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Study of Groundwater Depletion in Charkhi Dadri District (Haryana)

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ABSTRACT

Groundwater depletion has emerged as a critical environmental and socio-economic challenge in the semi-arid regions of Haryana, where agriculture is heavily dependent on underground water resources. Present study examines farmers' awareness, participation, and perceptions, alongside the roles and coordination of government institutions in groundwater management. Primary data were collected from 100 respondents across 20 villages through structured interviews, supported by secondary data from official reports. The results reveal that although awareness of groundwater depletion is moderate, knowledge of government schemes such as Atal Bhujal Yojana and PMKSY remains limited. Panchayats play a visible role, but institutional coordination and monitoring are weak. The majority of respondents perceived groundwater governance as moderately effective, citing lack of participation, poor enforcement, and inadequate funding as major challenges. Respondents emphasised the need for enhanced community participation, farmer training, and stronger institutional frameworks. Study concludes that sustainable groundwater management in Charkhi Dadri requires a participatory, multi-institutional approach that integrates policy implementation with local empowerment and awareness generation.

Keywords: Groundwater depletion, Policy effectiveness, Institutional coordination, Sustainable management

INTRODUCTION

Groundwater presents a vital lifeline for agriculture in India, particularly in the north-western states, where rainfall is unreliable and surface water infrastructure is limited. Agricultural systems in states such as Haryana have become deeply reliant on pumped groundwater for irrigation, enabled by subsidised electricity and widespread bore-well installation. However, this increasing dependence has triggered steep declines in water tables, posing grave risks for agricultural productivity, rural livelihoods and overall water-food security (Jain et al., 2021; Sagwal, Kumar, Garhwal, & Kumar, 2022). With the aquifers of semi-arid regions like the Charkhi Dadri District increasingly stressed, questions of governance, policy effectiveness and institutional coordination become critical for sustainable groundwater management.

Recent empirical evidence shows that groundwater depletion is not just an environmental issue, but has direct consequences for agriculture. For example, the study by Jain et al. (2021) found that in highly depleted groundwater areas, cropping intensity may decline by up to 68 % compared to less-stressed areas. This suggests that when farmers lose confidence in groundwater availability, they reduce the number of cropping seasons, change cropping patterns, or abandon some land. Similar work by Bhattarai et al. (2021) links declining groundwater levels with reductions in yield, area under crop and production of major cereals across India. These findings emphasise that groundwater stress threatens agricultural output and, by extension, national food security.

Within Haryana, the problem is acute. Research indicates that the state has experienced an average annual groundwater decline of approximately 24 cm per year over nearly five decades, with 14 districts classified as over-exploited (Sagwal et al., 2022). The dominance of water-intensive crops such as paddy and wheat under the Green Revolution regime, combined with subsidised electricity for tube-wells, has exacerbated the imbalance between extraction and recharge (Singh & Deshmukh, 2021; Kumar, 2022). This overexploitation has also increased irrigation costs, forced farmers to deepen wells, and rendered smaller farmers especially vulnerable.

Such trends underscore the need for not only technical and agronomic adaptation (e.g., drip irrigation, crop diversification), but also institutional and policy responses. Governance issues such as coordination among departments, transparency in scheme implementation, community participation and enforcement of regulations are all vital. Reviews of groundwater management stress that policies must address institutional weaknesses and demand-side behaviours, rather than just supply-side infrastructure fixes (Mukherjee et al., 2023; World Bank, 2020). Yet many studies note a gap between policy formulation and field-level outcomes.

The Present Study addresses this gap by examining the policy and institutional responses to groundwater depletion in the Charkhi Dadri district of Haryana – a region representative of the semi-arid, groundwater-dependent agricultural zone of north-western India. The study investigates four major aspects: farmers' awareness and participation, the roles and coordination of institutions, perceptions of policy effectiveness, and implementation gaps. In so doing, it contributes to understanding how localised governance mechanisms can mediate the impacts of groundwater stress on agriculture.

