

Changing Pattern of Irrigation Intensity in Haryana: A Geographical Analysis

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Abstract

Irrigation has been a central feature of agriculture for some 5,000 years and is a product of many cultures. The process of irrigation helps with the production of crops. Haryana is an agriculturally developed state and the second largest contributor of food grains in India. Irrigation plays a vital role in Haryana's agricultural development because the state is largely dependent on irrigational facilities as Haryana has no permanent and perennial river system like Punjab. However, the fertile plains of Haryana provide a sound base for agricultural development. Haryana constitutes about 1.4% of India's total geographical area yet contributes 15% of its agricultural produce, which has grown seven times since the formation of Haryana in 1966. About 86% of the area in the state is arable, and of that, 96% is cultivated. Its irrigation intensity has seen changes over the years, especially after the Green Revolution, due to the presence of canals and other sources, including tube wells. This increasing irrigation intensity is due to certain factors, which need to be highlighted. Therefore, the major objective of the present study is to analyse the patterns of irrigation intensity in Haryana between the time periods of 2004–2005 and 2019–2020, with the district as the unit of study. It also aims to highlight the factors responsible for the change in irrigation intensity.

Keywords: Changing Pattern, Irrigation Intensity, Agricultural Development, Canals and Tube Wells

INTRODUCTION

Since man has started to live in a civilised society, agriculture has been the primary activity. For the

agricultural development of any region, irrigation plays an important role and is an indispensable requirement for agricultural production. It is so because the present-day modernised agricultural pattern requires more water for irrigation. Irrigation is essentially the artificial process of applying water to land to assist in production of crops. It is a protective measure to supplement rainfall and precaution against the failure of crops, and thus, is practiced in various parts of the world. Sakila Haque (2015), attempted to make a comparative study of percentage of area under groundwater irrigation in Murshidabad district of West Bengal. The study revealed that with an increase in irrigation, groundwater abstraction has become very high, resulting in groundwater depletion.

Cultivation of any crop is dependent on the availability of water, and this water comes from groundwater (extracted from springs or by using wells or tube wells), from surface water (withdrawn from rivers, lakes or reservoirs) or from non-conventional sources like treated wastewater, desalinated water, drainage water or fog collection. Earlier, agriculture directly relied on rainfall, and people grew only those crops that were naturally suited to their lands and followed a multiple cropping pattern.

In India, an increasing population coupled with a shortage of food production, created famine-like conditions in the early 1960s. Thus, the Green Revolution was introduced first in Punjab and Haryana in 1966. It required intensive agriculture, use of fertilisers and HYV seeds and the expansion of tube well, canal well irrigated area. All this brought a quantum jump in food production in Punjab and Haryana, though the revolution came with its own set of disadvantages, such as, it led to soil, underground water and land degradation. Aggarwal and Moudgill (2015), concluded that cropping intensity, irrigation intensity

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and crop yield and density of tractors had increased since Green Revolution but contribution of agriculture to Haryana's GDP had declined over the years. However, subsequently, farmers started practising a water-intensive monocropping pattern, leaving behind the traditional multiple rain-fed cropping pattern.

