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CHANGING TRENDS IN WATER AVAILABILITY AND USING IRRIGATION TECHNIQUES, WITH SPECIAL REFERENCE TO MAHOBA DISTRICT (U.P.)

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I. ABSTRACT

Water is an essential resource in the agriculture sector. However, the changing trends in water availability and use of irrigation techniques have already been studied. The first objective of the study is to analyze the availability of water in the study area using water from the dams and the usable water potential of the ponds. The second objective is then to study the changing scenario of irrigation water use so as to suggest better modern methods and techniques of irrigation for water use in the event of water scarcity. The water availability is calculated by secondary source from the executive engineer of dams and ponds, the changing trends are analyzed by primary field survey in four blocks divided by the government. The main reasons for the low water availability in the study area are low rainfall, hard land of Bundelkhand plateau and mismanagement of water resources etc. Mahoba district is located in a drought prone area. Therefore, in this research paper, an attempt has also been made to analyze the changing scenario of water availability and use of water source for irrigation, which is related to water conservation and policy by the government to improve agricultural production and convert barren land into cultivable land. It is helpful in suggesting modern techniques for construction.

Keywords: Resource, Availability, Utilization, Mismanagement, Mahoba district, Irrigation, Conservation.

II. INTRODUCTION

Water is a valuable natural resource on earth which is the basis of irrigation in agriculture. The production of food and fodder depends on the availability of water in any given area. Water availability is the total amount of usable water without any hindrance to the ecosystem. Mahoba district is located in the water scarce areas of Bundelkhand region of central India.

Naturally, the availability of water in the study area is less but now the availability of water is getting less than before for few years. The main reason for less water availability is less rainfall and the land surface is covered with hard rock, due to which the process of seepage of rain water is slow, so rain water flows through surface runoff and some evaporates due to strong sunlight. Due to human activities like mismanagement of water resources, mining, urbanization, lack of awareness, irrigation techniques inappropriate according to geographical conditions, it is now becoming more imbalanced. Due to less availability of water, the land is becoming unusable without proper irrigation.

Mainly seven rivers are flows in the Mahoba district which are Dhasan, Urmil, Chandrawali, Verma, Arjun, Sih and Shyam; all these are flows in monsoon or rainfed and in summer season their water is decreases or dried up. This study area is irrigated by mainly Urmil dam, Majhgawan dam, Kabrai dam, Arjun dam and also there are many ponds in the study area. Due to these facilities in this area people faces the problem of water scarcity. Irrigation is the backbone of agricultural production. It is the process of watering the soil and seeds as supplements to make plants from seeds. Agriculture in the study area mainly depends on monsoon as a source of irrigation. But the landscape of water sources for irrigation is changing. Nowadays, the use of tube wells for irrigation is in vogue.

If we look at the data of the last 20 years, there has been a significant reduction in irrigated deprived areas but a large part of the study area is still without irrigation facilities. Therefore, due to less irrigation, the fertility of the land decreases. If we look at the example of Punjab, it is one of the largest producers of rice in our country, but according to its geographical conditions and land type, it is not suitable for paddy cultivation, yet it is adapted to the latest irrigation facilities and it is possible only through the network of canals. Along with this, the problem of water scarcity can also be solved by adopting modern irrigation techniques according to the water availability areas in the study area.

III. AIMS AND OBJECTIVES

- To analysis the changing trends in water availability in the study region.
- To analysis the changing scenario of water sources for irrigation.
- To suggest better modern irrigation techniques.

IV. RESEARCH METHODOLOGY AND DATABASE

This study is based on both primary and secondary data. Primary data was collected by conducting a household survey at the village level. Respondents delivered a well-structured schedule to understand changing scenario of water source for irrigation in the study region. Secondary data will be collected from a variety of sources, executive engineer of dams and ponds, various websites, including the district census handbook and town and village directories.

Selection of sample villages and households by simple random sampling for try to cover the whole area of the study region. The district is divided on the basis of block divisions by government. For analysis of the data tabulation method, different types of statistics will be used, like average, percentage, etc. and cartographic tools like maps, tables, diagrams, etc. will be used to represent the data.

V. STUDY REGION

The study area (Mahoba district) extends from 25°01'30" to 25°39'40" North latitude and from 79°15'00" to 80°10'30" East longitude. Its area is 3144 sq km. It has an average elevation of 214 metres (702 feet). According to the 2011 census, 8,75,958 people live in it. The area under study is located in the south-western part of the state of Uttar Pradesh. To its north is Hamirpur district, Madhya Pradesh to the south are the districts of Banda and Jhansi in the east and west respectively.

