

2. Arsenic in Rice – Environment

Microbial link between arsenic in soil, lower rice yield uncovered. A recent study revealed that the microbial composition of rice paddies—not just the arsenic content in soil—plays a decisive role in arsenic toxicity and yield loss in rice. Managing soil microbes could therefore be crucial to maintaining rice productivity and ensuring food safety.

Current Status

Global Situation – Around 150 million people are exposed to arsenic-contaminated rice globally. Arsenic toxicity can cause up to 70% yield loss in severely affected fields due to straight head disease.

India's Context – India is the 2nd largest rice producer, with 45 million hectares under cultivation. High-risk states include West Bengal, Bihar, Assam, and Uttar Pradesh, where groundwater arsenic exceeds 0.05 mg/L (WHO limit – 0.01 mg/L). Rice grains in these areas contain 0.2–0.4 mg/kg arsenic, reducing yield by 15–40%.

Developing Linkages – In West Bengal, rice grain arsenic ranged from 0.41 to 1.68 mg/kg dry weight; roots showed 29–167 mg/kg, with a translocation factor of 4–45%. In eastern Uttar Pradesh, under the genotype “Shatabdi”, deficit irrigation reduced grain arsenic by 6–25%, while yield declined only by 0.9%. Alternate Wetting and Drying (AWD) irrigation in West Bengal reduced arsenic bioavailability by 26%, resulting in 6–8% higher profit compared to continuous flooding.

Key Findings – Elevated arsenic in paddy soils and irrigation water leads to higher arsenic uptake in rice. Even minor yield impacts (≈1%) can be reduced by changing irrigation practices. Arsenic-specific yield loss in India remains under-studied, but mitigation practices preserve yield and quality.

Implications of Arsenic in Soil

1. Agricultural Impact – Arsenic toxicity reduces rice yield by 15–70%, depending on soil and microbial balance. In high-risk states, arsenic causes poor grain filling and straight head disease. Global yield loss due to arsenic contamination is estimated at 1.4–4.9 million tons annually.

2. Food Security & Nutrition – Rice provides around 40% of caloric intake in India. Arsenic-contaminated rice threatens food safety and dietary nutrition. Long-term exposure poses greater risk among rural and low-income populations.

3. Human Health Implications – Chronic exposure to arsenic-contaminated rice can cause skin lesions, cancer, cardiovascular diseases, and cognitive impairment. Around 150 million people globally are at risk of health issues due to arsenic exposure through rice.

4. Environmental & Ecological Impact – Arsenic disturbs soil microbial communities, enhancing methylating bacteria that convert inorganic arsenic to more toxic organic forms (DMA, DMMTA). These compounds accumulate in rice and persist in soil–water systems, worsening toxicity over time.

5. Economic Impact – Annual economic loss due to arsenic-related yield decline in South and Southeast Asia exceeds \$3 billion. Farmers in affected districts face reduced income due to low grain quality and export restrictions.

Government Measures – India's Food Safety and Standards Authority (FSSAI) has not set a specific arsenic limit for rice; general food safety rules apply. The central government has identified West Bengal and Bihar as most impacted states, suggesting adaptive cropping and water monitoring. Regional agricultural research in West Bengal has developed an “arsenic-free rice” variety to address the issue.

Country-wise Comparison

Country / Region	Regulation on Arsenic in Rice	Rice Arsenic Data	Remarks
European Union	Limit of 0.15 mg/kg for non-par-boiled rice, 0.25 mg/kg for par-boiled rice	Average levels below limits	One of the strictest standards globally
China	Inorganic arsenic limit – 0.15 mg/kg	Contamination varies regionally	Strong regulation

India	No rice-specific national standard	Higher levels (up to ~0.446 mg/kg) in hotspot states	Regulatory gap
Bangladesh	No national limit specified	High soil and water arsenic levels	High exposure risk
United States	No FDA-established limit	Variable levels, especially in southern states	Lack of standard regulation

Way Forward

1. Adopt Arsenic Standards - India should adopt a rice-specific arsenic limit of 0.2 mg/kg as per global guidelines.

2. Smart Irrigation (AWD) - Alternate Wetting & Drying reduces arsenic uptake by about 26% without yield loss.

3. Soil & Microbial Management - Practices such as mid-season drainage and silicon fertilizer reduce toxic microbial activity and arsenic uptake.

4. Low-Arsenic Varieties - Cultivars developed by ICAR show 20–40% less arsenic accumulation in grains.

5. Safe Water Use - Shift irrigation from arsenic-contaminated groundwater (>0.05 mg/L) to surface or rainwater sources to ensure safety and sustainability.

Source - <https://www.thehindu.com/sci-tech/science/microbial-link-between-arsenic-in-soil-lower-rice-yield-uncovered/article70165810.ece>