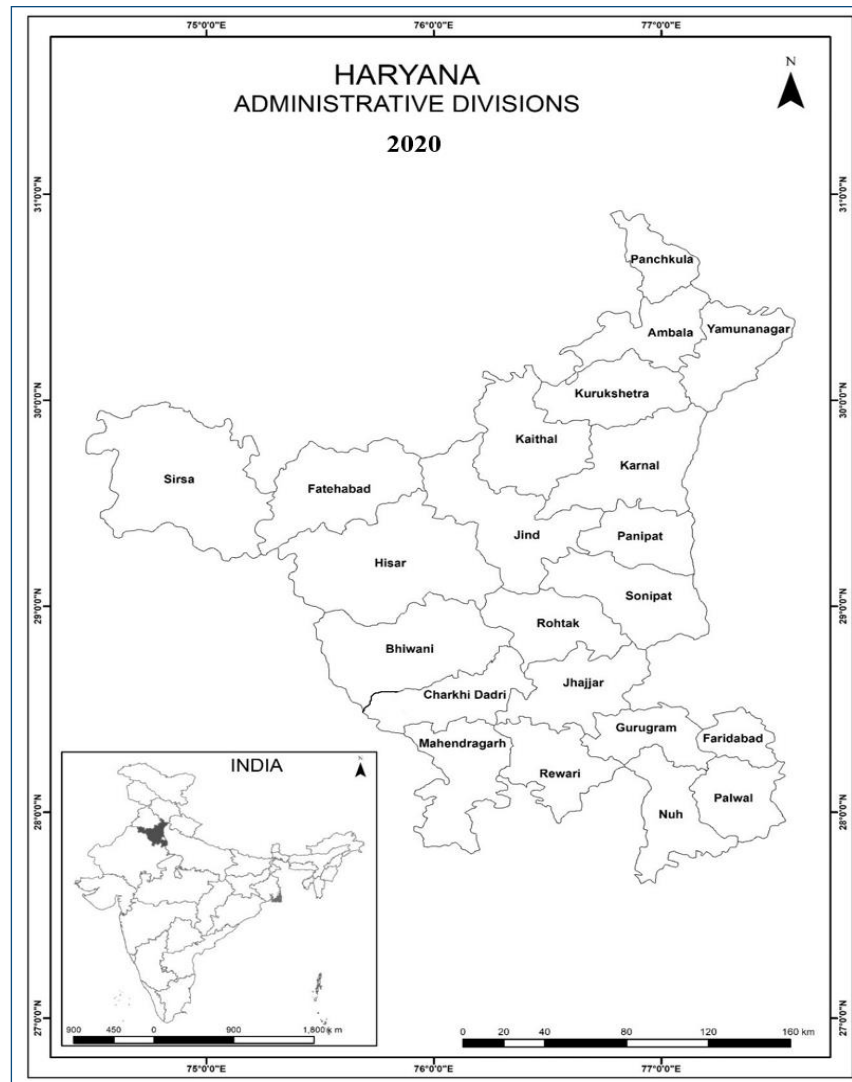
As stated earlier, irrigation, simply refers to the artificial way of providing water to plants. Irrigation is an important non-physical input in modern agriculture, as crop production in an area largely depends on existing irrigation facilities. In a state like Haryana, where rainfall is both inadequate and irregular, it has an adverse effect on agricultural productivity. In view of the spatial variation in its distribution and uncertainty of monsoons, agriculture has become highly dependable on artificial supply of water. Thus, irrigation affects the level of agricultural production. Irrigation intensity is chief parameter for measuring agricultural patterns and level of development in a region. Vanita Ahlawat and Renu (2016), studied regional disparity in cropping intensity and their relative impact of irrigation in Haryana. The study revealed that enhanced cropping intensity is possible with improved irrigational facilities. The irrigation ratio has moderate level positive impact on cropping intensity as supported by the results in the study. The term irrigation intensity here refers to percent of Gross Irrigated Area to Gross Cropped Area. Irrigation intensity of an agricultural field means that percentage of irrigation proposed to be irrigated annually. It helps in finding whether the available irrigation facilities are sufficient or deficient to meet the irrigation requirements of the agricultural area. On the basis of available irrigation sources, projects can be made for the future development of irrigation. This monocropping pattern required assured irrigational development. Haryana, among the selected site for green revolution, saw huge changes since the revolution. Gross Cropped Area and Gross Irrigated Area has increased since then. Deshmukh and Tanaji (2017) studied cropping pattern and irrigation intensity of India. The study reveals that cropping intensity increased with increasing of

effective irrigation potential. Increased cropping intensity had higher irrigation intensity, and similarly irrigation being an important input in agricultural development and production, its study is of great significance in the field of agricultural studies. The irrigation intensity of an agricultural field means the percentage of irrigation proposed to be irrigated annually.

The study would be helpful in knowing the factors responsible for change in irrigation intensity. Kamble and Mane (2019), studied the sources and methods of irrigation in Malshiras tehsil of Solapur district. Their analysis revealed that there is a spatial variation in economics of canal, well and lift irrigation. It showed that the spatial distribution is highly uneven throughout Malshiras tehsil ranging from 25.95 to 86.53%. Most studies showed the linkage between higher cropping intensity leading to higher irrigation intensity. Though different sources of irrigation were not mentioned, most of the studies mentioned cropping intensity and crop production as its responsible factors but did not mention the government schemes provided. The present study is an attempt to analyse the district-wise changing irrigation intensity of Haryana from 2004 to 2020 and the factors responsible for its changing intensity. It is important to study the changing pattern of irrigation intensity in Haryana, as it could help us know the intensity at which irrigation is being used and whether the irrigational input is being used judiciously or not.

Study Area

The Haryana state of India is located in the northern part. It was carved out of the former state of East Punjab on 1 November 1966 on linguistic basis. With a total geographical area of 44,212 km², the state of Haryana is located between 27°39' N and 30°35' N latitude and between 74°28' E and 77°36' E longitude. The altitude of Haryana varies between 200 metres to 1200 metres above sea level.



Source: Official Website of Chief Minister Office, Government of Haryana.

