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Irrigation in Haryana since green revolution

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Abstract

Since the advent of the Green Revolution, Haryana has emerged as a major user of water for agricultural irrigation. Rivers and groundwater have become backbone of state's agricultural productivity and development. Irrigation is essential not only on behalf of transforming agriculture and ensuring food security but also as a key source of income for Haryana's population. As population growth continues to drive demand for food, shelter, and clothing, agriculture remains the region's primary economic pursuit, entirely dependent on reliable irrigation methods. Furthermore, industrial and technological advancements, as well as institutional progress, hinge on effective water resource management. Addressing both present and future water requirements necessitates the prudent and efficient use of available water, with the urgent adoption of advanced soil-water management and micro-irrigation techniques. This transition from traditional flood irrigation to methods like drip and sprinkler irrigation is critical to sustaining Haryana's agricultural future.

Keywords: Irrigation, development, traditional, technological, water management

Introduction

The state of Haryana has undergone a remarkable transformation in its agricultural sector since the onset of the Green Revolution. Once primarily reliant on traditional irrigation methods, Haryana has surfaced as solitary of India's leading users of water for irrigation, leveraging both surface and groundwater resources to drive agricultural productivity with rural development. The role of irrigation in state extends beyond crop cultivation it has been fundamental to securing food supplies, supporting rural livelihoods, and underpinning Haryana's broader economic progress.

Agriculture forms backbone of Haryana's economy, making efficient management of water resources a critical priority. The region's semi-arid climate, coupled with an uneven distribution of rainfall and mostly sandy or sandy loam soils, makes irrigation indispensable for sustaining crop yields and meeting the growing demands of a rising population. Over the decades, the state's irrigation infrastructure has evolved rapidly, transitioning from canals and wells to widespread adoption of tube wells and, more recently, a growing emphasis on modern micro-irrigation systems.

The expansion of irrigation has enabled Haryana not only to meet its own food security requirements but also to contribute surplus grain to national reserves. However, this impressive growth has brought with it new challenges declining groundwater tables, increasing pressure on water resources, and the need for sustainable and equitable management of irrigation systems. As Haryana continues to modernize its agricultural sector, espousal of advanced water-saving techniques, such as drip as well as sprinkler irrigation, and judicious allocation of water resources have become more urgent than ever. A substantial body of research has explored the evolution and impact of irrigation in Haryana, reflecting broader themes in Indian agricultural geography and resource management. Gautam (2012) ^[2] offers a foundational overview of agricultural geography in India, highlighting the critical role that irrigation has played in transforming agrarian economies, with emphasis on the period following the Green Revolution. Similarly, Hussain (1996) ^[5] provides a systematic analysis of agricultural practices and their spatial variation, acknowledging that regions such as Haryana have seen significant shifts in cropping patterns and productivity due to expanded irrigation networks. Kaushik and Om Parkash (2010) ^[6] specifically examine how groundwater

levels influence cropping patterns in Haryana's Karnal district. Their study underscores the direct relationship between irrigation availability and the selection of water-intensive crops, a pattern also seen statewide. Kumar (2014)^[7] investigates both the economic advantages and environmental drawbacks associated with the Green Revolution in Haryana, noting that increased irrigation has led to higher yields but also to concerns regarding groundwater depletion and soil degradation. Neeraj (2014)^[8] tracks the expansion of rice cultivation in Haryana from the late 1960s through 2010, attributing much of this growth to enhanced irrigation infrastructure, particularly the proliferation of tube wells. Sangwan and Monica (2017)^[9] analyze spatio-temporal trends in irrigation development, finding that while access to irrigation has generally improved, disparities persist between districts due to differences in natural resource endowments and the availability of canal water versus groundwater. Sarkar, Sen, and Kumar (2009) extend the discussion to neighboring Punjab, comparing the sustainability of different irrigation systems within the rice-wheat cropping cycle. Their findings are relevant to Haryana, as both states share similar agro-ecological conditions and challenges related to water resource management. The Statistical Abstracts of Haryana (2001-02, 2011-12, 2017-18) provide comprehensive data on irrigation sources, coverage, and trends over time. These official reports serve as primary data sources in many academic and policy studies, documenting the transition from traditional wells and canals to modern tube wells and highlighting the increasing intensity of irrigation practices in the state. Collectively, these studies and sources emphasize that while Haryana's agricultural sector has greatly benefited from expanded irrigation, this progress has also brought new challenges. Groundwater depletion, declining water quality, and uneven access to reliable irrigation continue to threaten the long-term sustainability of farming in the region. The literature consistently calls for improved water management strategies, greater adoption of efficient irrigation technologies, and stronger policy interventions to ensure the future viability of Haryana's agriculture. This study examines the development of irrigation in Haryana from the Green Revolution to the present, focusing on trends in irrigated area, shifts in irrigation sources, and regional disparities in access. By analyzing historical data, the paper aims to provide insights that will inform more sustainable water management and agricultural policy in the years ahead.