The district is administratively divided into 3 tehsils, namely Mahoba, Charkhari and Kulpahar. For implementation and monitoring for various developmental plans, the district is divided into 4 development blocks: Kabrai, Charkhari, Jaitpur and Panwari. The rural area is spread over an area of 3116.1 sq.km. and the urban area records 27.9 sq km. There are 247gram panchayats and 521 revenue villages in the entire study area, which includes 435 inhabited villages and 86 uninhabited villages.

Mahoba district topography is the hard rock surface due to this rainwater percolation process is very slow and not getting enough ground water recharge. The Aznar hill is the highest peak of the study area, its elevation from msl is 500 feet, which is located in Jaitpur block. The area under forest cover is 162 sq. km. and mainly seven rivers flow the area are Dhasan, Urmil, Chandrawali, Verma, Arjun, Sih and Shyam.

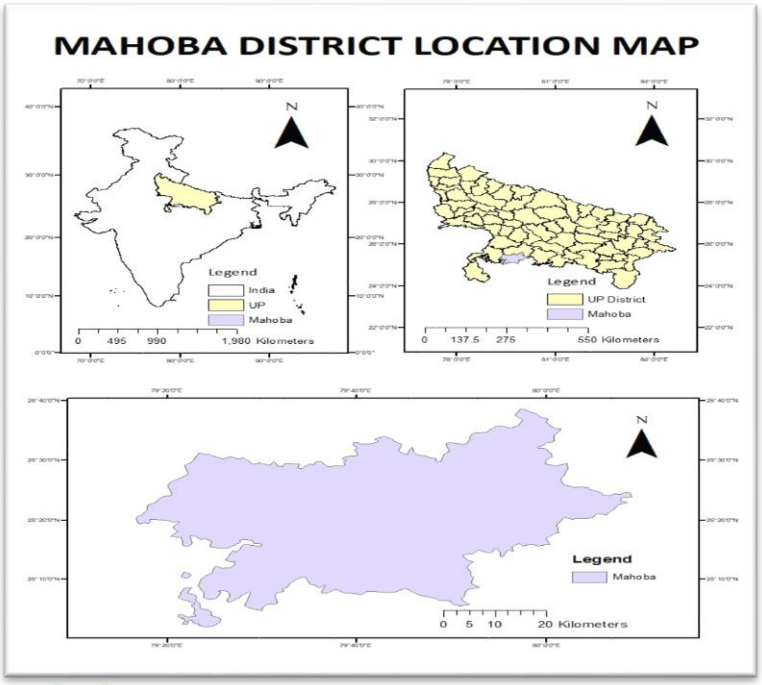

Figure 5.1: Map of Study Area

VI. CHANGING TRENDS IN WATER AVAILABILITY

Water availability is low in the study area and seasonal fluctuations are commonly observed. The main sources of water availability are rivers and ponds. Irrigation is done through a canal network from dams on the rivers flowing in and out of the district. There are mainly five dams which contribute maximum to the irrigation in the study area, namely Urmil Dam, Majhgawan Dam, Kabrai Dam, Arjun Dam, Chandrawal Dam and other dams as well. The changing trends of irrigation by major dams in the study region is following:

Table 6.1: Usable water availability for irrigation by major Dams

Usable water availability for irrigation by major Dams in the study region (in Hectares)							
Dams & Years	**Urmil Dam**	**Majhgwan Dam**	**Kabrai Dam**	**Arjun Dam**	**Chandrawal Dam**	**Other dams**	**Total**
1998	5256	7513	4520	23244	6852	29027	78410
1999	5067	6075	4375	12693	4650	22264	57123
2000	3536	4887	1531	9630	4481	16946	43011
2001	4995	7587	321	17416	5096	22714	58129
2002	5541	6741	341	4088	1114	11816	29641
2003	6001	7724	3939	16779	6773	30990	72206
2004	5512	5652	388	9684	3501	11105	35842
2005	5512	3101	1714	6239	5433	7838	29837
2006	5011	4265	301	9570	4171	5875	29193
2007	349	330	288	895	821	439	3122
2008	5425	6510	1181	7487	2753	14853	38209
2009	3301	3528	162	1256	802	6428	15477
2010	2359	702	159	4581	1664	5041	14506
2011	4623	4796	4908	11940	2151	12381	43769
2012	2825	1952	750	11480	5788	10508	34303
2013	5380	7625	2947	15434	6292	20486	58164
2014	3202	3428	168	1156	802	6328	15084
2015	2725	1852	650	11180	5688	10108	32203
2016	4523	4696	4808	10940	2051	11381	38399

