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# Impact of groundwater depletion on agricultural practices in Jhunjhunu district

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**Abstract**
Groundwater depletion has emerged as a significant challenge for agricultural practices in many parts of India, particularly in regions like Jhunjhunu District in Rajasthan. The present analytical study investigates the impact of groundwater depletion on cropping patterns in Jhunjhunu District, Rajasthan, with a particular focus on the year 2023. Drawing upon both primary and secondary data sources, the research explores the dynamic relationship between declining groundwater levels and shifts in agricultural practices. A structured survey conducted among 200 farmers across Chirawa, Nawalgarh, and Jhunjhunu blocks further substantiates these trends. The majority of respondents (85%) attributed changes in crop choice to groundwater scarcity, followed by rising irrigation costs (72%) and past crop failures (63%). This research underscores the urgent need for sustainable water management strategies and policy interventions to support climate-resilient agriculture in water-stressed regions like Jhunjhunu.

**Keywords:** Groundwater depletion, irrigation, agriculture, water scarcity, cropping pattern

## 1. Introduction
Groundwater depletion is one of the most pressing environmental issues facing the world today, particularly in regions heavily reliant on agricultural practices. Groundwater serves as a critical source of irrigation, drinking water, and industrial use, but its over-exploitation, particularly in agricultural areas, has led to alarming rates of depletion. This issue is particularly significant in countries where agriculture is the mainstay of the economy, and water resources are limited. In many regions, the agricultural sector is the primary consumer of groundwater, often exceeding natural recharge rates and leading to a significant reduction in the water level. The depletion of groundwater has serious implications not only for the sustainability of agricultural practices but also for the environment and the communities that depend on it.

The rapid growth in agricultural demands driven by increasing populations, changing diets, and shifting climatic conditions has placed enormous pressure on groundwater resources. In many countries, particularly in regions like South Asia, the Middle East, and parts of Africa, groundwater is relied upon to meet the irrigation needs of crops. Traditional agricultural practices, especially in water-scarce regions, have led to the over-extraction of groundwater for irrigation purposes, often in the absence of efficient water management practices. This overuse of groundwater is often exacerbated by the absence of proper regulation, leading to unsustainable withdrawal rates and a gradual decline in water levels.

In many areas, the practice of pumping large quantities of groundwater for irrigation has caused a significant drop in the water table, making it harder for wells and boreholes to access water. This has led to an increase in the cost of water extraction, as farmers are forced to drill deeper wells to access water, further compounding the problem. In addition to this, the lack of effective water conservation practices and the use of inefficient irrigation systems such as flood irrigation has resulted in the excessive waste of water, accelerating the depletion process. The excessive withdrawal of groundwater can lead to a vicious cycle of reduced water availability, decreased agricultural productivity, and heightened economic stress.

The environmental impacts of groundwater depletion are wide-ranging. As groundwater levels drop, the natural replenishment process of aquifers is disrupted, and the rate of recharge from rainfall and surface water becomes inadequate to keep up with the rate of extraction. This creates a long-term imbalance in the water cycle, and in some cases, entire aquifers may be irreversibly damaged. In coastal regions, excessive pumping can lead to saltwater intrusion, where seawater infiltrates freshwater aquifers, making the water undrinkable. The depletion of groundwater also affects ecosystems that rely on groundwater-fed wetlands, rivers, and springs. As groundwater levels fall, these ecosystems can dry up, leading to the loss of biodiversity and degradation of habitats for a wide range of species.

In addition to the environmental consequences, groundwater depletion poses a significant threat to food security. Many of the world's major food-producing regions rely heavily on groundwater for irrigation. When groundwater levels fall, agricultural yields can decrease, leading to reduced food production and, in turn, higher food prices. This has economic and social consequences, particularly in developing countries where agriculture is the primary source of livelihood for the majority of the population. Smallholder farmers, who are often the most vulnerable, are particularly affected, as they lack the resources to drill deeper wells or invest in more efficient irrigation technologies. Consequently, groundwater depletion contributes to poverty, inequality, and food insecurity, making it a critical issue that requires immediate attention.

The role of climate change in groundwater depletion cannot be overlooked. Changes in precipitation patterns, rising temperatures, and increased frequency of extreme weather events are affecting groundwater recharge rates. In many regions, droughts are becoming more frequent, further reducing the amount of water available for replenishing aquifers. This creates a feedback loop where the impacts of climate change exacerbate existing water scarcity issues, leading to a further intensification of groundwater depletion. In some cases, changing climatic conditions have led to the alteration of cropping patterns, with farmers shifting to more water-intensive crops that require even greater amounts of groundwater. The impact of climate change on groundwater resources, combined with the unsustainable practices of over-extraction, poses a significant challenge to long-term agricultural sustainability.

