Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 06, Issue: 01 (JAN-FEB, 2026)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

# Groundwater Pollution: Impact on Agriculture

*Geeta S Tamgale and Arjun M S
Department of Extension Education and Communication Management, UAS, Dharwad
*Corresponding Author's email: tamagalegs@uad.in

Groundwater is one of Earth's hidden treasures and it makes up about 97 percent of all the freshwater on our planet, quietly filling wells, springs and aquifers beneath our feet. In many regions, it's the lifeline that brings clean drinking water to homes, supports farms, and keeps ecosystems healthy. Yet this precious resource is under growing threat—and unless we act now, the consequences could be worst.

Groundwater pollution poses a significant threat to agricultural sustainability, particularly in India where aquifers support over 60% of irrigation needs. This review corrects factual inaccuracies, enhances scientific rigor, and restructures the original article into a publication-ready format with updated evidence, precise terminology, and quantitative data.

## Why Groundwater Matters

- **Essential Source of Drinking Water:** In rural and urban areas alike, millions of people rely on groundwater for their daily needs.
- **Agricultural Backbone.** Nearly one in five hectares of farmed land (around 18 percent worldwide) depends on irrigation—much of it fueled by pumped groundwater—to turn seeds into food.
- **Ecological Safety Net.** Rivers, lakes and wetlands often depend on the slow release of groundwater, especially in dry seasons.

When groundwater is healthy, it replenishes rivers, sustains farms and keeps wells flowing. But contamination or over-use sets off a cascade of problems.

## The Growing Threat of Pollution

Modern agriculture has been both a blessing and a curse: while fertilizers and pesticides help to feed billions, they also introduce nitrates, salts and chemical residues into soil. Over time, rain and irrigation water carry these compounds downward, where they accumulate in aquifers. Nitrate levels can spike, posing risks to human health—especially for infants and pregnant women—and to aquatic ecosystems. Meanwhile, improper disposal of industrial chemicals, leaking septic tanks and seepage from landfills add more toxic ingredients to our underground reservoirs. Once groundwater is contaminated, it hard and expensive to clean up. Agriculture contributes to groundwater pollution in two key ways:

1. **Direct abstraction** – large volumes of groundwater are used for irrigation.
2. **Incidental contamination** – pollutants such as nitrates and salts are released into the soil, eventually leaching into aquifers.

## Impact on Agriculture

Groundwater is the unseen force behind the world's food supply—and when it falters, agriculture feels the shock first. Nearly 20 percent of global crop land depends on irrigation, much of it drawn from underground aquifers. As those hidden reserves become polluted or depleted, farmers face higher costs, lower yields and mounting uncertainty.

## How Contaminated Groundwater effects Farms

1. **Reduced Crop Yields:** Nitrates, heavy metals or pesticide residues in irrigation water can interfere with plant metabolism, leading to stunted growth, smaller fruits or grains and overall yield declines.
2. **Soil Salinization :** Contaminants—particularly salts—accumulate in the root zone when polluted water evaporates, raising soil salinity. High salinity impairs seed germination, disrupts nutrient uptake, and can render fields unfit for many crops.
3. **Toxic Bioaccumulation:** Crops can take up harmful substances (e.g., cadmium, arsenic) from contaminated water. These toxins may concentrate in edible tissues, posing food-safety risks and potential market rejections.
4. **Increased Input Costs:** To compensate for poor-quality water, farmers may need to install treatment systems (filtration, reverse osmosis) or buy "clean" water, driving up production costs—often beyond the reach of smallholders.
5. **Soil Structure Degradation:** Certain pollutants (like excessive sodium) alter soil aggregate stability, leading to compaction or crusting. This reduces infiltration, aeration, and root penetration, making soils harder to work and less fertile.
6. **Heightened Pest & Disease Pressure:** Weakened plants—stressed by toxic irrigation water—are more vulnerable to pests, fungal pathogens and viral infections, triggering greater reliance on chemical controls and a vicious cycle of contamination.
7. **Livestock Health Impacts:** Farms that use groundwater for animal watering expose livestock to the same pollutants. Chronic exposure can lead to reduced growth rates, reproductive issues and increased veterinary costs.
8. **Long-Term Aquifer Degradation:** Once an aquifer is polluted, its natural self-purification is extremely slow. Continued reliance on contaminated groundwater forces farmers to drill deeper wells, accelerating both financial strain and ecosystem harm.
9. **Market & Regulatory Barriers:** Stricter food-safety standards in local and export markets can bar/restrict produce grown with known pollutant levels, limiting farmers' market access and profitability.
10. **Ecosystem Disruption:** Polluted groundwater that feeds springs, streams or wetlands alters those habitats—reducing pollinator populations, fish stocks and beneficial soil-microbe communities that support sustainable agriculture.