2017	2459	602	659	4481	1564	5241	15006
Source: Details of dam and pond, executive engineer, sichai prakhand, district Mahoba							

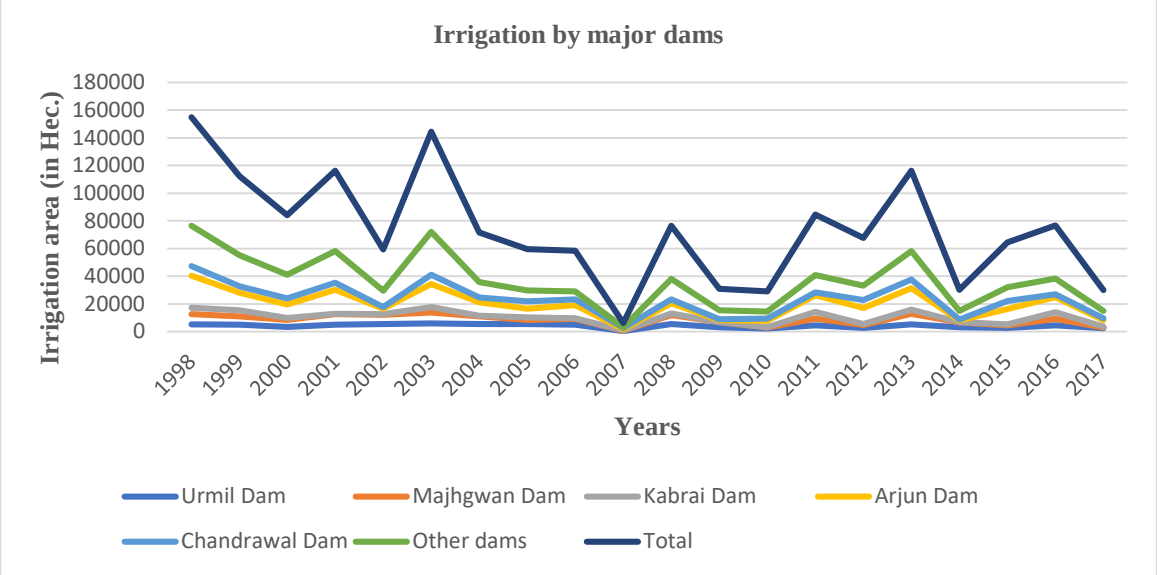

Figure 6.1: Irrigation by major dams

After analyses this data we can see that many fluctuations and variations can be observed. In 1998 these dams irrigated about 78,410 hectares land in the study area, which is highest water availability year in two decades. Lowest water availability is the year 2007 in which only 3122 hectares land was irrigated by these dams. As per 2015 data, these dams irrigate only 15006 hectares of land and we can see that water irrigation potential of these dams has reduced by 50-80 percent.

Arjun Dam, located in Charkari block of Mahoba district, contributes the most for irrigation in the study area. In 1998, it irrigated 23244 hectares of land but in 2017 it irrigated only 4481 hectares which is only 19.2 percent of the 1998 capacity. In these two decades the contribution of Urmil Dam has come down by 50 per cent. The maximum loss in the capacity of Majhgawan dam has been 90 percent in 1998 to 2017. The condition of contribution of Kabrai dam is very poor, every other year the irrigation contribution has been observed to be negligible as compared to the situation in 1998. In 1998, 6852 hectares of land was irrigated by the Chandrawal dam but in 2017 it came down to 1564 hectares. Also, in 1998 the contribution of other dams was 29027 hectares of land but in 2017 their contribution came down to 5241 hectares which has seen a decline of 82 percent.

The other main source of water availability in the study area is ponds. There are many big ponds namely, Bela Sagar Pond, Raipura pond, Solarpur pond, Madan Sagar Pond, Kirat Sagar pond, Vijay Sagar Pond etc. which holds a large amount of water. The changing trends of total usable water capacity of ponds of the study area is following:

