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Arsenic Cycling in Irrigated Paddy Soils in Bangladesh: Long-term Risks to Food Security

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Abstract

Arsenic (As) in groundwater poses a major health risk to millions of people in southeast Asia. The main exposure pathway is via drinking water extracted from shallow groundwater wells. However, there is also an increasing use of As-rich groundwater for irrigation of Boro rice cultivated during the dry season. Meanwhile, a large percentage of the agricultural land area in Bangladesh is irrigated with As-rich groundwater, and Boro rice production accounted for 48 % of the total rice production of Bangladesh in 2005. It was estimated that ca. 0.4 kg ha^{-1} of As are applied each year to rice paddy soils with irrigation water. Thus, there is major concern that As may accumulate in paddy soils and lead to (i) increased As uptake by rice and increased exposure of the local population to As via rice consumption, and (ii) yield decreases due to the phytotoxicity of As.

In a three-year field study, we investigated the cycling of As in an irrigated rice paddy system in Munshiganj district, Bangladesh. Our objectives were (i) to understand the spatial distribution of As in irrigated rice fields, (ii) to quantify the gains and losses of As during irrigation and monsoon flooding, and (iii) to assess possible long-term effects on rice yields and As uptake into rice grain.

Soil samples were collected twice a year on a rice field and analysed for total As. Soil As decreased with increasing distance from the irrigation water inlet within paddy fields. Gains and losses of As during the irrigation season and monsoon flooding could be documented and quantified. Analyses of rice grains sampled along a gradient in soil As, in combination with controlled pot experiments, showed that elevated soil As leads to increased As uptake by rice, and eventually, decreased rice yields. First trend estimates suggest that average As contents in rice grain produced at the site may increase ca. 2.5 fold by the year 2050.

Keywords: Arsenic, food security, groundwater, paddy soils, rice

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