Map 1: Administrative Divisions of Haryana

It is bounded by Rajasthan to the west and south, Himachal Pradesh to the north, the Yamuna River along its eastern border with Uttar Pradesh, and the Ghaggar-Hakra River flowing along its northern border with Punjab. The region is rich in history, monuments, heritage, flora and fauna, and human resources. Haryana is included in the economically significant National Capital Area for planning and development purposes because it borders the Nation's Capital Delhi on three sides (the north, west and south). It had 20 districts in 2005–06, but currently, it has 6 administrative divisions, 22 districts, 72 sub-divisions, 93 revenue tehsils, 50 sub-tehsils, 140 community development blocks, 154 cities and towns, 6,848 villages and 6,222 village panchayats.

The word Haryana is derived from the Sanskrit phrases Hari (the Hindu divinity Vishnu) and ayana (home), which combined mean “the Abode of God.” The Indus Valley Civilization sites at Rakhigarhi village in Hisar district and Bhirrana in Fatehabad district are 9,000 years old and are among the largest and most ancient civilisations in the world. According to the 2011 Census of India, the state has a total population of 25,3,51,462 and is the 18th most populous in the nation. In Haryana, on average there are 573 people per square km. Haryana has a 65.12% rural and 34.88% urban population. The largest city in the state by population is Faridabad, which is a part of the NCR. More than two-thirds of the state's population resides in villages, and agriculture is the primary occupation. The

Ganges and its tributaries supplied fertile alluvial lands to this state. One of the most significant rivers in the state is the Yamuna River, which also forms its eastern border. Agriculture has developed throughout the state as a result of the availability of water and rich soil. The Green Revolution had a significant impact on the state and enhanced crop and food output.

RESEARCH OBJECTIVES

- To analyse the changing pattern of irrigation intensity in Haryana from 2005–2006 to 2019–2020.
- To highlight the factors responsible for the change in irrigation intensity in Haryana.

RESEARCH METHODOLOGY

The research objectives of the present study are based on secondary data taken from the statistical abstract of Haryana between the years 2004–2005 and 2019–2020 respectively, it also included the official data from government reports, Socio-Economic Survey of Haryana District Census Handbook 2011, Census of India. District is taken as a unit of the study. To calculate the irrigating intensity, the following statistical techniques have been used:

$$\text{Irrigation Intensity} = \frac{\text{Gross Irrigated Area}}{\text{Gross cropped Area}} * 100$$

After calculating the irrigation intensity value of each district for the years 2005–2006 to 2019–20, tables have been prepared to process the data. Similarly, data has been analysed using Excel sheet and GIS-based maps have been prepared to interpret the data.

RESULT AND DISCUSSION

Irrigation, in simple terms, is the process of giving water to plants in an artificial way. A crucial non-physical input in contemporary agriculture is irrigation, which helps a region produce crops. It has an impact on the volume of agricultural produce. The main metric for assessing a region's level of development and agricultural pattern is irrigation intensity. In this context, irrigation intensity is defined as the ratio of gross irrigated area to gross cropped area. After evaluations of Haryana's irrigation intensity using districts as study units, it was discovered that overall, as shown in Table 1, the irrigation intensity of Haryana increased from 84.6 to 91.2% from 2005–2006 to 2019–2020, respectively. Fig. 1 depicts this.

Table 1: Haryana: District Wise Irrigation Intensity from 2005–2006 to 2019–2020

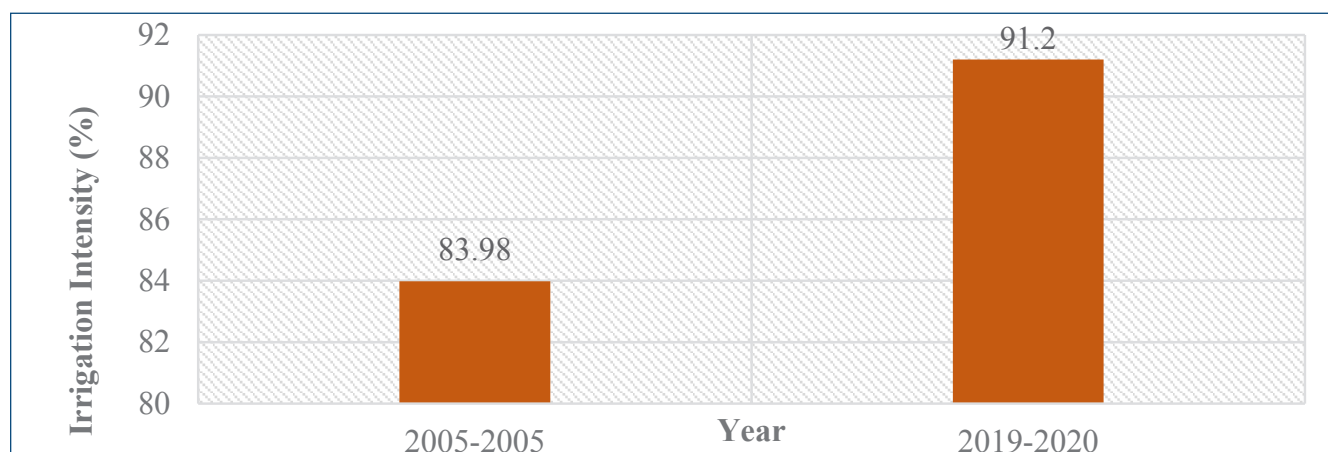
District	Gross Cropped Area (000' Hectares)		Gross Irrigated Area (000' Hectares)		Irrigation Intensity (%)		% Change in Irrigation Intensity (2005–2006 to 2019–2020)
	2005–2006	2019–2020	2005–2006	2019–2020	2005–2006	2019–2020	
Ambala	202	213	184	204	91.1	95.7	4.6
Bhiwani	814	532	430	401	52.8	75.4	22.6
Charkhi Dadri	-	221	-	175	52.8*	79.2	26.4
Faridabad	270	60	240	60	88.9	100	11.1
Fatehabad	422	432	411	425	97.4	98.4	1
Gurugram	288	104	197	104	68.4	100.0	31.6
Hisar	618	655	530	589	85.8	89.9	4.1
Jhajjar	234	254	179	234	76.5	92.1	15.6
Jind	466	472	431	470	92.5	99.6	7.1
Kaithal	377	414	376	414	99.7	100.0	0.3
Karnal	388	390	387	391	99.7	100.3	0.6
Kurukshetra	277	281	277	218	100.0	100.0	0
Mahendragarh	248	297	150	172	60.5	57.9	-2.6
Nuh	200	188	130	150	65	79.8	14.8