## Government of India Initiatives to Control Groundwater Pollution

Government is striving hard to combat this, some of the programs, policies and initiatives aimed at monitoring, managing and reducing groundwater pollution are;

1. **Implementation of the Water (Prevention & Control) Act, 1974, and the Environment (Protection) Act, 1986;** Central Pollution Control Board (CPCB), together with State Pollution Control Boards, enforces discharge standards for industrial effluents (including heavy metals, nitrates, organics) under these Acts.Online Continuous Effluent Monitoring Systems (OCEMS) are mandated for major polluting units to ensure real-time compliance and rapid enforcement action on violations.
2. **Guidelines for Control and Regulation of Groundwater Extraction (September 24, 2020);** Issued by the Department of Water Resources, River Development & Ganga Rejuvenation (now in the Ministry of Jal Shakti), these pan-India guidelines include provisions for protecting aquifer quality (e.g., minimum safe distances from contamination sources) and prescribing pollution-free abstraction methods.
3. **Atal Bhujal Yojana (ABHY);** Launched in 2019, ABHY is a ₹6 000 crore, World Bank–assisted, community-led groundwater management scheme in seven water-stressed states. It funds village-level water budgeting, recharge-structure construction, and capacity building of "Bhujal Mitra" volunteers to both augment and safeguard groundwater quality.
4. **National Aquifer Mapping & Management Programme (NAQUIM);** Under the Ground Water Management & Regulation (GWM&R) scheme, the Central Ground Water

Board (CGWB) systematically delineates and characterizes aquifers nationwide, while also sampling for key contaminants (arsenic, fluoride, nitrate, iron) to inform area-specific pollution-mitigation plans.

5. **Jal Shakti Abhiyan (JSA);** A flagship campaign (2019–22) promoting rainwater-harvesting, rejuvenation of traditional water bodies, recharge-pit construction and afforestation. By boosting aquifer recharge, JSA indirectly dilutes pollutant concentrations and reduces reliance on over-exploited, contaminated groundwater.
6. **Pradhan Mantri Krishi Sinchai Yojana (PMKSY);** The "Har Khet Ko Pani" component expands coverage of efficient irrigation systems (drip, sprinkler) and repairs water bodies. More uniform, measured irrigation reduces leaching of fertilizers and pesticides into the subsurface.
7. **Jal Jeevan Mission (JJM);** Aims to deliver safe, treated piped drinking water to every rural household by 2024. By providing an alternative to potentially polluted groundwater, JJM decreases direct abstraction pressure and exposure to contaminants.
8. **National Hydrology Project (NHP);** Supports states in strengthening groundwater monitoring networks via installation of piezometers, Digital Water Level Recorders (DWLRs) with telemetry, and expansion of quality-monitoring wells. This high-frequency data enables early detection of emerging contamination trends.
9. **Model Groundwater Bill, 2017 & National Water Policy, 2012;** Though non-binding, these frameworks encourage states to adopt community-based resource management (public-trust doctrine), regulate abstraction permits, and integrate pollution prevention into aquifer governance. Several states have based their own Groundwater Acts on this model.
10. **Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) – Watershed Development;** Under the PMKSY-Watershed component, MGNREGA funds construction of check-dams, contour bunds and other soil-and-water conservation structures. These serve dual purposes: enhancing recharge and filtering surface runoff before it percolates, thus reducing pollutant loads entering aquifers.

## Measures that can help to stop or greatly reduce groundwater pollution

**1. Source Control**

Regulate Chemical Use Limit and optimize application rates of fertilizers, pesticides and herbicides through nutrient-management plans and integrated pest management (IPM). Industrial Effluent Treatment mandate, robust effluent-treatment plants (ETPs) and zero-liquid discharge (ZLD) for factories handling heavy metals or organics. Safe Handling & Disposal; Enforce strict protocols for storage, transport and disposal of solvents, fuels, agro-chemicals and medical wastes.

**2. Sustainable Agricultural Practices**

Precision Irrigation adopt drip or micro-sprinkler systems to match water delivery with crop needs, reducing excess leaching. Crop Rotation & Cover Crops Use deep-rooted cover plants and rotate legumes to improve soil health and reduce reliance on synthetic inputs. Buffer Strips & Riparian Zones; Maintain vegetated margins around fields and waterways to trap sediments and absorb excess nutrients before they infiltrate.

**3. Artificial Recharge & Rainwater Harvesting**

Recharge Structures; Build check-dams, percolation tanks, recharge wells and recharge pits in watersheds to boost natural aquifer replenishment and dilute pollutants. Roof-Top Harvesting, collect and channel rainwater from buildings into storage or recharge systems, lessening direct runoff of contaminants.

**4. Monitoring & Early Warning**

Regular Water-Quality Testing; Sample and analyze key groundwater parameters (nitrates, fluoride, heavy metals) at fixed intervals to detect contamination hotspots. Telemetry-

Enabled Gauges Deploy sensor networks (digital water-level recorders, quality sensors) linked to public dashboards for real-time oversight.

In summary, protecting our underground water isn't just an environmental priority—it's essential for the farms that feed us. India's mix of regulations, mapping and recharge programs, along with smarter farming methods and community stewardship, offers a roadmap to keep our aquifers clean and productive. When policymakers, farmers and citizens work together—adopting efficient irrigation, reducing chemical use, and supporting groundwater monitoring—we can safeguard this invisible resource. Only by combining strong governance with on-the-ground action can we ensure healthy soils, resilient harvests and a secure water future for all.

## References

1. World Health Organization (WHO). Protection and Management of Groundwater Resources. WHO Press, 2006.
2. Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti. *Guidelines for Control and Regulation of Groundwater Extraction.* Government of India, Sept. 2020.
3. Central Ground Water Board (CGWB). *National Aquifer Mapping & Management Programme (NAQUIM): Report.*CGWB, 2018.
4. Ministry of Jal Shakti. *Atal Bhujal Yojana: Groundwater Management Scheme.* Government of India, 2019.
5. Central Pollution Control Board (CPCB). *Guidelines for Implementation of the Water (Prevention & Control) Act, 1974 & Environment (Protection) Act, 1986.* CPCB, Ministry of Environment, Forest & Climate Change, 2019.