Study Area

For this research, Haryana has been selected as study area. Recognized as one of India's most industrial states, Haryana is entirely landlocked, sharing its borders by Himachal Pradesh and Punjab to north, Rajasthan to west and south, and Uttarakhand to south. Most of the state consists of flat plains, though it is located at tail end of Aravalli mountain range. Geographically, Haryana spans from 27°39' to 30°35' North latitude in addition to 74°28' to 77°36' East longitude, with elevations ranging from 700 to 3,600 feet on top of sea level. The state can be divided into four major geographic regions: Yamuna-Ghaggar plain, Shivalik Hills in northeast, southwestern plains, and Aravalli hills in south.

Haryana experiences a steamy climate similar to extra northern plains states, with most of region falling under a semi-arid classification. The state sees significant

temperature variation all over year, by summer warmth rising to 40-46°C as well as winter temperatures dropping as low as 1.5-4°C; extremes can range from near freezing in winter to as high as 50°C in summer. Summers generally occur from April to July, while winters are from November to February. Rainfall is intense during monsoon months (July to September), which account for 80-90% of annual precipitation. The state's annual rainfalls vary on or after 300 mm in south and west to 700 mm in northeast, with an average around 450 mm. Of this, roughly 354 mm falls in the monsoon, with the remainder brought by western disturbances in winter. The brief and limited rainfall period necessitates substantial irrigation for agriculture.

Haryana's soils are predominantly sandy and sandy loam, requiring additional irrigation to sustain farming. The Yamuna is solitary Perennial River, while Ghaggar, Markanda, Sahibi, as well as Dohan are seasonal, providing water only intermittently. Given the scarcity of reliable surface water, the state has become increasingly dependent on groundwater not only for irrigation excluding as well to meet broader needs of its human moreover animal populations.

Objectives

1. To analyze temporal changes in Haryana's gross irrigated area from 1970-71 to 2020-21.
2. To examine relationship between disgusting cropped as well as gross irrigated area during the same period.
3. To assess the source-wise and district-wise irrigation patterns in Haryana for 2020-21.

Data Base and Methodology

This research relies on secondary data from the Statistical Abstract of Haryana (1972-73 to 2022-23) and Census of India (2011). The study employs comparative, descriptive, and percentile approaches to examine trends and spatial patterns in irrigation.

4.1 Trends of Irrigation in Haryana

Irrigation development in Haryana has not been uniform. In 1970-71, canals and wells were the primary irrigation sources, serving 1.532 million hectares (43% of net sown area). With the introduction of tube wells in the 1980s, irrigated area expanded to 2.134 million hectares by 1980-81, covering 59.2% of net sown land. Factors contributing to this growth included supportive policies, access to tube well technology, and credit facilities.

By 1990-91, tube wells had largely replaced traditional wells, accounting for 48% of irrigated land; the net irrigated area reached 2.6 million hectares (72.7% of net sown area). In 2000-01, for the first time, the area irrigated by tube wells (1.467 million hectares) surpassed that of canals (1.436 million hectares), with the state's irrigation coverage rising to 83.9% of net sown land. Tanks, wells, and other minor sources became negligible.

A slight decline in irrigated area occurred in 2010-11 (2.887 million hectares; 82.1% coverage), but by 2020-21, total irrigated area had increased to 3.388 million hectares, with canals and tube wells accounting for 36.4% and 63.6% of irrigation, respectively. The percentage of irrigated land to net drill area peaked at 94.9% in Table 1 and Figure 1. Specifically, 1,467 thousand hectares were irrigated by tube wells, while canal irrigation covered 1,436 thousand hectares. By this year, irrigation infrastructure had expanded

to cover 83.9% of the state's net sown area. At this point, the contribution of tanks, traditional wells, and other sources

had diminished to nearly zero, leaving canals and tube wells as the primary sources of irrigation throughout Haryana.