District	Gross Cropped Area (000' Hectares)		Gross Irrigated Area (000' Hectares)		Irrigation Intensity (%)		% Change in Irrigation Intensity (2005–2006 to 2019–2020)
	2005–2006	2019–2020	2005–2006	2019–2020	2005–2006	2019–2020	
Palwal	-	196	-	191	88.9*	97.4	8.5
Panchkula	44	46	22	31	50.0	67.4	17.4
Panipat	186	185	186	185	100.0	100.0	0
Rewari	191	199	156	133	81.7	66.8	-14.9
Rohtak	222	214	183	205	82.4	95.8	13.4
Sirsa	697	743	638	704	91.5	94.8	3.3
Sonipat	278	294	271	293	97.5	99.7	2.2
Yamunanagar	203	215	186	212	91.6	98.6	7
Total	6,625	6,605	5,564	6,024	83.98	91.2	7.22

Source: Statistical Abstracts of Haryana, 2005-06 and Statistical Abstracts of Haryana, 2020–21.

*For the better Comparative Analysis of the data Charkhi Dadri has given the same percentage of irrigation intensity as of Bhiwani (52.8) for the Year 2005-2006, as this new formed district of Charkhi Dadri was earlier a part of Bhiwani district.

*Similarly, Palwal has given the same percentage of irrigation intensity as of Faridabad (88.9) for the Year 2005-2006, as this newly formed district was earlier a part of Faridabad district.



Source: Computed from Table 1.

Fig. 1: Haryana: Irrigation Intensity (%) for the Years 2005–2006 and 2019–2020

From the above Table 1, it is clear that the gross cropped area has increased from 6,625 hectares for 2005–2006 to 6,605 hectares for the year 2019–2020. Similarly, the gross irrigated area increased from 5,564 hectares to 6,024 hectares during 2005–2006 to 2019–2020, respectively. Due to this increase in gross cropped area and gross irrigated area, the irrigation intensity has also increased; it was 83.98 % for the year 2005–2006 and increased to 91.2% for the year 2019–2020.

Regional Patterns of Irrigation Intensity for the Year 2005–2006

In Table 1, we have categorised all the districts of Haryana into three categories, that is, low, medium and high according to their irrigation intensity for the year 2005–2006:

Table 2: Haryana: Categories of District Wise Performance of Irrigation Intensity, 2005–2006

Low (0-60)	Panchkula (50), Bhiwani (52.8), Mahendragarh (60.5)
Medium (60-90)	Gurugram (68.4), Jhajjar (76.5), Rewari (81.7), Rohtak (82.4), Hisar (85.8), Faridabad (88.9), Nuh (65)
High (Above 90)	Ambala (91.1), Sirsa (91.5), Yamunanagar (91.6), Jind (92.5), Fatehabad (97.4), Sonipat (97.5), Kaithal (99.7), Karnal (99.7), Panipat (100), Kurukshetra (100)