Governments and policymakers have increasingly recognized the severity of groundwater depletion and the need for effective water management strategies. There is a growing emphasis on promoting water conservation techniques, such as drip irrigation, rainwater harvesting, and the use of water-efficient crops. Additionally, there is an increasing focus on the importance of recharging groundwater aquifers through measures such as artificial recharge, recharge pits, and improving watershed management. However, the successful implementation of these strategies requires a collaborative approach involving farmers, local communities, government authorities, and environmental organizations. Education and awareness-raising campaigns are also vital to changing agricultural practices and promoting sustainable water use.

## 2. Review of literature

Alyami, Saleh, *et al*. (2022) [1] This research emphasizes the significant impacts of diminished water supplies on agricultural operations in Najran, Saudi Arabia. "Over the past decade, several experts have observed a significant decline in water availability in the region, attributed to urban growth, excessive groundwater extraction leading to diminished land fertility, and degradation of soil structure." The region's water supplies and agricultural legacy are under risk, and the environmental, economic, and social repercussions of these acts may be significant if similar practices persist in the future. The objective of the project is to get comprehensive information concerning the primary factors contributing to water depletion in the Najran Valley, based on inhabitants' perspectives. A survey questionnaire was developed with significant flexibility, including critical subjects such as the causes of groundwater depletion, variables influencing agricultural operations and irrigation practices, the environmental effect of the Najran Dam, and associated flood hazards. A substantial response was garnered from the local populace. Substantial findings emerged from the investigation, with the primary consequences and causes delineated as conclusions. The study will assist municipal planners and policymakers in understanding the primary causes of water depletion and the genuine requirements of inhabitants to manage the area's water resources effectively. Comprehending public opinion on the topics addressed in this study would establish a foundation for formulating management strategies for water resource challenges tailored to local settings that meet community needs.

Bhattarai, Nishan *et al*. (2021) [3] India depends on groundwater irrigation to cultivate staple grain crops that supply more than half of the caloric intake for its population exceeding 1.3 billion. Although groundwater has enabled India to attain grain self-sufficiency, aquifers have been over mined throughout most of the nation, and the consequences for crop output remain ambiguous. We conducted district-level panel regressions utilizing agricultural census, groundwater observation, and gridded meteorological datasets over a decade (2004-2013) to analyze the impact of groundwater depletion on staple crop (wheat, rice, maize, pearl millet, and sorghum) output in India. Nationally, diminishing groundwater levels correlate with substantial decreases in yield, cultivated area, and output of wheat, rice, and maize throughout the winter season. Notwithstanding the adverse effects of groundwater depletion on agricultural yield, there is few data indicating that farmers are transitioning from cultivating more water-intensive crops to less water-intensive varieties. Employing profit-based decision modeling, we examined the impact of agricultural energy prices on crop selection during the monsoon season in Haryana and Punjab, regions that contribute over 60% of India's grain output, benefit from substantial electricity subsidies, and face rapidly diminishing water tables. Our analysis indicates that the removal of energy subsidies for groundwater extraction is unlikely to motivate farmers to transition to less water-intensive crops; nevertheless, sensitivity studies imply it may promote enhanced water conservation initiatives. Our studies indicate a significant effect of groundwater depletion on agricultural productivity in India and show that diminishing or eliminating energy subsidies may substantially influence water usage without altering crop selection.

Srivastava, Shivendra, *et al*. (2017) [7] The paper evaluates the causes contributing to groundwater depletion in Punjab, India, and analyzes the economics of groundwater irrigation across different farm sizes, varying groundwater levels, and energy policy scenarios. Evidence at the farm level indicates that farmers with smaller land holdings pay groundwater costs that are 2 to 3 times higher than those with larger land holdings. Moreover, small farmers are disproportionately impacted by declining groundwater levels. Moreover, the financial costs associated with groundwater extraction are shared evenly between society and farmers. The elimination of energy subsidies is anticipated to diminish net returns, but at differing rates across various crops. Nonetheless, agricultural production would remain lucrative, and the removal of subsidies would provide savings of 29-82% in current groundwater use across various crops.

Marouane, Bouchra *et al*. (2014) [8] The application of fertilizers and pesticides in agricultural practices is the primary contributor to groundwater pollution. The study conducted in the Mnasra region of the Gharb plain's coastal zone in northwest Morocco aimed to assess the geographical and temporal variability of groundwater nitrate (NO-3) and pesticide concentrations in 2012. The surveillance has concentrated on superficial groundwater next to agricultural fields (9 sites). A total of 36 groundwater samples were collected in March, April, May, and September, and evaluated for nitrate amounts using ion chromatography and pesticide residues by accelerated solvent extraction (ASE). All groundwater samples had NO-3 values beyond the crucial threshold of 50 mg. L-1. Three pesticides, benalaxyl, chlorpyrifos, and cypermethrin, have been monitored. No pesticide molecules were discovered, which can be attributed to the little quantity of these compounds used in the region, the utilization of foliar spray products, or the breakdown of molecules in the topsoil prior to reaching the groundwater.

