71	700	12.28	0.08
1969-60	491200	113.07	52.15	1200	21.05	0.13
1960-61	484100	111.44	51.59	2700	47.37	0.29
1961-62	483300	111.26	50.38	1000	17.54	0.10
1962-63	576500	132.71	55.65	1300	22.81	0.13
1963-64	532300	153.53	50.47	1600	28.07	0.15
1964-65	547200	125.97	49.81	2300	40.35	0.21
1965-66	489500	112.68	48.95	95.00	166.67	0.95
1966-67	575900	132.57	51.73	6800	119.30	0.61
1967-68	555100	127.78	47.75	1900	33.33	0.16
1968-69	662100	152.42	48.57	9600	168.42	0.70
1969-70	675300	155.45	45.91	3300	57.89	0.22
1970-71	619700	142.66	40.67	1700	29.82	0.11
1971-72	666000	153.31	39.07	1100	19.30	0.06
1972-73	658900	151.68	37.40	3800	66.67	0.22
1973-74	600700	138.28	34.67	1500	26.32	0.09
1974-75	571900	131.65	33.63	8600	150.88	0.51
1975-76	610200	140.47	32.19	1200	21.05	0.06
Linear Growth Rate	-	1.8	-	-	1.6	-

Appendix Table 4.17

Cropwise Irrigated Area in Madhya Pradesh (1950-51 to 1975-76)

(For Index Base year 1952-53=100)

	Wheat			Barley		
	Irrigated Area(Hect)	Index	Percentage to Gross Iri. Area	Irrigated Area(Hect)	Index	Percentage to Gross Irrig Area
1950-51	119000	78.70	13.14	52200	92.55	5.77
1951-52	115600	76.46	14.13	55300	98.05	6.76
1952-53	151200	100.00	18.33	56400	100.00	6.84
1953-54	135200	8942	16.01	45000	79.79	5.33
1954-55	166200	109.92	19.46	48700	86.35	5.70
1955-56	180400	119.31	21.55	46300	82.09	5.53
1956-57	164000	108.46	19.55	44700	79.25	5.33
1957-58	165300	106.33	16.54	43200	76.60	4.32
1958-59	185100	122.42	21.83	44200	78.37	5.21
1969-60	195700	129.43	20.78	44300	78.55	4.70
1960-61	191200	126.45	20.38	43800	77.66	4.67
1961-62	202700	134706	21.13	42400	75.18	4.42
1962-63	192100	127.05	18.54	43800	77.66	4.23
1963-64	230300	152.31	21.84	46900	83.16	4.45
1964-65	240800	159.26	21.92	43400	76.95	3.95
1965-66	204800	135.45	20.48	45400	80.50	4.54
1966-67	220800	146.03	19.83	53600	95.04	4.81
1967-68	281800	186.37	24.24	57600	102.13	4.96
1968-69	340300	225.07	24.96	51500	91.31	3.78
1969-70	420300	277.98	28.57	49800	88.30	3.38
1970-71	520500	344.25	34.16	43200	76.60	2.84
1971-72	652300	431.42	38.27	41100	72.87	2.41
1972-73	687100	454.43	39.00	46900	83.16	2.66
1973-74	674600	446.16	38.94	54100	95.92	3.12
1974-75	613200	405.56	36.06	69700	123.58	4.10
1975-76	789900	522.42	41.67	62900	111.52	3.32
Linear Growth Rate	-	15.7	-	-	0.5	-

Appendix Table 4.18

Cropwise Irrigated Area in Madhya Pradesh
(1950-51 to 1975-76)

(For Index Base Year 1952-53=100)

	Gram			Total Pulses		
	Irrigated Area(Hect)	Index	Percentage to Gross Irrig.Area	Irrigated Area(Hect)	Index	Percentage to Gross Irrig.Area
1950-51	29400	77.98	3.25	41000	79.92	4.53
1951-52	34100	90.45	4.17	45900	89.47	5.61
1952-53	37700	100.00	4.57	51300	100.00	6.22
1953-54	29100	77.19	3.45	42800	83.43	5.07
1954-55	38300	101.59	4.48	51100	99.61	5.98
1955-56	35500	94.16	4.24	48400	94.35	5.78
1956-57	27800	73.74	3.31	39800	77.58	4.74
1957-58	33600	89.12	3.36	45900	89.47	4.59
1958-59	35000	92.84	4.13	48100	93.76	5.67
1959-60	40900	108.49	4.34	54000	105.26	5.73
1960-61	36200	96.02	3.86	48300	94.15	5.15
1961-62	41900	111.14	4.37	54900	107.02	5.72
1962-63	33800	89.66	3.26	46400	90.45	4.48
1963-64	50000	132.63	4.74	63900	124.56	6.06
1964-65	57400	152.25	5.22	72900	142.10	6.64
1965-66	55000	145.89	5.50	70300	137.04	7.03
1966-67	67800	179.84	6.09	36900	71.93	3.31
1967-68	65300	173.21	5.62	84400	164.52	7.26
1968-69	77300	205.04	5.67	96300	187.72	7.06
1969-70	84100	223.08	5.72	104500	203.70	7.10
1970-71	97500	258.62	6.40	116400	226.90	7.64
1971-72	97500	258.62	5.72	115300	224.76	6.76
1972-73	116600	309.28	6.62	136400	265.88	7.74
1973-74	116400	308.75	6.72	138700	270.37	8.01
1974-75	117800	312.47	6.93	140400	273.68	8.26
1975-76	130700	346.68	6.89	151200	294.74	7.98
Linear Growth Rate	-	10.5	-	-	8.3	-