Table 1: Haryana: Net Irrigated Area 1970-71 to 2020-21

Years	Net Area Irrigated in 000 Hectares						Gross Irrigated Area as % to Net Sown Area
	Canals	Tanks	Wells	Tube-wells	Other Sources	Total	
1970-71	952	1	574	0	5	1532	43
1980-81	1161	0.45	26	941	6	2134	59.2
1990-91	1337	1	0.48	1248	14	2600	72.7
2000-01	1436	1	0.43	1467	14	2958	83.9
2010-11	1236	0.35	0.31	1650	1	2887	82.1
2020-21	1232	0.32	0	2156	0	3388	94.9

Source: Statistical Abstract of Haryana 1972-73, 1982-83, 1992-93, 2002-03, 2012-13 and 2022-23.

According to the Statistical Abstract of Haryana, the year 2010-11 saw a slight reduction in both the total irrigated area in addition to irrigation intensity. During this age, 2,887 thousand hectares of gross harvest area were irrigated, with canals and tube wells contributing 43% and 57% respectively to the total irrigated land area dropped to 82.1%. However, by 2020-21, the overall irrigated area had

risen to 3,388 thousand hectares. Of this, canals accounted for 1,232 thousand hectares and tube wells for 2,156 thousand hectares, representing 36.4% and 63.6% of the total respectively. By the close of the decade, Haryana's irrigation facilities covered an impressive 94.9% of its net sown area.

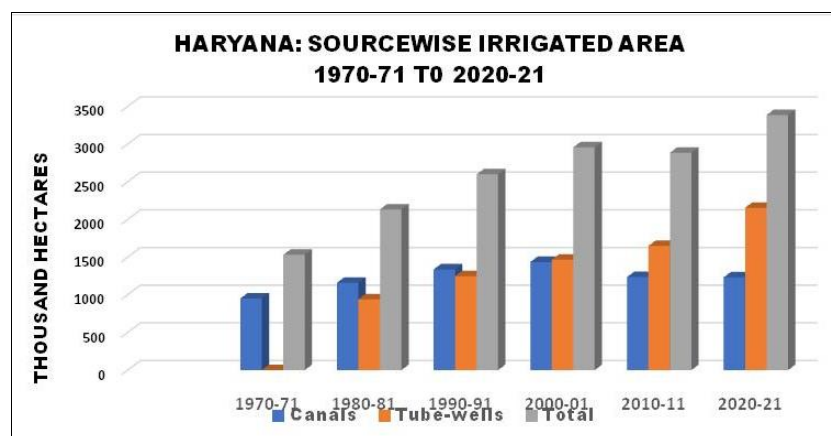


Fig 1: Haryana: Net Irrigated Area 1970-71 to 2020-21

Table 2: Haryana: Source wise Irrigated Area

Sr. No.	District	Net Area Irrigated in 000 Hectares			Gross Irrigated Area as % to Net drill Area
		Canals	Tube wells	Total	
1	Mewat	14	71	85	77.2
2	Mahendergarh	1	119	120	78.9
3	Bhiwani	58	180	238	81
4	Panchkula	0	19	19	82.6
5	Charakhi Dadri	26	70	96	85.7
6	Hisar	206	106	312	93.1
7	Jhajjar	52	70	122	93.8
8	Panipat	40	157	97	95.2
9	Palwal	21	78	99	95.2
10	Sirsa	268	114	382	97.7
11	Fatehabad	0	32	218	98.6
12	Ambala	3	145	148	99.3
13	Kurukshetra	28	111	139	99.3
14	Y. Nagar	2	109	111	100
15	Kaithal	76	121	197	100
16	Karnal	57	144	201	100
17	Sonapat	24	129	153	100
18	Rohtak	75	79	154	100
19	Faridabad	0	32	32	100
20	Gurugram	0	85	85	100
21	Rewari	0	126	126	100
22	Jind	218	36	254	100

Source: Statistical Abstract of Haryana 1972-73, 1982-83, 1992-93, 2002-03, 2012-13 and 2022-23.

Analysis of Table 2 and Figure 2 reveals district-wise distribution of irrigation methods in Haryana for 2020-21. The data indicates that districts such as Bhiwani, Charakhi Dadri, Rohtak, Jhajjar, Hisar, Jind, Fatehabad, and Sirsa rely extra heavily on canal irrigation compared to previous

regions. In contrast, districts like Panchkula, Faridabad, Gurugram, and Rewari use tube wells exclusively for their irrigation needs. Based on proportion of irrigated area relative to net introduced area, Haryana's districts can be grouped into three categories.