The specific focus on Charkhi Dadri is timely. Though much of the literature highlights state-level trends in Haryana, fewer studies explore district-level institutional dynamics, particularly in newly formed or marginal districts. Given that policy interventions such as the Atal Bhujal Yojana and micro-irrigation subsidies depend on local-level delivery, analysing how institutions function and how farmers perceive and engage with them is critical. As the literature notes, one of the primary limiting factors for policy success is low community participation and weak institutional coordination (Jain et al., 2021; Sagwal et al., 2022). The present study, therefore, adopts a mixed-methods approach to capture both quantitative levels of awareness and qualitative insights into institutional effectiveness.

The challenges of groundwater depletion in India's agricultural regions are not solely technical or hydrological; they are also deeply institutional and social. While agronomic solutions such as drip irrigation or crop diversification are essential, without effective governance, they may not deliver. As groundwater levels continue to decline, farming systems become increasingly vulnerable, underscoring the imperative of understanding the linkages among policy, institutions, and farmers for resilience. The study investigates these linkages in Charkhi Dadri, aiming to fill a gap in the literature and to provide policy-relevant recommendations for sustainable groundwater governance in semi-arid agricultural districts.

Objectives of the Study

The present study aims to critically assess the role, effectiveness, and limitations of policy and institutional mechanisms addressing groundwater depletion in the Charkhi Dadri district, Haryana.

The specific objectives are as follows:

i. To identify and document major government policies, programmes, and institutional frameworks implemented for groundwater conservation and management in Charkhi Dadri district (e.g., Atal Bhujal Yojana, Pradhan Mantri Krishi Sinchai Yojana, MGNREGS water conservation works, and electricity use regulation).
ii. To assess the effectiveness and challenges of institutional mechanisms (e.g., District Groundwater Cell, Department of Agriculture, Panchayati Raj Institutions) in implementing these policies.
iii. To identify policy gaps and suggest strategic measures for improving institutional coordination and sustainable groundwater governance in the district.

Limitations of the Study

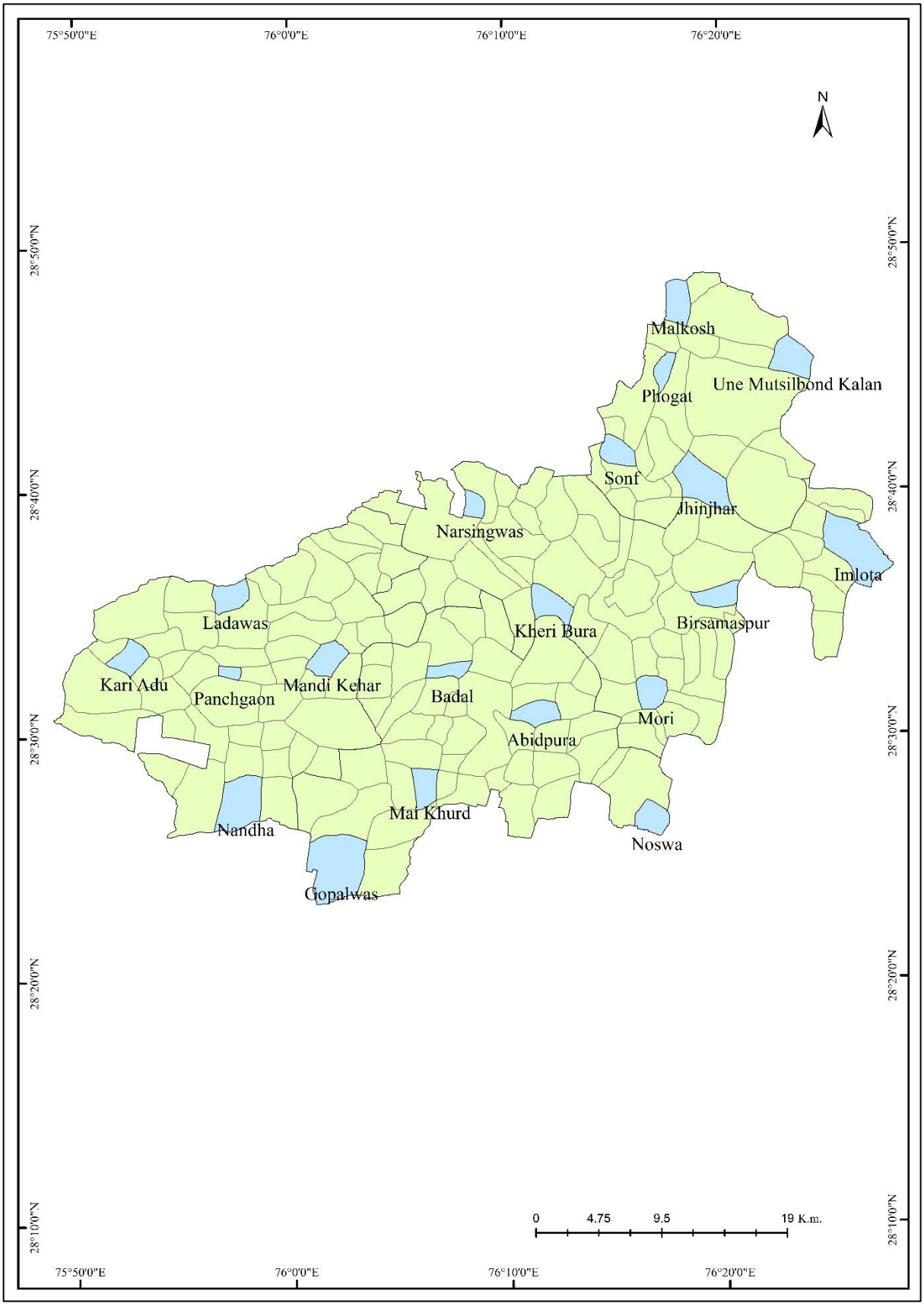
i. The study focuses on a single district, so results may not be fully generalizable to all of Haryana.
ii. Self-reported data may involve perception bias, especially regarding policy effectiveness.
iii. Time and resource constraints may limit coverage of all schemes.