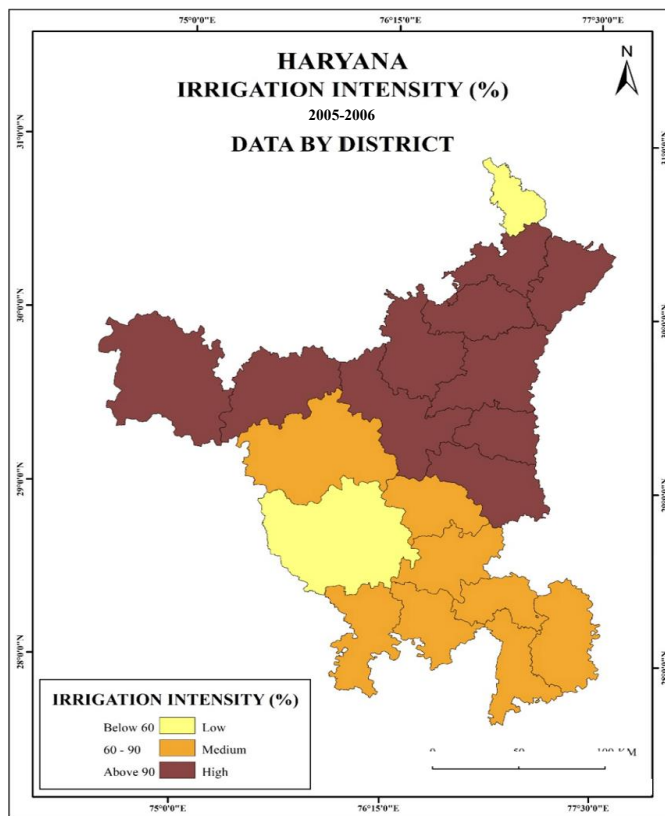
Source: Summarized from Table 1.

From the table above, districts with an irrigation intensity of ≤ 60 are categorised as having low irrigation intensity. Districts between 61 and 90 have moderate irrigation intensity, and districts having irrigation intensity above 90 have the highest irrigation intensity in state.

Districts with High Irrigation Intensity: There are only two districts with highest irrigation intensity, that is, Panipat and Kurukshetra, with 100% intensity, that is, the gross cropped area is being irrigated at its full potential, along with the districts of Ambala (91.1), Sirsa (91.5), Yamunanagar (91.6), Jind (92.5), Fatehabad (97.4), Sonipat (97.5), Kaithal (99.7) and Karnal (99.7), which also falls in the category of high irrigation intensity due to well-developed irrigation network of tube wells and canals.

Districts with Medium Irrigation Intensity: Similarly, districts of Nuh (65), Gurugram (68.4), Jhajjar (76.5), Rewari (81.7), Rohtak (82.4), Hisar (85.8) and Faridabad (88.9) falls in the medium category of irrigation intensity due to low ground water level, less developed irrigation facilities and over population.

Districts with Low Irrigation Intensity: Panchkula (50.0), Bhiwani (52.8) and Mahendragarh (60.5) are the districts with least irrigation intensity in Haryana reason because they are highly populated and developed areas with high population and less gross cropped area as shown in Table 2. The Map 2 shows pattern of irrigation intensity for the year 2005–2006.



Source: Statistical Abstracts of Haryana, 2005–2006

Map 2

Regional Patterns of Irrigation Intensity for the Year 2019–2020: In the Table 1, we have categorised the districts into three categories for the year 2005–2006. Similarly, we can categorise all the districts of Haryana

into three categories, that is, low, medium and high according to their irrigation intensity for the year 2019–2020:

Table 3: Haryana: Categories of District Wise Performance of Irrigation Intensity, 2019–2020

Low (0-60)	Mahendragarh (57.9)
Medium (60-90)	Rewari (66.8), Panchkula (67.4), Bhiwani (75.4), Charkhi Dadri (79.2), Nuh (79.8), Hisar (89.9)
High (Above 90)	Jhajjar (92.1), Sirsa (94.8), Ambala (95.7), Rohtak (95.8), Palwal (97.4), Fatehabad (98.4), Yamunanagar (98.6), Jind (99.6), Sonipat (99.7), Gurugram (100.0), Panipat (100.0), Faridabad (100.0), Kaithal (100.0), Kurukshetra (100.0), Karnal (100.3)

Source: Summarized from Table 1.

In the table above, districts having irrigation intensity of ≤ 60 are categorised as low irrigation intensity, districts between 61 and 90 have moderate irrigation intensity and districts having irrigation intensity above 90 have the highest irrigation intensity in State.