Table 6.2: Total usable water capacity of ponds

Total useable Water Capacity of Ponds (in MCM)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	Belasagar	**Kulpahar**	**Kamalpura**	**Pawa**	**Bilkhi**	**Urwara**	**Tikamau**	**Badibandhi**	**Chhatarwara**	**Raipura**	**Salarpur**	**Madan sagar**	**Kirat sagar**	**Kalyan sagar**	**Dashrapur**	**Vijay sagar**	**Raheliya**	**Thana**	**Total**
1998	15.02	1.09	1.48	0.19	0.06	0.79	0.27	0.35	0.25	4.34	3.98	2.49	1.70	0.33	1.69	2.76	0.18	1.60	38.57
1999	21.25	2.77	4.98	1.01	0.52	1.75	0.27	0.56	0.28	3.63	4.02	2.70	1.70	0.42	1.60	2.96	0.50	1.60	52.52
2000	16.66	1.32	2.30	0.31	0.09	1.34	0.16	0.56	0.22	4.23	2.94	1.95	1.12	0.34	1.80	3.81	0.24	0.90	40.29
2001	20.92	2.77	4.90	0.99	0.42	1.05	0.15	0.24	0.30	4.88	1.51	1.89	1.70	0.39	1.57	2.06	0.26	0.38	46.38
2002	7.84	0.93	0.55	0.12	0.03	0.87	0.15	0.08	-	0.51	1.76	2.42	-	0.35	0.56	0.37	-	-	16.54
2003	21.25	2.77	4.98	1.01	0.52	1.74	0.34	0.90	0.31	6.63	4.02	2.70	1.70	0.50	1.84	5.02	0.59	2.10	58.92
2004	10.41	0.50	0.15	0.09	0.09	0.78	-	-	-	0.27	3.36	1.92	-	-	-	-	-	-	17.57
2005	3.60	0.20	0.18	-	-	-	0.27	0.19	-	2.26	2.03	1.35	-	0.13	0.98	0.81	-	0.06	12.06
2006	6.90	0.99	1.11	0.19	0.19	1.18	-	0.12	-	-	-	1.10	-	-	-	-	-	-	11.78
2007	-	-	-	-	-	0.25	0.08	-	-	-	-	-	-	-	-	-	-	-	0.33
2008	19.33	2.12	2.06	-	0.05	1.41	0.11	0.28	0.19	2.85	2.23	3.04	0.19	0.45	1.41	1.16	-	0.41	37.29
2009	8.46	0.52	0.95	-	-	-	-	-	-	1.06	1.63	1.19	-	-	-	-	-	-	13.81
2010	6.16	0.56	0.37	-	-	0.80	0.03	-	-	2.74	-	1.19	-	-	-	-	-	-	11.85
2011	9.09	0.82	0.79	0.50	0.41	1.18	0.30	0.75	-	3.83	1.45	1.72	-	0.28	1.10	0.69	0.31	0.24	23.46
2012	4.50	0.70	0.77	0.24	0.18	1.51	0.16	0.27	-	4.76	4.52	2.29	-	0.11	0.62	-	0.40	0.28	21.31
2013	19.67	2.77	4.99	0.52	0.52	1.75	0.36	0.90	0.28	7.76	4.24	3.00	1.92	0.50	1.87	3.45	0.58	0.90	55.98
2014	9.45	1.36	1.13	-	-	-	0.02	0.09	-	2.44	0.38	-	0.18	0.08	1.42	1.58	-	0.10	18.23
2015	10.41	0.50	0.15	0.09	0.09	0.78	-	-	`	0.27	3.36	1.92	-	-	-	-	-	-	17.57
2016	9.41	0.50	0.15	0.09	0.09	0.78	0.36	0.90	0.28	6.76	2.23	2.04	0.19	0.45	1.41	1.16	0.58	0.90	28.28
2017	7.09	0.32	0.59	0.50	0.41	0.68	0.30	0.75	-	2.83	1.05	1.72	-	0.28	1.10	0.69	0.31	0.24	18.86

Source: Details of dam and pond, executive engineer, sichai prakhand, district Mahoba