STUDY AREA

The present study has been conducted in Charkhi Dadri District, located in the southwestern part of Haryana State, India. The district lies between 28°18′ N to 28°42′ N latitudes and 75°23′ E to 76°00′ E longitudes. It was carved out from the Bhiwani district in 2016 and comprises four community development blocks: Charkhi Dadri, Badhra, Bond Kalan, and Jhojhu. The district covers approximately 1,370 square kilometres and is predominantly rural, with agriculture as the principal occupation. The region falls within a semi-arid climatic zone, characterised by hot summers, scant rainfall, and a high reliance on groundwater for irrigation and domestic use.

Charkhi Dadri experiences low annual rainfall, averaging around 400–450 mm, making it highly vulnerable to groundwater depletion. The terrain is mostly undulating plains with sandy loam soils, suitable for crops such as wheat, mustard, bajra, and cotton. Due to limited surface water resources, the agricultural sector largely relies on tube wells and bore wells, leading to a continuous decline in the groundwater table. The selection of Charkhi Dadri as the study area is therefore appropriate for analysing the policy and institutional responses to groundwater depletion, as it reflects the broader challenges of water scarcity in semi-arid Haryana.

Map 1: ***Location of the selected villages for study***



Source: Prepared by Research Scholar with the help of Arc-GIS

METHODOLOGY

The study adopts a descriptive-analytical approach using both primary and secondary data. Charkhi Dadri district comprises four community development blocks: Charkhi Dadri, Badhra, Bond Kalan, and Jhojhu. From each block,

five villages were selected, and five respondents from each village, all actively engaged in farming, were personally interviewed, making a total of 100 respondents. Data were collected through a structured questionnaire focusing on awareness, policy effectiveness, and institutional coordination related to groundwater management. Secondary data were sourced from government reports and publications. The collected data were analysed using descriptive statistical methods to interpret major patterns and trends.

RESULTS AND ANALYSIS

The results of the present study are as follows:

Awareness of Groundwater Depletion

The field survey conducted in Charkhi Dadri district reveals varying levels of awareness among respondents regarding groundwater depletion and related policy initiatives. When asked to describe the groundwater situation over the past decade, a significant proportion of respondents reported a negative trend. About 32 respondents (32%) indicated that groundwater levels are slightly declining, while 28 respondents (28%) perceived a rapid decline. Only 19 respondents (19%) believed that the situation had remained stable, and a small fraction of 21 respondents (21%) felt that the condition was improving. This pattern clearly shows that the majority of the population is aware of the deteriorating groundwater situation in the region.

