Arsenic in the Irrigation Water-Soil Environment and Flows of Arsenic in the Food System

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Groundwater from shallow aquifers is extensively used for drinking and irrigation in Bangladesh. The installation of hundreds of thousands of shallow tube wells (STW) in Bangladesh over the last three decades may, very justifiably, be considered a "groundwater revolution" because it supplied "safe" drinking water for hundreds of millions of people and, on the other hand, uniquely contributed to the tripling of the annual production of rice, the staple food crop. This paved the way for the long cherished goal of achieving self-sufficiency in food production for the teeming millions of Bangladesh citizens. However, two decades since the first STWs were commissioned it began to be known that the water which was once thought to be safe for drinking had, in many places, been slowly contaminated with As, a dreaded poison. Alarming levels of As in shallow groundwater in about 35% of the STWs in Bangladesh have been reported. Agricultural soils in many areas of the country also have been found to contain high As levels. Also, evidence of elevated As accumulation in rice is mounting. There is a growing national concern about arsenic contamination of groundwater in Bangladesh, because many millions of people in Bangladesh is facing a two-way risk of exposure, directly through drinking water and indirectly through food crops grown on soils contaminated by arsenic through groundwater irrigation. The grave consequences of arsenic pollution of water, soils and crops to the environment and human and animal health notwithstanding, the behavior of As, especially in agricultural-production systems and the food chain is not yet well understood. There is an urgent need, especially in Bangladesh, which is probably the worst affected country, for an understanding of the nature and extent of arsenic pollution of the irrigation waters, soils and crops and developing water-soil-crop management practices to mitigate the arsenic problem in agriculture and food.

Irrigation-water As interacts with the soil in a very complicated manner. The interactions are influenced by both water and soil properties, like pH, texture, mineralogy, organic C, redox potential, reactions with free iron oxide, P, etc. These water-soil interactions largely regulate the bioavailability of As, e.g., its uptake and accumulation in edible plant parts. Of special interest is the behavior of As in rice soils that remain flooded and anaerobic throughout the rice-growing season. In the reduced condition, As (III) predominates, and this species of As is believed to be responsible for an elevated level of As in rice. High As accumulation in rice grain and straw in Bangladesh has been reported.

Little is known about the real or potential As exposure of the rice-eating people of Bangladesh. Estimates showed about 50% of daily As intake could come from rice grain

when the intake of both water As and rice As was considered. Arsenic may also affect animals through feeding with high-As straw, which can be an additional indirect health hazard for humans. However, very little is known about this potential hazard in Bangladesh.

There are critical knowledge gaps in the understanding of As in crop-production systems. Continued research/education is needed for the development of As-management technology to ensure food security and safe food. Some important issues that need attention are summarized below.

- Develop a nationwide database on current As levels in soils
- Assess impact of As in irrigation water on soil As levels
- Understand which arsenic species predominate in plants; understand the bioavailability of As in food and feed
- What should be the safe levels of arsenic be in irrigation water, soils and crops under the prevailing cropping systems of Bangladesh in terms of yield and crop quality?
- How do crops and cultivars vary in their tolerance and uptake of arsenic? If there is significant variation, can this be used as a management tool?
- Fill the void in the education sector. Help develop undergraduate and graduate level courses for Bangladeshi students on the behavior of arsenic in agricultural systems and options for management