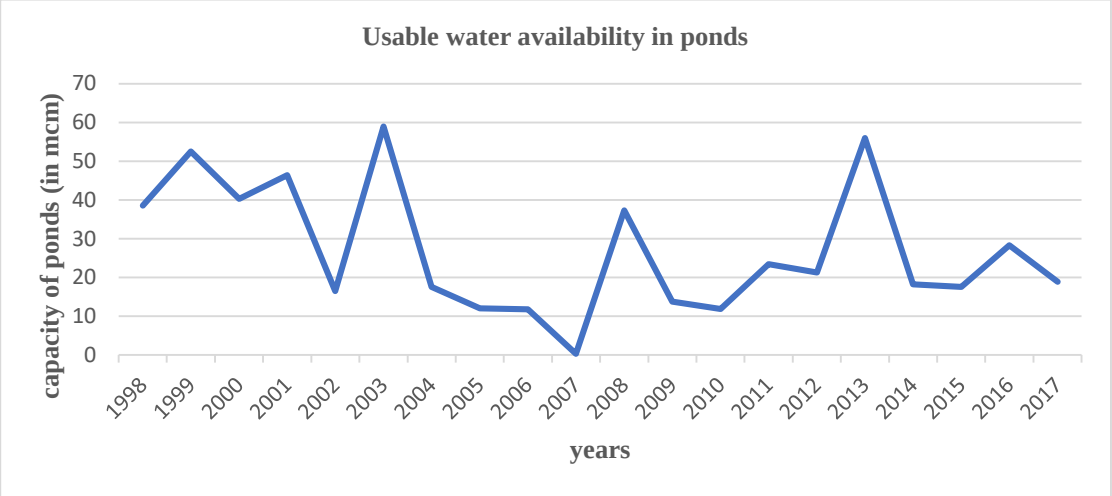

Figure 6.2: Usable water availability in the ponds

In this table we can see that in 1998, these main 18 ponds hold 38.5 mcm water but after two decades its usable water capacity came down to 18.86 mcm water. In the year 2007, almost all the ponds had dried up, only the Urwara talab and Tikamau ponds had 0.25 mcm and 0.08 mcm of water respectively. Many fluctuations can be seen which are affected by the monsoon. The condition of ponds has been good in these 7 years during 1998-2001, 2003, 2008, 2013.

Bela Sagar pond is the biggest pond in the study region which holds 15.02 mcm water in 1998 but its water availability is decreased by 7.09 mcm water in these two decades. Chhatarwara pond, Kirat Sagar pond and Rahelia pond had faced drought situation more than 10 years in two decades. Also, Pawa, Bilkhi, Badibandhi, Kalyan Sagar, Dashrapur, Raheliya and Thana ponds had faced the drought situation more than 5 years in two decades. We can see that about 50 percent usable water availability is decreased in last 20 years.

VII. CHANGING TRENDS IN WATER SOURCE OF IRRIGATION

Irrigation is the artificial application of water to the soil through various processes. Irrigation is done in those areas where rainfall is not regular or inappropriate for cultivation. Our study region is located in water deficit area. Due to advancement of technology water source of irrigation is changes with time according their local people as shown in following table:

Table 7.1: Trends of Major Sources of Irrigation

Trends of Major Sources of Irrigation (In Percent)										
	Wells	**Tube Wells**	**Ponds**	**Rivers**	**Canals**	**Dams**	**Others**	**Nil**	**Total**	
Charkari	20	10	5	4	25	0	3	33	100	**0-5 years ago**
Jaitpur	52	5	4	3	8	0	5	23	100	
Kabrai	28	7	4	8	10	2	3	38	100	
Panwari	25	13	1	5	23	0	4	29	100	
Study Area	**31.25**	**8.75**	**3.5**	**5**	**16.5**	**0.5**	**3.75**	**30.75**	**100**	
Charkari	14	4	4	4	26	1	3	44	100	**5-10 years ago**
Jaitpur	42	0	4	8	11	0	5	30	100	
Kabrai	22	3	3	12	17	6	6	31	100	
Panwari	18	8	1	11	35	0	5	22	100	
Study Area	**24**	**3.75**	**3**	**8.75**	**22.25**	**1.75**	**4.75**	**31.75**	**100**	
Charkari	10	0	3	6	35	1	4	41	100	**10-15 years**
Jaitpur	28	0	4	8	12	0	7	41	100	
Kabrai	18	0	3	18	14	7	5	35	100	
Panwari	12	2	1	4	42	0	5	34	100	

Study Area	**17**	**0.5**	**2.75**	**9**	**25.75**	**2**	**5.25**	**37.75**	**100**	
Charkari	7	0	2	17	24	1	5	44	100	**15-20 years ago**
Jaitpur	20	0	4	1	15	0	5	55	100	
Kabrai	12	0	1	6	28	2	3	48	100	
Panwari	8	0	0	1	46	0	2	43	100	
Study Area	**11.75**	**0**	**1.75**	**6.25**	**28.25**	**0.75**	**3.75**	**47.5**	**100**	
Source: Personal field survey,2023										

If we talk about the response of the local people and farmers of Mahoba district, then the scenario of irrigation water source has changed as we have seen from the above table. About 20 years ago 11.75 percent people used to irrigate their fields from wells but now 31.25 percent people use this water source for irrigation. Before two decades no people used tube wells as source of irrigation but now 8.75 percent people use this source, it seems that there has been some development and awareness about advanced techniques in these two decades. Rivers as a source of irrigation have not seen so many changes. According to the perception of the people, the use of canals and dams as a source of irrigation is already being reduced. Also, we can see that the number of people who were not able to use any source of irrigation is decreasing. The people of Charkari, Jaitpur and Panwari blocks do not use dam water for irrigation and maximum development of wells and tube wells has been observed in Panwari and Kabrai blocks.