In terms of policy awareness, the responses reveal a significant gap between government efforts and local understanding. Of the total, only 38 respondents (38%) were aware of government schemes related to groundwater conservation or irrigation efficiency, whereas 62 respondents (62%) had no knowledge of such programmes. Among those familiar with government initiatives, 29 respondents had heard of the Jal Shakti Abhiyan, followed by 28 respondents who were aware of the Atal Bhujal Yojana (Atal Jal), and 25 respondents who were familiar with the Pradhan Mantri Krishi Sinchai Yojana (PMKSY). Fewer participants were aware of MGNREGA Water Conservation Works (21 respondents) and State-level groundwater regulation (14 respondents). These figures show that, despite multiple government interventions, awareness and outreach at the grassroots level remain limited. Regarding sources of information, 13 respondents reported learning about these programmes through television or radio, 12 through the Gram Panchayat, 7 through social media, and only 6 directly through government offices. This suggests that informal and community-based communication channels play a more active role in disseminating information than formal institutional mechanisms.

Table 1: ***Awareness of Groundwater Depletion***

Sr. No.	Awareness of Groundwater Depletion	Response	No. of Respondents
1	How would you describe the groundwater situation in your area over the past 10 years?	Improving	21
		Stable	19
		Slightly declining	32
		Rapidly declining	28
2	Do you know about any government schemes related to groundwater conservation or irrigation efficiency?	Yes	38
		No	62
	If yes, which of the following are you aware of? (Tick all that apply)	Atal Bhujal Yojana (Atal Jal)	28
		Pradhan Mantri Krishi Sinchai Yojana (PMKSY)	25
		MGNREGA Water Conservation Works	21
		Jal Shakti Abhiyan	29
		State-level groundwater regulation	14
3	How did you first hear about these schemes?	Government office	6
		Gram Panchayat	12
		Television/Radio	13
		Social media	7
4	Do you believe that groundwater depletion is a serious problem for agriculture in your village?	Strongly agree	23
		Agree	31
		Neutral	35
		Disagree	7
		Strongly disagree	4

Source: Computed by Research Scholar from the data collected during the primary survey

When asked about the perceived severity of groundwater depletion, a majority of respondents acknowledged it as a serious concern. About 23 respondents (23%) strongly agreed and 31 respondents (31%) agreed that groundwater depletion poses a major threat to agriculture in their villages. Meanwhile, 35 respondents (35%) remained neutral; 7 respondents (7%) disagreed, and 4 respondents (4%) strongly disagreed. This indicates that although awareness of the crisis exists, the perceived urgency varies, possibly due to differential dependence on groundwater resources or local variations in water availability.

Overall, the findings suggest that while most respondents recognise the decline in groundwater levels and its impact on agriculture, awareness of specific government policies and institutional interventions remains relatively low. This highlights a critical need for improved dissemination of information, participatory communication, and capacity-building programmes to ensure that groundwater management policies reach and engage the farming community effectively.

Institutional Roles and Coordination

The survey results presented in Table 2 reveal significant insights into the functioning, coordination, and perceived effectiveness of institutions responsible for groundwater management in the Charkhi Dadri district. When respondents were asked about the institutions most active in groundwater-related activities, the Gram Panchayat emerged as the most visible local institution, cited by 39 respondents.

Table 2: ***Institutional Roles and Coordination***

Sr. No.	Institutional Roles and Coordination	Response	No. of Respondents
1	Which institutions are most active in groundwater management in your area?	Panchayat	39
		Irrigation Department	28
		Agriculture Department	23
		NGOs	0
		None	10
2	How often do government officials visit your village for groundwater or irrigation-related issues?	Regularly	5
		Occasionally	45
		Rarely	33
		Never	17
3	Do you think there is effective coordination among different government departments working on water issues?	Yes	41
		No	16
		Not Sure	43
4	What are the main challenges you have observed in the implementation of groundwater policies?	Lack of awareness among farmers	20
		Delayed funds or approvals	8
		Weak institutional coordination	26
		Lack of technical knowledge	24
		Others	22
5	Do you think Panchayats have sufficient powers and resources to manage local groundwater issues?	Yes	6
		No	67
		To some extent	27
6	How transparent are the groundwater-related schemes and fund utilisation in your area?	Very transparent	14
		Somewhat transparent	25
		Not transparent	8
		Don't know	53
7	Are local farmers consulted in the decision-making or planning of groundwater conservation works?	Always	0
		Sometimes	4
		Rarely	35
		Never	61