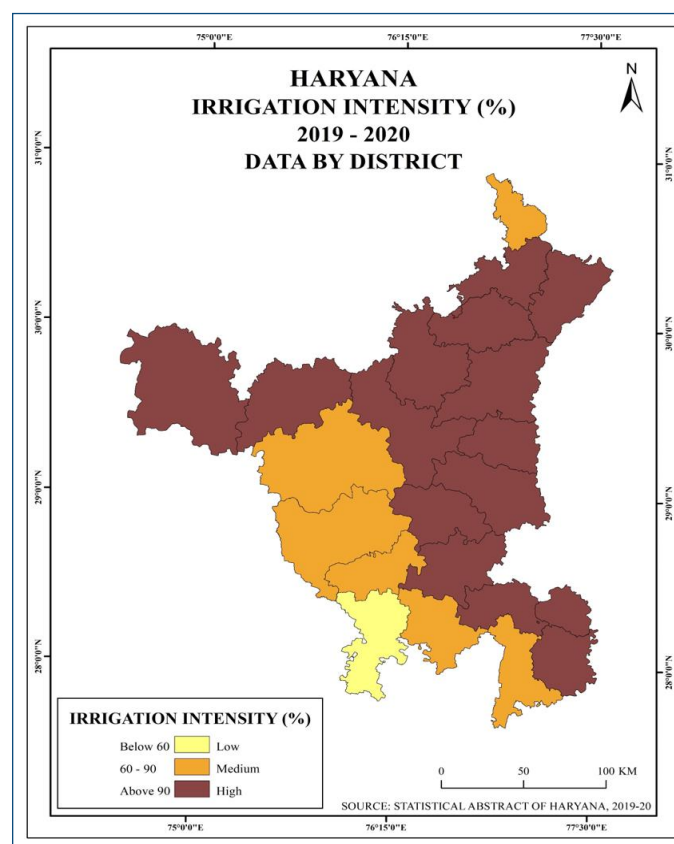
Districts with High Irrigation Intensity: The districts of Jhajjar (92.1), Sirsa (94.8), Ambala (95.7), Rohtak (95.8), Palwal (97.4), Fatehabad (98.4), Yamunanagar (98.6), Jind (99.6), Sonipat (99.7), Gurugram (100.0), Panipat (100.0), Faridabad (100.0), Kaithal (100.0), Kurukshetra (100.0) and Karnal (100.3) falls in the category of high irrigation intensity due to well-developed irrigation network of tube wells and canals and better irrigation and more gross cropped area and irrigated area as compare to before.

Districts with Medium Irrigation Intensity: Similarly districts of Rewari (66.8), Panchkula (67.4), Bhiwani (75.4), Charkhi Dadri (79.2), Nuh (79.8) and Hisar (89.9) falls in the medium category of irrigation intensity. It is due to decrease in gross irrigated area.

Districts with Low Irrigation Intensity: The irrigation intensity of Mahendragarh has decreased from 60.5 to 57.9%. The total net area under irrigation in 2005 was 121 thousand hectares which decreased to 89 thousand hectares in 2020. One thousand hectares of land is irrigated by government canal while 88 thousand hectares by tube wells.

There is a dependence on tube well irrigation. The total gross cropped area in 2005 was 248 thousand hectares which rose to 297 thousand hectares in 2020. Also the

total gross irrigated area also rose from 150 thousand hectares to 172 thousand hectares in the same period. Thus, the irrigation intensity has decreased to -2.6% and this decrease is due to the decrease in tube well irrigation. Map 3 shows the patterns of irrigation intensity for the year 2019–2020.



Source: Statistical Abstracts of Haryana, 2019–2020.

Map 3

Comparative Analysis of Total Percentage Change in Irrigation Intensity from 2005–2006 to 2019–2020

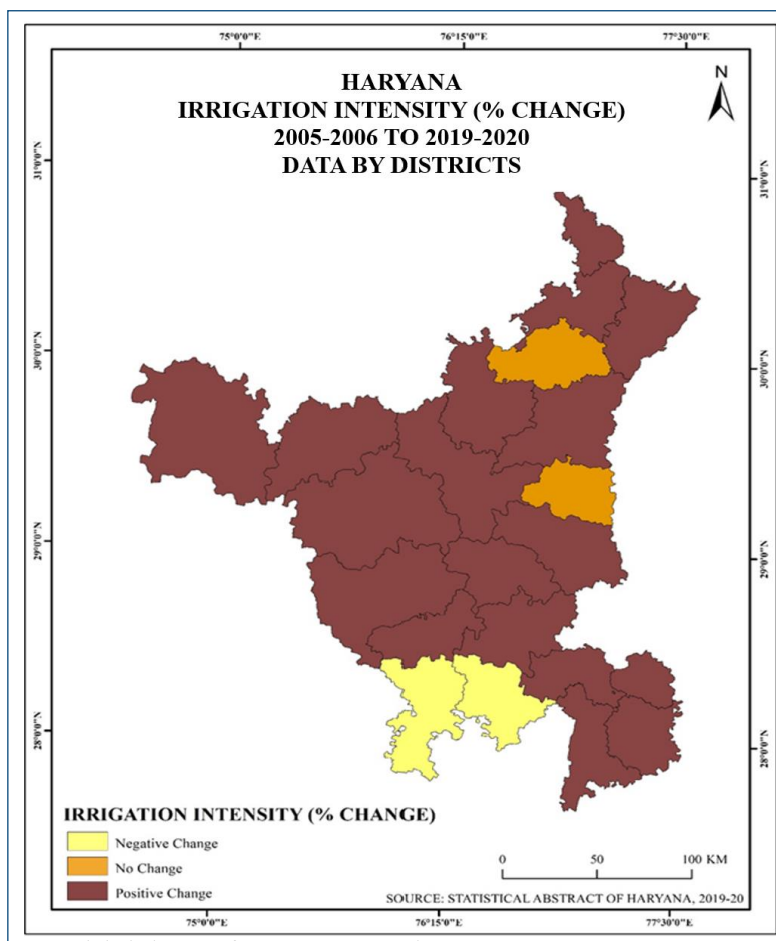
From the Table 1 it is evident that in some districts the irrigation intensity has increased from 2005–2006 to 2019–2020, for example, the districts of Gurugram, Charkhi Dadri, Bhiwani, Panchkula, Jhajjar, Nuh, Rohtak, Faridabad, Palwal, Jind, Yamunanagar, Ambala,