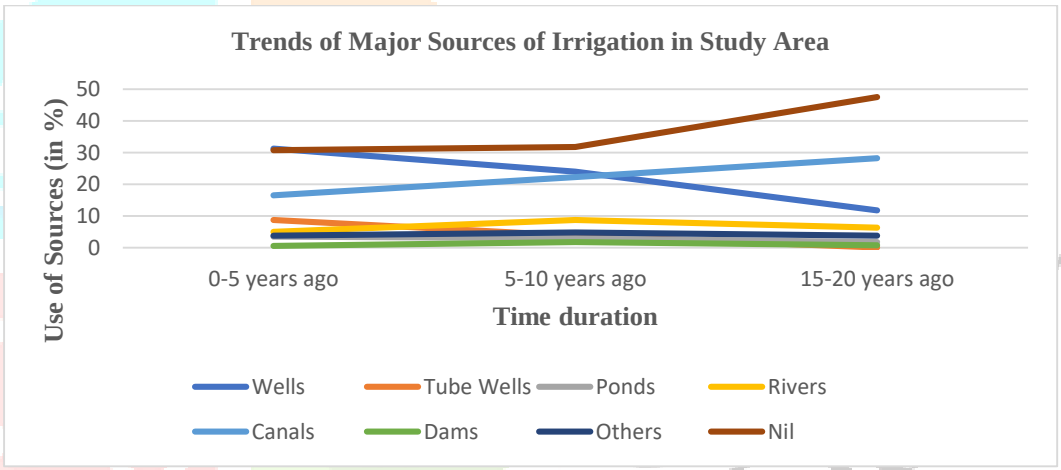

Figure 7.1: Trends of Major Sources of Irrigation in Study Area

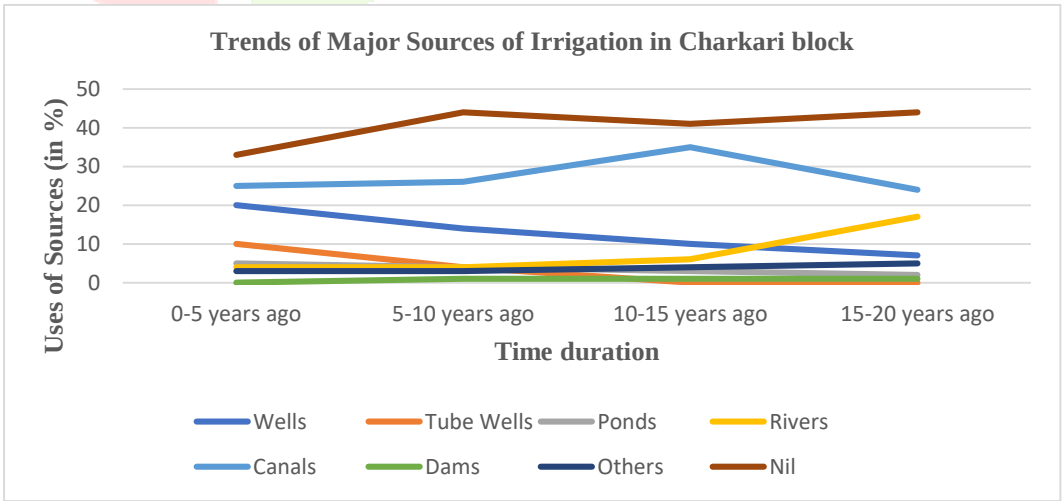

Figure 7.2: Trends of Major Sources of Irrigation in Charkari block

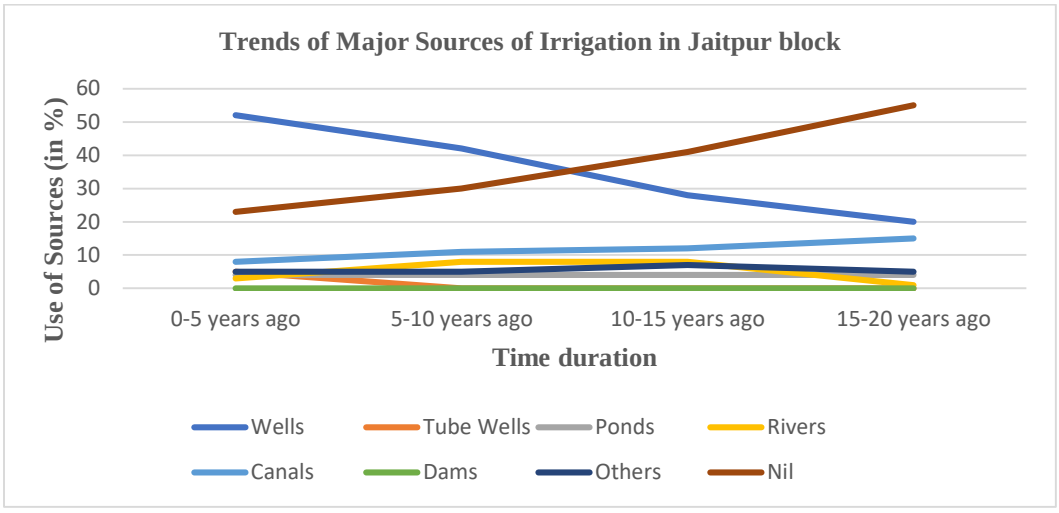

Figure 7.3: Trends of Major Sources of Irrigation in Jaitpur block

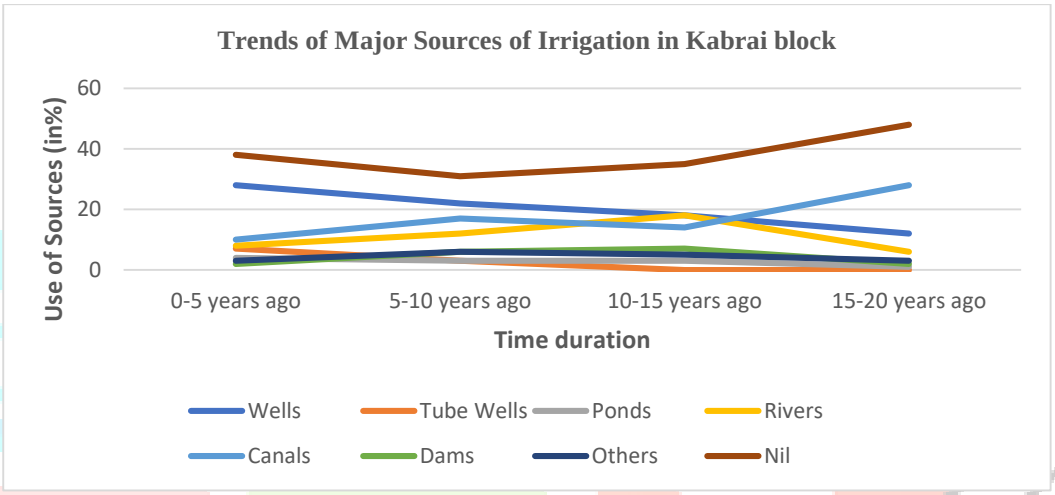

Figure 7.4: Trends of Major Sources of Irrigation in Kabrai block