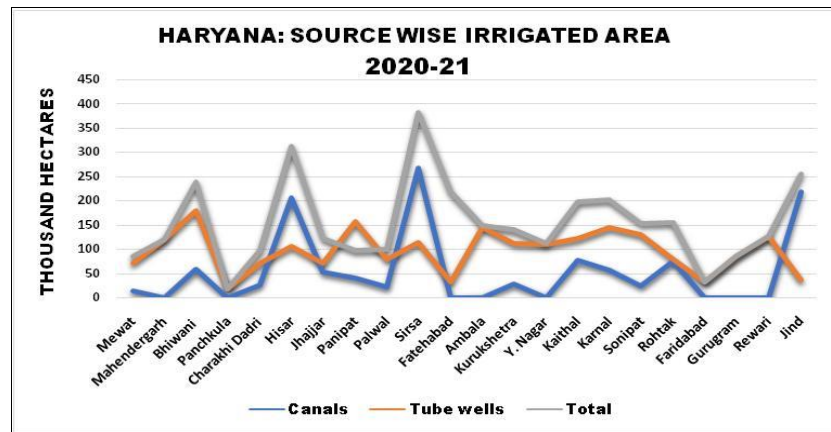


Fig 2: Haryana: Source wise Irrigated Area

Districts with Less Than 85% Irrigated Area

This group includes Panchkula, Mewat, Mahendergarh, and Bhiwani. The main feature in charge on behalf of the lower irrigation coverage here are limited or ineffective canal networks and the prevalence of saline groundwater in certain areas. Additionally, the topography of Bhiwani in addition to Mahendergarh does not support canal irrigation effectively. Water availability in canals is also insufficient to meet irrigation needs throughout the year in these districts.

Districts with 85-95% Irrigated Area

Kurukshetra, Jhajjar, Hisar, and Charakhi Dadri fall into this category. The moderate irrigation coverage is primarily due to inconsistent canal water supply, saline underground water, and high demand for water driven by dense

populations. These constraints collectively limit the extent of land that can be reliably irrigated.

Districts with More Than 95% Irrigated Area

Districts such as Ambala, Yamuna Nagar, Kaithal, Karnal, Panipat, Sonapat, Rohtak, Faridabad, Palwal, Gurugram, Rewari, Jind, Fatehabad, and Sirsa exhibit very high levels of irrigation coverage. This is largely attributed to robust and well-maintained irrigation networks. Many of these districts, including Ambala, Yamuna Nagar, Karnal, Panipat, Sonapat, Faridabad, and Palwal, are situated near Haryana's only perennial river, the Yamuna. Meanwhile, the presence of high-quality groundwater in districts like Faridabad, Gurugram, and Rewari further bolsters their irrigation capacity.

Table 3: Haryana: Gross irrigated area, Gross Cropped Area as well as Irrigation Intensity 2020-21

Sr. No.	District	Gross Cropped Area	Gross Irrigated Area	Gross Irrigated Area % to Gross Cropped Area	Irrigation Intensity
1	Ambala	207	208	99.5	140.5
2	Panchkula	30	37	81	178.6
3	Y. Nagar	217	217	100	195.5
4	Kurukshetra	275	277	99.3	199.3
5	Kaithal	386	386	100	195.9
6	Karnal	395	395	100	196.5
7	Panipat	192	192	100	197.9
8	Sonapat	303	303	100	198
9	Rohtak	227	227	100	147.4
10	Jhajjar	222	237	93.7	194.3
11	Faridabad	63	63	100	196.9
12	Palwal	185	195	95.1	197
13	Gurugram	110	110	100	129.4
14	Mewat	107	140	76.5	164.7
15	Rewari	208	208	100	165.1
16	Mahendergarh	180	228	78.9	190
17	Bhiwani	344	425	81	178.6
18	Jind	467	467	100	183.9
19	Hisar	566	608	93.1	194.9
20	Fatehabad	427	431	99.1	197.7
21	Sirsa	715	732	96.6	190.8
22	Charakhi Dadri	164	191	85.9	200

Source: Statistical Abstract of Haryana 1972-73, 1982-83, 1992-93, 2002-03, 2012-13 and 2022-23.