Hisar, Sirsa, Sonipat, Fatehabad, Karnal and Kaithal, however there are some districts where the percentage irrigation intensity has remained same like the districts of Kurukshetra and Panipat. In some other districts the percentage of irrigation intensity has decreased as compared to 2005–2006 level like in the districts of Mahendragarh and Rewari. Therefore, on the basis of this changes we categorise all the districts of Haryana into three categories as shown below in Table 4.

Table 4: Haryana: Total Percentage Change in Irrigation Intensity from 2005–2006 to 2019–2020

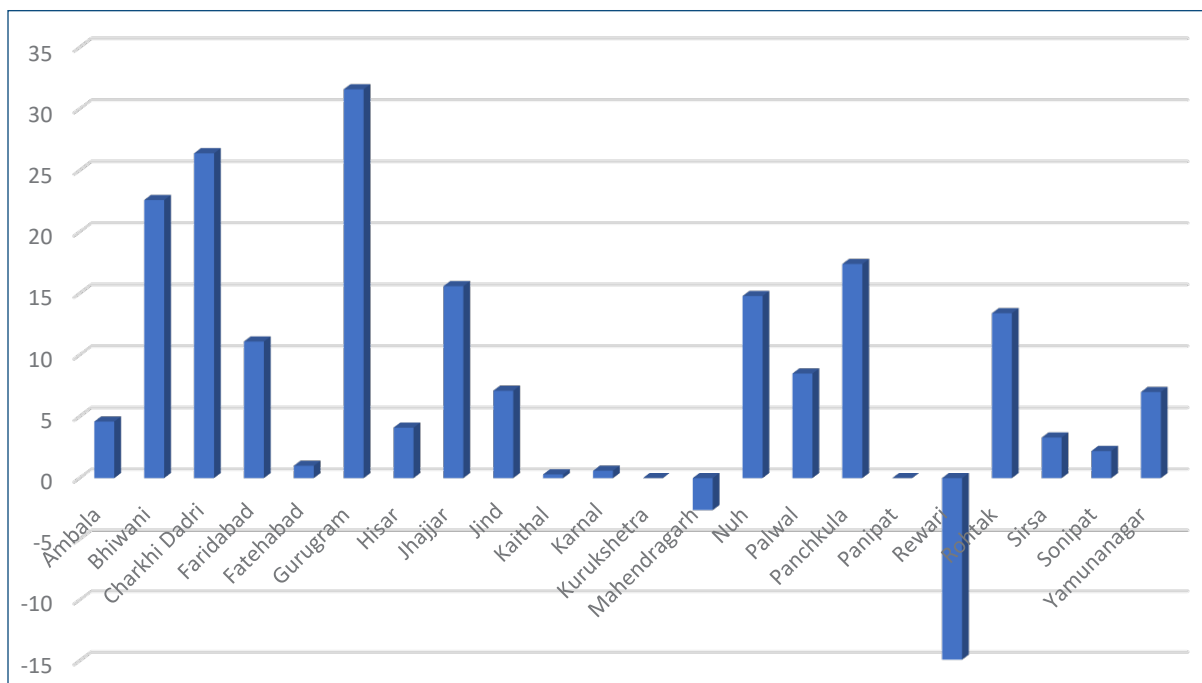
Districts with Negative Change	Mahendragarh (-2.6) and Rewari (-14.9).
Districts with No Change	Kurukshetra (0) and Panipat (0)
Districts with Positive Change	Gurugram (31.60), Charkhi Dadri (26.4), Bhiwani (22.6), Panchkula (17.4), Jhajjar (15.6), Nuh (14.8), Rohtak (13.4), Faridabad (11.1), Palwal (8.5), Jind (7.1), Yamunanagar (7), Ambala (4.6), Hisar (4.1), Sirsa (3.3), Sonipat (2.2), Fatehabad (1), Karnal (0.6), Kaithal (0.3)

Source: Summarized from Table 1.