Appendix Table 4.19

Cropwise Irrigated Area in Madhya Pradesh
(1950-51 to 1975-76)

(For Index Base Year 1952-53 = 100)

	Cotton			Sugarcane		
	Irrigated Area(Hect)	Index	Percentage to Gross Irrig. Area	Irrigated Area(Hect)	Index	Percentage to Gross Irri. Area
1950-51	5893	128.11	0.65	32700	118.05	3.61
1951-52	3900	84.78	0.48	38800	140.07	4.74
1952-53	4600	100.00	0.56	27700	100.00	3.36
1953-54	3000	65.22	0.36	23000	83.03	2.72
1954-55	4700	102.17	0.55	26800	96.75	3.14
1955-56	4300	93.48	0.51	38600	139.35	4.61
1956-57	2300	50.00	0.27	50800	183.39	6.05
1957-58	3400	73.91	0.34	44200	159.57	4.42
1958-59	4300	93.48	0.51	32300	116.61	3.81
1969-60	4000	86.97	0.42	37800	136.46	4.01
1960-61	3800	82.61	0.40	47400	171.12	5.05
1961-62	5100	110.87	0.53	51500	185.92	5.37
1962-63	4500	97.83	0.43	51700	186.64	4.99
1963-64	5100	110.87	0.48	48400	174.73	4.59
1964-65	6300	136.96	0.57	63600	229.60	5.79
1965.66	4900	106.52	0.49	70600	254.87	7.06
1966-67	6300	136.96	0.57	38300	138.27	3.44
1967-68	5600	121.74	0.48	32900	118.77	2.83
1968-69	7300	158.70	0.54	51500	185.92	3.78
1969-70	8600	186.96	0.58	63000	227.44	4.28
1970-71	11400	247.83	0.75	57000	205.78	3.74
1971-72	11400	247.83	0.67	49000	176.89	2.87
1972-73	13400	291.30	0.76	53400	192.78	3.03
1973-74	12500	271.74	0.72	63300	228.52	3.65
1974-75	18600	404.35	1.09	76700	276.89	4.51
1975-76	17200	373.91	0.91	73400	264.98	3.87
Linear Growth Rate -		10.2	-	-	5.3	-

Appendix Table 4.20

Cropwise Irrigated Area in Madhya Pradesh
(1950-51 to 1975-76)

(For Index Base year 1952-53=100)

	All Food Crops			All Nonfood crops		
	Irrigated Area(Hect)	Index	Percentage to Gross Irri.Area	Irrigated Area(Hect)	Index	Percentage to Gross Irri.Area
1950-51	857100	108.08	94.67	48300	150.94	5.33
1951-52	791500	99.81	96.75	26600	83.13	3.25
1952-53	793000	100.00	96.12	32000	100.00	3.88
1953-54	827100	104.30	97.95	17300	54.06	2.05
1954-55	834700	105.26	97.72	19500	60.94	2.28
1955-56	819300	103.32	97.87	17800	55.62	2.13
1956-57	821600	103.61	97.93	17400	54.38	2.07
1957-58	979000	123.46	97.94	20600	64.37	2.06
1958-59	822900	103.77	97.04	25100	78.44	2.96
1959-60	912900	115.12	96.92	29000	90.62	3.08
1960-61	909100	114.64	96.88	29300	91.56	3.12
1961-62	931000	117.40	97.04	28400	88 .75	2.96
1962-63	1013800	127.84	97.86	22200	69.37	2.14
1963-64	1030900	130.00	97.75	23700	74.06	2.25
1964-65	1074000	135.44	97.76	24600	76.87	2.24
1965-66	978600	123.40	97.85	21500	67.19	2.15
1966-67	1089800	137.43	97.89	23500	73.44	2.11
1967-68	1135100	143.14	97.65	27300	85.31	2.35
1968-69	1326000	167.21	97.27	37200	116.25	2.73
1969-70	1426200	179.85	96.96	44700	139.69	3.04
1970-71	1468200	185.15	96.35	55600	173.75	3.65
1971-72	1631600	205.75	95.72	72800	227.50	4.27
1972-73	1695600	213.82	96.24	66200	206.88	3.76
1973-74	1683600	208.52	95.45	78900	246.56	4.55
1974-75	1605500	202.46	94.40	95200	297.50	5.60
1975-76	1814600	228.83	95.72	81200	253.75	4.28
Linear Growth Rate	-	5.0	-	-	6.7	-