

# Risk Assessment for the Disposal in Rice Paddy of Arsenic Waste Generated From Using ARTs

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# The Outline of This Presentation

- Arsenic waste characteristics
- Acceptable methods of arsenic waste
- Risk Assessment:
  - Identification of hazard
  - Dose-Response analysis and risks estimate
  - Assessment of exposure to arsenic from arsenic wastes
  - Risk characterization and lifetime risks of dying from arsenic ingestion
- Concluding remarks



# The Characteristics of Arsenic Waste

- ❖ **Non-Hazardous according to the US-EPA Toxicity Characteristic Leaching Procedure (TCLP)**
- ❖ **Most wastes are also non-hazardous when tested under anaerobic environment with or without iron chelators.**
- ❖ **A non-hazardous waste could be**
  - **Disposed in a sanitary and/or industrial Landfill, and**
  - **Applied to land**



# Limits to the Land Disposal of Arsenic

- The US EPA limit for the land disposal of arsenic is 2 kg of As/hectare of land or 0.2 mg/kg of soil, assuming that As can be mixed well with soil to a depth of 10 cm – US EPA (2000):EPA/600/R-00/025
- The WHO limit for the land disposal of arsenic is 8 mg/kg of soil - WHO(2006):  
[http://www.who.int/water\\_sanitation\\_health/wastewater/gsuww/en/index.html](http://www.who.int/water_sanitation_health/wastewater/gsuww/en/index.html)
- IT IS SAFE TO DISPOSE ARSENIC WASTE ON FARMLAND



# Hazard Identification

- Arsenic is both toxic and carcinogenic
- Toxicity effect appears within 30-60 min. while carcinogenic effect appears between 7 (skin cancer) to more than 30 (internal organ cancer) years
- Carcinogenicity have been confirmed through ecological and cohort studies conducted in Taiwan, Japan, Chile, Argentina, and elsewhere
- Between 200,000 and 270,000 death per year in Bangladesh (WHO)



# Hazard Identification: Age-Adjusted Mortality (per 100,000) from various Cancers in Taiwan

Cancer site	Sex	≥600 ppb	200-590 ppb	≤300 ppb	General population
All Sites	M	434.7	258.9	154.0	128.1
	F	369.4	182.6	113.3	85.5
Liver	M	68.8	42.7	32.6	28.0
	F	31.8	28.8	14.2	8.9
Lung	M	87.9	64.7	35.1	19.4
	F	83.8	40.9	26.5	9.5
Bladder	M	89.1	37.8	15.7	3.1
	F	91.5	35.1	16.7	1.4
Kidney	M	21.6	13.1	5.4	1.1
	F	33.3	12.5	3.6	0.9
Skin	M/F	28/15.1	10.7/10	1.6/1.6	0.8/0.8
<i>Chen et al. (1988) Lancet, 1, 414-415</i>					