Source: Statistical Abstracts of Haryana, 2005–2006 and 2019–2020.

Map 4



Source: Statistical Abstracts of Haryana, 2005–2006 and 2019–2020.

Fig. 2: Percentage Change in Irrigation Intensity from 2005–2006 to 2019–2020

Factors Responsible for Change in Irrigation Intensity in Haryana

There are various factors responsible for this high and continuously increasing intensity. The main contributing elements include increased crop intensity, which results from extensive use of irrigational systems.

The government-provided canal irrigation is one of the primary causes. Considering the fact that canal irrigation covers these districts, Sirsa and Fatehabad have some of the highest levels of irrigation intensity in the state. The largest area of land in the State that is irrigated by a government canal is in the Sirsa district, where it covers 269 thousand hectares.

Farmers’ extensive use of tube well irrigation is another element contributing to the state’s high irrigation intensity, in addition to canal irrigation. The total number of tube well sets sunk in the State is 7,90,873 sets, with Hisar having the largest number of sets dug at 73,518 sets. Nonetheless, there is no denying that this intense tube well irrigation is hastening the subsurface depletion process.

The type of crops grown in the State is another responsible factor. Paddy’s net area seeded has significantly increased

since the Green Revolution. By 2020, it will have a 34% stake, up from 4% in 1960. Since rice crop uses a lot of water, irrigation is used more frequently here. The availability of canal irrigation, reliance on tube well irrigation and the frequency and development of monocropping patterns are further considerations.

Government Interventions

The Pradhan Mantri Krishi Sinchai Yojana was introduced on 1 July 2015, under the slogan “Har Khet Ko Paani,” with the goal of offering complete solutions for the irrigation supply chain, including water sources, a distribution network and farm level applications. By capturing rainwater at the micro level through “Jal Sanchay” and “Jal Sinchan,” PMKSY focuses on developing sources for assured irrigation as well as protective irrigation.

The Haryana government has been encouraging micro-irrigation methods like drip and sprinkler irrigation, which use water more effectively and can cut water usage by up to 40%, to address this problem. The establishment of monitoring stations and limitations on the drilling of new tube wells are just two of the steps the state has put in place to control the usage of groundwater.

According to the Chief Minister of Haryana, a new Micro Irrigation Programme has been launched in order to guarantee the availability of water in each and every agricultural sector in the State. NABARD (National Bank for Agriculture and Rural Development) has also committed to provide funding for this programme. Farmers who group at least 25 acres of land together will receive water through a micro irrigation system under this programme. A portal will shortly be developed for this, and interested farmers will be invited to submit applications.

The government has been pushing crop diversification and encouraging farmers to shift from rice and wheat, which require a lot of water, to less water-intensive crops like maize, cotton and pulses.

CONCLUSION AND RECOMMENDATIONS

Irrigation is a prerequisite for agricultural development and is essential for crop production. That is so because the current modernised agricultural pattern necessitates more irrigation water due to the growing use of contemporary agricultural inputs and the more effective use of various chemicals for soil conservation. The necessity of irrigation for the implementation of recent developments in agricultural technology has increased its significance even further. The majority of irrigation facilities, such as wells and tube wells, are artificial sources; thus, while increased irrigation intensity increases agricultural production, it also results in an overuse of groundwater resources. As a result, Haryana needs to switch from water-intensive crops to less water-intensive ones. There should be more programmes to diversify crop production. Farmers need training on how to switch from the prevalent monocropping paradigm to crop diversification or organic farming. The state government should encourage the use of rainwater collection for home and agricultural purposes at all administrative levels. The degree of irrigation has shifted across the state, while some regions have embraced these environmentally friendly approaches, others still largely rely on groundwater and are experiencing a severe water shortage. To maintain the long-term viability of agriculture in Haryana, the government must keep up its efforts to encourage sustainable irrigation methods and manage water resources effectively. The use of laser levelling, zero tillage, timely transplanting

of paddy cultivation, furrow plantation methods, etc. should be promoted at the farm level in order to conserve water. Widespread promotion should be made of the rehabilitation of village ponds, check dams, trenches, borewells, etc. to recharge aquifers. It is also important to adopt rainwater-harvesting methods. Moreover, the usage of groundwater is negatively impacted by the use of flat rates for electricity or heavily subsidised electricity when coupled with an unstable supply. Hence, the state of Haryana has to reform its agricultural power supply and price structure. A sound water policy for Haryana is urgently needed because it is yet to be established in the state.

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