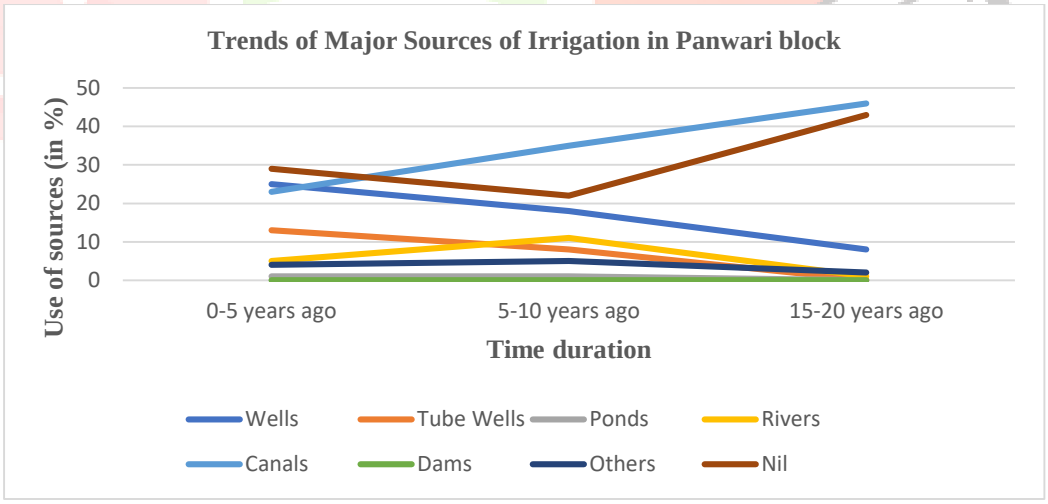

Figure 7.5: Trends of Major Sources of Irrigation in Panwari block

VIII. MODERN IRRIGATION TECHNIQUES IN AGRICULTURE

As we know our study area is location in drought prone region of Bundelkhand. So due to water deficiency people should use modern irrigation techniques for water conservation and management so that they can capable for more agriculture production in low water availability situation.