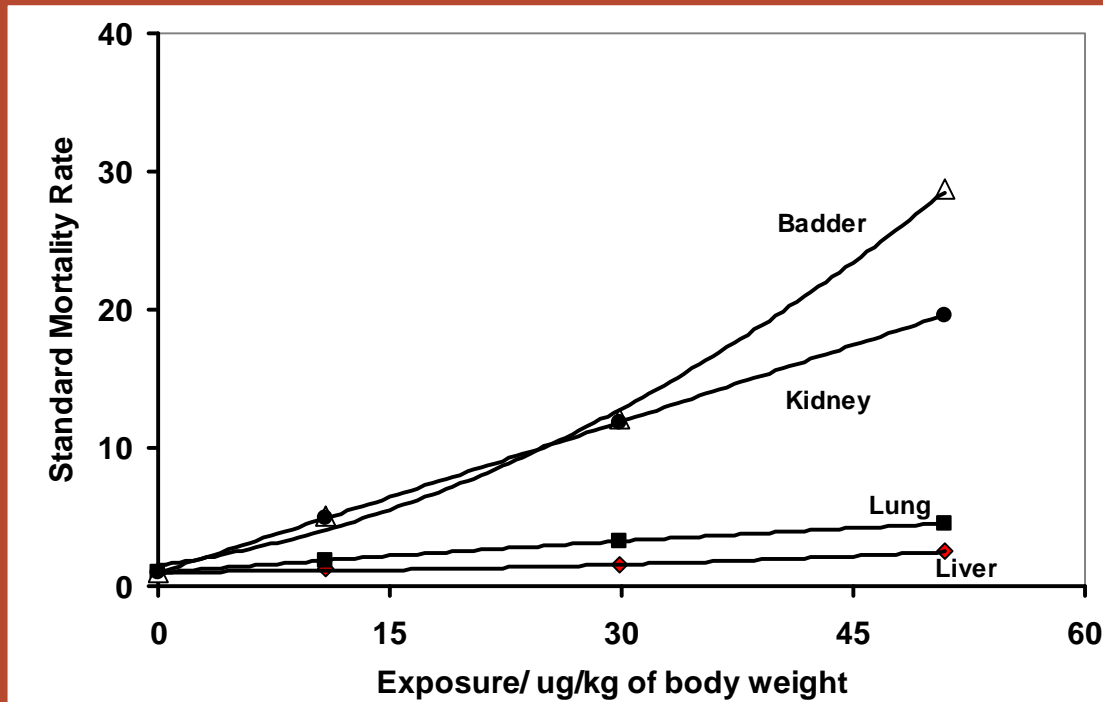


# Dose-Response Analysis

- Used Taiwanese data for Dose-response Analysis  
Due to: a) lack of Bangladeshi Data, b) Similarities - in education, means of income, caloric intake, access to health care, etc.-between the two population
- Quadratic equation was employed to represent the Dose-response relationships
- The finding can be represented well with by a quadratic equation and the representations are statistically significant
- Estimate background Standard Mortality Rate (SMR=Mortality rate/general mortality rate)
- Examples of SMR vs. Exposure Dose and regression data are given in the next slide



# Dose-Response Analysis



Cancer sites	Sex	Background SMR/Estimate	Linear Slope	Quadratic Slope	P-Value
All site	M	0.988	0.015	0.001	0.014
	F	1.052	0.004	0.054	0.054



# Exposure Assessment

- Assessment assumes that:
  - All arsenic is released into the soil
  - pulses, vegetable, meat, etc., contain as high arsenic as rice
  - Ground water As level=0.4 mg/L; annual water consumption/family = 20,000 L
  - Arsenic collected on ART media = 8 g
  - Arsenic waste is spread on the farm
  - Average farm size = 0.35 hectares
  - Average quantity of rice grown
  - Bangladeshi males and females weigh 55 kg and 50 kg respectively

- Arsenic Exposure:

Male/Female = 0.0005/0.0007  $\mu\text{g}/\text{kg}$  of body weight from Household waste

Roychowdhury, T. (2008). . *Food Chem. Toxicol.*, 46. 2656-2564



# Risk Characterization

- Risk Characterization are made assuming:
  1. An adult consumes 800 g of rice, pulses, meat, vegetable, spices, etc.
  2. Food grown on arsenic waste disposed land
  3. Foods currently available in Bangladesh and grown in arsenic affected areas
  4. Water contaminated with 50  $\mu\text{g}$  of As/L
  5. Water contaminated with 10  $\mu\text{g}$  of As/L
- As shown in the next Table, the risks of mortality from cancers caused by arsenic waste disposed on farm land is negligible

Williams et al., (2005 & 2006; ) *Environ. Sci. Technol.*, **39**: 5531-5540 & **40**, 4903-4908 .



# Risk Characterization

Arsenic Source	Sex	Estimated SMR	Background SMR	Estimated Mortality/1000
Household ARTs	M	0.9880	0.9880	0.002
	F	1.0520	1.052	<0.001
Community ART	M	0.9881	0.9880	0.034/20
	F	1.0520	1.0520	0.010/20
Food	M	1.0400	0.9880	13.08
	F	1.1016	1.0520	12.81
GoB Drinking Water	M	1.0334	0.9880	11.39
	F	1.0922	1.0520	10.37
WHO/EPA	M	0.994	0.9880	2.87
Drinking water	F	1.0571	1.0520	1.32
Bates, et al (1992). Arsenic	ingestion and internal cancers: A review. <i>Am. J. Epidemiol.</i> 135, 462-476.			



# Conclusion

- Risk from disposal of arsenic wastes in rice paddies of arsenic waste to human health is very, very low
- The above risks are orders of magnitude smaller than:
  - A. Eating foods currently grown in arsenic affected areas
  - B. Drinking water that conforms to Bangladesh Drinking Water Standard
  - C. Drinking water that meets WHO/US EPA guidelines.



THANK YOU  
for  
LISTENING

