Arsenic Accumulation in Irrigated Paddy Soils and Possible Mitigation Methods

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Structure of Presentation

Arsenic Accumulation in Soils

"*Arsenic toxicity in soils is no new problem*"

Reed and Sturgis (1936)

- Only recently recognised in Bangladesh
- Many countries not yet aware of potential problem

Arsenic in soils - II

- Arsenic from irrigation water mainly stays in the topsoil
- Accumulation most serious where rice irrigated
- Irrigated rice uses large amounts of water (400–1500 mm in Bangladesh)
- Arsenic available to roots in anaerobic paddy soils
- Immobilised by ferric iron in dryland soils

Arsenic toxicity (1)

- No single level at which soil arsenic is toxic to plants
- Varies with redox potential, pH, and OM, Fe, Mn, P and S contents
- Factors vary between soils, and within the year
- Different plants absorb or tolerate arsenic to different degrees
- Ditto for different rice varieties

Arsenic toxicity (2)

- Conventional soil analysis methods may not measure actual arsenic availability in paddy soils
- Assumed toxic limit for rice is 50 ppm
- Soils with >50 ppm reported in Bangladesh
- Straighthead disease reported in 2006

Features of arsenic toxicity in crops

Photographs courtesy of Dr Richard Loeppert, Texas A&M University

Arsenic Addition from Irrigation Water

	As load in irrigation water (ppb)		
	100	**250**	**500**
Years of irrigation	**As addition to soil mg/Kg**		
1	0.56	1.39	2.78
5	2.78	6.94	13.89
10	5.56	13.89	27.78
20	11.11	27.78	**55.56**
50	27.78	**69.44**	**138.89**

Arsenic in STW command areas

- Not all arsenic in irrigation water reaches fields
- Arsenic immobilised by iron on aeration
- Arsenic levels decrease in irrigation channels
- So different amounts of arsenic reach fields in different parts of command areas
- Soil differences within command areas also influence arsenic availability

Figure 2. (From Hossain, 2005)

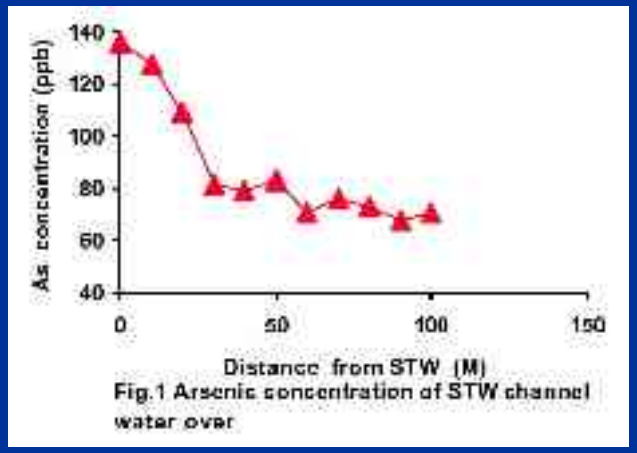


Fig.1 Arsenic concentration of STW channel water over

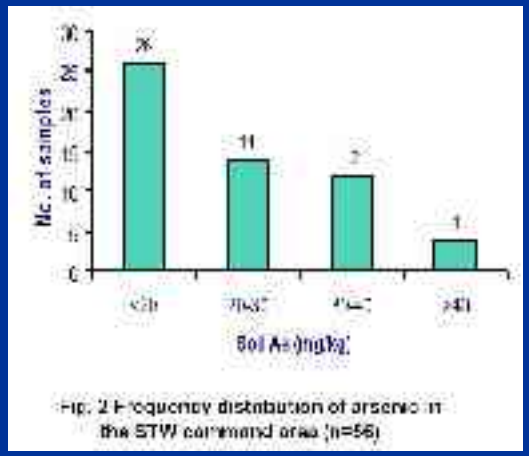
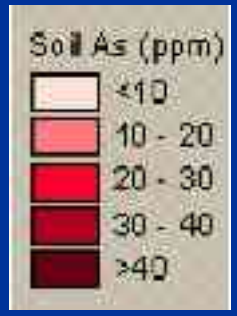


Fig. 2 Frequency distribution of arsenic in the STW command area (n=56)

Distribution of As in soil



Mitigation

- Most studies in developed countries on sites contaminated by mining/industrial wastes and agrochemicals
- Few of these methods apply to paddy farmers
- Mitigation/rehabilitation methods will vary from area to area

Mitigation Methods

1. Water treatment
2. Alternative irrigation supply
3. Alternative farming methods
4. Soil rehabilitation

Water Treatment

- Filtration/chemical treatment
- Co-precipitation with iron

Alternative Irrigation Supply

- Deep aquifer
- River/lake/pond
- Reservoir

Alternative Farming Methods

- Substitute dryland crops
- Grow dryland rice
- Use arsenic-tolerant varieties
- Soil amendments

Soil Rehabilitation

- As above:
  - Deep aquifer
  - River/lake/pond
  - Reservoir
  - Soil amendments

plus:

- Remove topsoil
- Grow hyperaccumulating plants

Institutional Needs (1)

- Increase awareness
- Identify areas already affected or at risk
- Test appropriate mitigation or rehabilitation methods
- Find locally-suitable methods
- Monitor and adjust

Institutional Needs (2)

- Recruit, train and equip staff
- Fund investments
- International funding
- Role of NGOs

The End