Sharif, Mahin & Ashok, K.R. (2011) [10] This research reports on the expenses associated with groundwater extraction, the effects of groundwater depletion on agricultural revenue, water usage efficiency, technological efficiency in crop production, and the costs of groundwater depletion across various groups of farmers. The research was carried out in the Chamarajanagar area of Karnataka, where groundwater serves as the primary irrigation supply. Data have been gathered from over-exploited, semi-critical, and secure villages. The analysis revealed a significant disparity in groundwater resource access costs between large and small farms. Functional analysis has demonstrated that agricultural revenue is diminished in over-exploited and semi-critical villages relative to safe villages. The average technical efficiency in crop production is higher among farmers in over-exploited communities. The overall expense of groundwater depletion is more pronounced in over-exploited settlements, and the cost escalates with the enlargement of land holdings. "This expense will predominantly affect small and marginal farmers due to their limited resources and revenue streams." The study has highlighted the necessity of incentivizing the optimal utilization of groundwater through the adoption of advanced irrigation technologies such as drip and sprinkler systems to provide livelihood security.

## 3. Research methodology

### Research Design

This study adopts an analytical research design.

### Sources of data

**Primary Data:** To understand farmers' perspectives on changing cropping patterns, primary data was gathered through a structured survey.

**Secondary Data:** Secondary data was sourced from credible government and institutional records, including the Central Ground Water Board (CGWB), District Agricultural Department, Jhunjhunu, and Krishi Vigyan Kendra (KVK) reports. Data pertaining to average groundwater levels (measured in meters below ground level - m bgl) from 2018 to 2023 was collected to analyze annual changes in the water table. Similarly, statistics on the area under cultivation for key crops during 2018 and 2023 were acquired to assess cropping pattern shifts.

### Sample of the study

200 farmers across the blocks of Chirawa, Nawalgarh, and Jhunjhunu were selected.

### Sampling technique

A purposive sampling technique was employed to select respondents engaged in both Rabi and Kharif cropping cycles.

### Data Analysis Techniques

**Trend Analysis of Groundwater Depletion:** Groundwater level data from 2018 to 2023 was analyzed to track annual changes.

**Comparative Analysis of Cropping Patterns:** Data on crop area from 2018 and 2023 was compared to identify changes in cropping patterns.

**Descriptive Analysis of Farmer Responses:** Survey data from 200 farmers was analyzed using frequencies and percentages.

## 4. Data analysis and interpretation

**Table 1:** Groundwater Level Trends in Jhunjhunu (2018-2023)

| Year | Average Water Table (m bgl) | Annual Change (m) |
|---|---|---|
| 2018 | 28.4 | - |
| 2019 | 29.7 | -1.3 |
| 2020 | 31.2 | -1.5 |
| 2021 | 33.1 | -1.9 |
| 2022 | 34.5 | -1.4 |
| 2023 | 36.0 | -1.5 |

Table 1 data reveals a consistent year-on-year decline in groundwater levels over the six-year period. In 2018, the average water table was recorded at 28.4 m bgl, which steadily deepened to 36.0 m bgl by 2023, indicating a cumulative drop of 7.6 meters. The annual change ranged from -1.3 meters in 2019 to a peak decline of -1.9 meters in 2021, highlighting an accelerating trend of groundwater depletion. This persistent decline underscores the growing water stress in the region and reflects the unsustainable extraction of groundwater for irrigation and other uses.

**Table 2:** Cropping Pattern Shift (2018 vs 2023)

| Crop | Area Sown in 2018 (Ha) | Area Sown in 2023 (Ha) | % Change |
|---|---|---|---|
| Wheat | 45,000 | 28,000 | -37.8% |
| Mustard | 50,000 | 32,000 | -36.0% |
| Bajra | 20,000 | 35,000 | +75.0% |
| Guar | 12,000 | 22,000 | +83.3% |
| Moong | 8,000 | 10,000 | +25.0% |
| Vegetables | 5,500 | 3,000 | -45.5% |

Table 2 data indicates a clear shift away from water-intensive crops towards more drought-resilient varieties. Wheat and mustard, traditionally dominant Rabi crops, saw considerable reductions in area sown—declining by 37.8% and 36.0% respectively. Similarly, vegetable cultivation dropped sharply by 45.5%, likely due to their high water demands and susceptibility to groundwater scarcity. In contrast, the cultivation of drought-resistant crops such as bajra and guar witnessed substantial increases of 75.0% and 83.3% respectively. Moong also saw a moderate increase of 25.0%, possibly influenced by both its lower water requirement and government incentives for pulse production.