Drip irrigation technique in which water is given to roots of plants by dripping by pipe network which are above or buried below to surface. It is the modern process which has potential to save water and time. It is also helpful to stop soil erosion which occurs during traditional methods of irrigation.

Pitcher irrigation technique in which a clay pot is laid below surface near roots of plant up to neck and filled with water than its mouth is covered with stone to stop evaporation, water hygiene and maintain percolation rate. In this process we take percolated clay pot or we pierce it so that keep plant roots getting enough water quantity.

Khet Talab technique which was launched by U.P. government in 2013 for small farmers who was not capable to occupied the expenditure of Tube Wells etc. In this technique two type of ponds are dug. Small pond of 22×20×3 meters and big pond of 35×30×3 meters. Its purpose is to collect rainwater in this pond which can be used for irrigation in dry days.

Sand dams is a traditional technique in which a little sand dam is made in any small channel or stream. This dam is about 80-100 meters in length and 3-4 meters high. In this process channel water is diverted in fields for irrigation. It is also helpful because in this a huge amount of water is stored in it which can be used for irrigation in dry season.

Plastic bucket irrigation is an extraordinary technique which helps to irrigate small or recently planted trees. This process is similar to pitcher irrigation technique. All in this, a plastic bucket or container is taken then one or two penetrate small holes at one side of bucket for percolation of water to irrigate the roots of plant. It is mostly used in vegetable gardening. This technique can be processes by two types. Firstly, put the container beside the plant and secondly, a very thin pipe is connected from bucket to plant roots into the soil to pour water gradually and then gravity itself does the rest work of irrigation.

Sprinkle technique of irrigation is also called center revolve irrigation system in which a pipe network is distributed in farm and vertical sprinkle is connected with them. This technique is excellent for growth of plants because its irrigation process feels like natural rainfall. This is majorly used in water deficit region and slopped land also.

Reuse of dirty water technique is good for irrigation in agriculture sector. Huge amount of dirty water is coming out from urban areas every day. Therefore, the government bodies should implement waste water treatment on large scale so that the agriculture areas around the city can take the advantage of this treated water.

By putting **Soil Moisture Sensor,** it helps to measure the amount of water presence in the soil. Cost of these sensors are not so much high. These sensors are of two types. Firstly, stationary sensors which are placed at predetermined location in very low depth of farm whereas, secondly are portable sensors which can be used at several locations for measuring soil moisture. By taking help of these sensors, we can avoid the surplus flow of water in fields and save that water for further use.

These are the major modern strategies which can be used in water deficit area and water management and conservation. Many other processes can be adopted like by dry farming in which we grow only those crops which consume less water, by changing food habits and reduce food wastage etc.

IX. CONCLUSION

Only surface water is included in the Water Availability Index. As we know that ground water is very important resource for agriculture but surface water also contributes for irrigation. Our study area Mahoba district of Bundelkhand region is a hard rocky plateau land situated near the Tropic of Cancer. The availability of water here completely depends on the monsoon rains. In this research paper, we have discussed about the trend of water availability in the dams and major ponds of the study area. We see that the area irrigated by major dams has decreased by 50-80 per cent in two decades and the Arjun Dam is the backbone of the water supply in the study area. Secondly, we have observed here the condition of major ponds in the study area, we have observed significant fluctuations in the usable water potential of the ponds every year. In 2007, almost all the ponds had dried up. After analyzing the data, we observed that in five years only one year availability is sufficient for use and these ponds suffer from water scarcity condition, almost half of the water availability has been reduced in two decades.

Then, we discussed about the changing scenario of the major source of irrigation in two decades. Here we have seen that nowadays people mainly use tube wells and wells and by using these advanced facilities they get good production but still about 31 percent people do not use any source of irrigation, they do dry farming which is completely dependent on rainfall. To solve these problems, we try to suggest some modern techniques like sand dams, plastic bucket, sprinkle system, pitcher method, khet talab, drip irrigation and reuse

of dirty water etc. so that it become helpful into improve agriculture production, water conservation and management in this water deficit region.

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