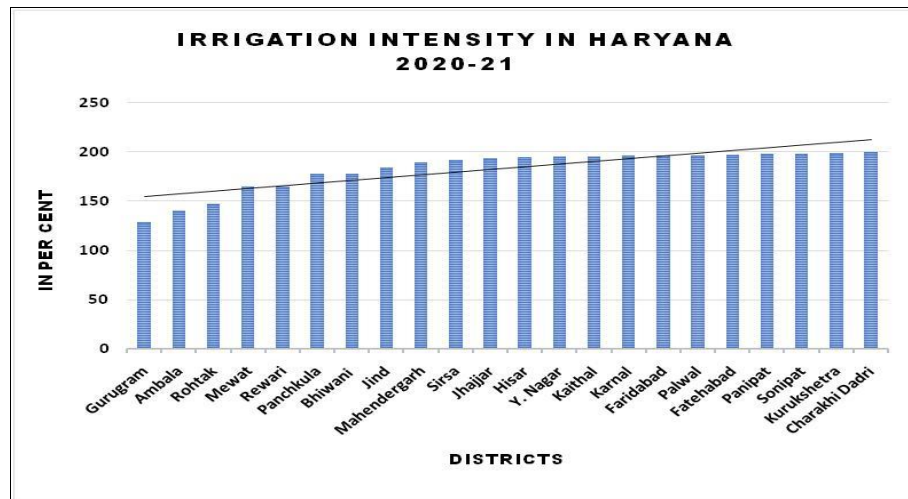


Fig 3: Haryana: Gross irrigated area, Gross Cropped Area and Irrigation Intensity 2020-21

Conclusion: The irrigation scenario in Haryana largely mirrors the broader trends observed in other agricultural states across India. Over the past several decades, the state has made significant progress in expanding irrigation coverage and intensity, successfully transforming its agricultural landscape. This expansion has empowered Haryana not only to meet the food requirements of its own population but also to contribute substantial surplus grains to the national reserves, solidifying its role in India's food security network.

However, this impressive achievement has not come without serious challenges. The widespread reliance on intensive irrigation, often through inefficient practices, has direct to a rapid exhaustion of groundwater resources and a growing scarcity of potable water for both humans and livestock. The over-extraction of groundwater, combined with the mismanagement of canal networks and the continued use of traditional flood irrigation methods, has created an unsustainable situation. As a result, many parts of the state now face falling water tables, deteriorating water quality, and increased vulnerability to drought and water stress.

Given these realities, Haryana finds itself at a crossroads. The focus must now shift from merely maximizing irrigated area to guarantee sustainable and judicious use of water resources. Additionally, policies should be enacted to promote rainwater harvesting, groundwater recharge, and the rehabilitation of traditional water bodies. Community participation, farmer education, and government support will be crucial in implementing these reforms. Without decisive and collective action, the gains made in agricultural productivity could be eroded by an impending water crisis, threatening both rural livelihoods and ecological balance. Therefore, rather than celebrating past successes, it is imperative to recognize the looming challenges and take proactive, concrete steps towards conserving and managing water resources more efficiently. Only through such measures can Haryana ensure the long-term sustainability of its agriculture and safeguard the well-being of its people and future generations.

Future Scope of the Study: While the current research offers a detailed account of irrigation development in Haryana since the Green Revolution, several avenues remain open for further exploration:

Adoption and Impact of Micro-Irrigation: Future studies can focus more closely on the adoption rates, barriers, and field-level impacts of micro-irrigation techniques such as drip and sprinkler systems. Understanding the economic and ecological benefits in different agro-climatic zones of Haryana will help refine policy and extension efforts.

Groundwater Sustainability and Recharge: Continued research is necessary to assess the region's groundwater balance, trends in depletion, and the effectiveness of artificial recharge and rainwater harvesting interventions. Integrating satellite data and remote sensing can provide real-time monitoring of groundwater dynamics.

Climate Change and Water Use Efficiency: Haryana's irrigation needs and water availability are likely to be significantly affected by climate change. Future research should model the implications of altered rainfall patterns, higher temperatures, and extreme weather events on crop water requirements and irrigation scheduling.

Socio-Economic Dimensions: There is scope to study the social and economic impacts of irrigation development, including its role in rural livelihoods, gender equity in water access, and the financial sustainability of smallholder farmers under different irrigation regimes.

Policy and Institutional Innovations: Investigating the effectiveness of new water management policies, community-based water governance, pricing mechanisms for water use, and public-private partnerships in irrigation infrastructure can provide valuable insights for scaling sustainable practices.

Integration of Technology: Research can also examine the role of digital technologies, including mobile-based advisory services, IoT sensors for real-time water management, and GIS-based decision support systems in optimizing irrigation at the farm and regional scales.

Comparative Studies: Comparative analyses between Haryana and other states or between different districts within Haryana can identify best practices and lessons learned for improving irrigation efficiency and sustainability.

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