**Table 3:** Farmer Responses on Reasons for Crop Change (Multiple responses allowed)

| Reason | Frequency | % Respondents |
|---|---|---|
| Groundwater scarcity | 170 | 85% |
| Increased cost of irrigation | 144 | 72% |
| Government incentives on pulses | 56 | 28% |
| Crop failure in previous years | 125 | 63% |

Table 3 presents a significant majority, 85%, identified groundwater scarcity as the main factor influencing their shift, highlighting the critical impact of water availability on agricultural decisions. Additionally, 72% of respondents pointed to the increased cost of irrigation as a major concern, suggesting that deeper water tables have led to higher energy and resource expenditure to access water. Crop failures in previous years were also a key reason, with 63% of farmers reporting past losses as a motivation for switching to more resilient crops. Interestingly, 28% of farmers acknowledged that government incentives for cultivating pulses encouraged them to diversify their crop choices.

## 5. Conclusion

The findings of this study clearly demonstrate that the depletion of groundwater resources in Jhunjhunu District between 2018 and 2023 has had a profound effect on agricultural practices, particularly in shaping cropping patterns. A cumulative decline of 7.6 meters in the average water table has made it increasingly difficult for farmers to sustain water-intensive crops like wheat, mustard, and vegetables. As a result, there has been a marked shift towards drought-tolerant crops such as bajra and guar, reflecting a strategic adaptation to the growing water crisis. The perspectives of local farmers further emphasize that groundwater scarcity, rising irrigation costs, and repeated crop failures are compelling factors influencing these changes. This study underscores the urgent need for sustainable water management, promotion of low-water-requirement crops, and policy support for farmers to ensure the long-term viability of agriculture in water-stressed regions like Jhunjhunu. The insights gained can serve as a valuable reference for policymakers, agricultural planners, and researchers working towards climate-resilient and resource-efficient farming

## 6. References


1. Alyami S, Alqahtany A, Ghanim A, Elkhrachy I, Alrawaf T, Jamil R, *et al*. Water resources depletion and its consequences on agricultural activities in Najran Valley. Resources. 2022;11(12):122. doi:10.3390/resources11120122.
2. Gahlawat A. A study of groundwater depletion and its impact on agriculture in Eastern Haryana. Int J Geogr Geol Environ. 2022;4(1b):141-4. doi:10.22271/27067483.2022.v4.i1b.99.
3. Bhattarai N, Pollack A, Lobell D, Fishman R, Singh B, Dar A, *et al*. The impact of groundwater depletion on agricultural production in India. Environ Res Lett. 2021;16(9):094020. doi:10.1088/1748-9326/ac10de.
4. Jain M, Fishman R, Mondal P, Galford G, Bhattarai N, Naeem S, *et al*. Groundwater depletion will reduce cropping intensity in India. Sci Adv. 2021;7(4):eabd2849. doi:10.1126/sciadv.abd2849.
5. Panda D, Ambast S, Shamsudduha M. Groundwater depletion in northern India: Impacts of the sub-regional anthropogenic land-use, socio-politics and changing climate. Hydrol Process. 2020;35(2):e14003. doi:10.1002/hyp.14003.
6. Lwimbo, Komakech H, Muzuka. Impacts of emerging agricultural practices on groundwater quality in Kahe catchment, Tanzania. Water. 2019;11(11):2263. doi:10.3390/w11112263.
7. Srivastava S, Chand R, Singh J, Kaur A, Jain R, Kingsly I, *et al*. Revisiting groundwater depletion and its implications on farm economics in Punjab, India. Curr Sci. 2017;113(3):422-9. doi:10.18520/cs/v113/i03/422-429.
8. Marouane B, Belhsaien K, Jahdi M, El Hajjaji S, Dahchour A, Dousset S, *et al*. Impact of agricultural practices on groundwater quality: Case of Gharb region-Morocco. J Mater Environ Sci. 2014;5(6):2151-5.
9. Sarkar A. Sustaining livelihoods in face of groundwater depletion: A case study of Punjab, India. Environ Dev Sustain. 2012;14(1):1-13. doi:10.1007/s10668-011-9315-7.
10. Sharif M, Ashok KR. Impact of groundwater over-draft on farm income and efficiency in crop production. Agric Econ Res Rev. 2011;24:99-106.
11. Kumar R, Jeevandas A, Singh RP. Concerns of groundwater depletion and irrigation efficiency in Punjab agriculture: A micro-level study. Agric Econ Res Rev. 2008;21:47-56.
12. Kettle N, Harrington L, Harrington J Jr. Groundwater depletion and agricultural land use change in the High Plains: A case study from Wichita County, Kansas. Prof Geogr. 2007;59(2):221-35. doi:10.1111/j.1467-9272.2007.00609.x.
13. Bhalla P. Impact of declining groundwater levels on acreage allocation in Haryana. Econ Polit Wkly. 2007;42(27-28):2701-7. doi:10.2307/4419762.