Source: Computed by Research Scholar from the data collected during the primary survey

The Irrigation Department and Agriculture Department were identified by 28 and 23 respondents, respectively, as being involved in groundwater management activities. Notably, no respondents recognised the role of non-governmental organisations (NGOs) in water management initiatives, while 10 respondents reported that no institution was active in their area. This suggests that while local governance bodies and government departments have a visible presence, there is limited involvement of civil society or private organisations in groundwater governance in the district.

Regarding the frequency of official engagement, institutional interaction with local communities appears sporadic. Only 5 respondents stated that government officials visit their villages regularly for groundwater or irrigation-related

issues, while 45 respondents said such visits occur occasionally. A considerable number (33 respondents) reported rare visits, and 17 respondents indicated that officials never visit their areas. This infrequent interaction reflects a lack of consistent field monitoring and direct communication between government agencies and rural stakeholders, which may hinder effective policy implementation.

When asked about inter-departmental coordination, the responses were mixed. 41 respondents (41%) believed that there is effective coordination among government departments working on water-related issues, while 16 respondents (16%) disagreed. However, 43 respondents (43%) were unsure, indicating ambiguity or a lack of awareness about the collaborative functioning of different institutions. This uncertainty points toward a communication gap between the administrative framework and the local population.

Respondents identified multiple institutional and procedural challenges to groundwater policy implementation. The most frequently mentioned problem was weak institutional coordination (26 respondents), followed closely by lack of technical knowledge (24 respondents) and lack of awareness among farmers (20 respondents). Other issues included delayed funds or approvals (8 respondents) and miscellaneous factors such as poor infrastructure or political interference (22 respondents). These findings underscore the complexity of groundwater governance, where administrative inefficiency, inadequate dissemination of knowledge, and limited technical support contribute to poor policy outcomes.

Regarding local empowerment, a large majority (67 respondents) stated that Panchayats lack sufficient powers and resources to manage groundwater issues effectively. Only 6 respondents believed Panchayats are adequately empowered, while 27 respondents felt they have limited or partial capacity ("to some extent"). This highlights a crucial governance gap at the grassroots level: Panchayats are often expected to play a central role but lack the financial, technical, and administrative autonomy to act effectively.

Transparency in groundwater-related schemes and in the utilisation of funds was also found to be inadequate. Only 14 respondents considered the process very transparent, and 25 respondents found it somewhat transparent. In contrast, 8 respondents found it not transparent, and a striking 53 respondents reported no knowledge of transparency mechanisms. This reflects a weak accountability framework and limited public access to information regarding water conservation expenditures.

Finally, community participation in decision-making remains minimal. None of the respondents reported that local farmers are always consulted in groundwater conservation planning. Only 4 respondents said farmers are sometimes involved; 35 stated they are rarely consulted; and a significant majority of 61 respondents affirmed they are never included in such decision-making processes. This data clearly indicates that groundwater governance in Charkhi Dadri is largely top-down, with little participatory planning or community inclusion.

In summary, the institutional landscape of groundwater management in Charkhi Dadri district is characterised by limited inter-agency coordination, weak Panchayat empowerment, poor transparency, and low community participation. Although local governance structures, such as Gram Panchayats, are active, their effectiveness is constrained by resource limitations and the absence of collaborative frameworks. Strengthening institutional linkages, enhancing local capacity, and ensuring participatory planning are therefore essential for achieving sustainable groundwater management in the district.

Perception of Policy Effectiveness

The analysis of respondents' perceptions regarding the effectiveness of groundwater management policies in Charkhi Dadri district provides valuable insights into the existing policy framework and its implementation gaps. As shown in Table 3, the majority of respondents identified several limiting factors that hinder the success of groundwater policies at the local level. The most frequently cited challenge was the lack of public participation, reported by 43 respondents, highlighting the limited involvement of local communities in policy planning and implementation. 14 respondents noted inadequate enforcement of rules and guidelines, while 12 respondents identified insufficient funding as a major obstacle. Additionally, 10 respondents identified poor monitoring mechanisms as a major issue, and 21 respondents mentioned other factors, such as political interference, delayed implementation, or a lack of coordination between departments. These findings collectively suggest that, despite well-formulated policies, their effectiveness is undermined by systemic weaknesses in participatory governance, monitoring, and institutional efficiency.

Table 3: ***Perception of Policy Effectiveness***

Sr. No.	Perception of Policy Effectiveness	Response	No. of Respondents
1	What factors limit the success of groundwater policies in Charkhi Dadri?	Poor monitoring	10
		Lack of public participation	43

		Insufficient funds	12
		Inadequate enforcement	14
		Others	21
2	How would you rate the overall effectiveness of groundwater governance in your area?	Very effective	28
		Moderately effective	57
		Ineffective	15
3	What should be improved for better groundwater management? Select all that apply	Awareness programmes	64
		Farmer training and capacity building	71
		Strengthening local institutions	68
		Better coordination among departments	46
		Community participation	78
4	In your opinion, who should play the important role in managing groundwater sustainably?	Government	5
		Panchayats	13
		Farmers' groups	82
		NGOs	0

Source: Computed by Research Scholar from the data collected during the primary survey

When evaluating the overall performance of groundwater governance in the district, most respondents held a moderate view. About 57 respondents (57%) rated groundwater governance as moderately effective, suggesting that some progress has been made but that much remains to be improved. Only 28 respondents (28%) considered the governance system very effective, whereas 15 respondents (15%) found it ineffective. This distribution reflects cautious optimism among the local population, recognising governmental efforts while simultaneously acknowledging ongoing administrative and operational shortcomings.

The respondents also provided constructive suggestions for improving groundwater management in the district. The most common recommendation was to enhance community participation, supported by 78 respondents, indicating the widespread belief that grassroots engagement is essential for sustainable water governance. 71 respondents emphasised farmer training and capacity building, followed closely by strengthening local institutions (68 respondents) and awareness programmes (64 respondents). Furthermore, 46 respondents stressed the need for better coordination among departments, underscoring the importance of an integrated approach involving multiple stakeholders. These results clearly highlight that the local farming community perceives participatory mechanisms, institutional empowerment, and educational outreach as major to addressing groundwater depletion effectively.

When asked who should play the most significant role in managing groundwater sustainably, an overwhelming majority, 82 respondents (82%), believed that farmers' groups should take the lead. This response reflects a strong sense of local ownership and recognition that farmers, as the primary users of groundwater, have the greatest responsibility and potential to contribute to conservation efforts. A smaller number of respondents (13) identified Panchayats as the most suitable authority, while only 5 respondents placed the responsibility primarily on the government. Notably, none of the respondents viewed NGOs as having a major role in groundwater management, indicating limited engagement or visibility of non-governmental actors in this sector.

Overall, the findings suggest that although groundwater policies and programmes are in place, their effectiveness is limited by inadequate enforcement, insufficient monitoring, and low community participation. Respondents strongly believe that empowering local institutions, enhancing farmer capacity, and promoting collective responsibility among stakeholders are critical to achieving sustainable groundwater management in Charkhi Dadri district. The results emphasise a clear shift from a top-down administrative model toward a community-centred and participatory approach to groundwater governance.

CONCLUSION

The study concludes that groundwater depletion in the Charkhi Dadri district poses a serious threat to agricultural sustainability and rural livelihoods. While several government initiatives exist, their effectiveness is constrained by weak institutional coordination, limited farmer awareness, and inadequate enforcement. Panchayats and local institutions lack sufficient authority and resources to manage groundwater effectively. The findings highlight the urgent need for participatory governance, farmer capacity building, and improved inter-departmental collaboration. Strengthening policy implementation through local involvement and transparent monitoring can ensure sustainable groundwater management and enhance agricultural resilience in semi-arid regions like Charkhi Dadri.

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