

## TERMS OF REFERENCE #16

For the research proposal to be funded under NFPCSP Phase II

# Consumption of unsafe foods: heavy metal, mineral and trace element contamination

## 1. Background and Rationale

Heavy metals are an important source of food contamination and health hazard. The main threats to human health are associated with exposure to arsenic, cadmium, lead and mercury and copper. Sources of food contamination include environmental and industrial pollution, agricultural practices, food processing and packaging. Absorption of heavy metals through food has been shown to have serious consequences on health – and thereby economic development associated with a decline in labour productivity as well as the direct costs of treating illnesses – such as kidney disease, damage to the nervous system, diminished intellectual capacity, heart disease, gastrointestinal diseases, bone fracture, cancer and death<sup>1</sup>.

Preliminary studies in different parts of Bangladesh indicate that the food chain is exposed to contamination by heavy metals and trace elements. Islam et al.<sup>2</sup> found that industrial sludge, often used as a soil conditioner or fertilizer, has high concentrations of heavy metals. Similarly, high levels of heavy metals were found in soils in the Sundarbans<sup>3</sup>. When these metals are absorbed by crops and animals they enter the food chain and constitute a serious health hazard. An analysis of heavy metal concentrations in vegetables in Jessore shows that all of the vegetables commonly consumed in diets contain dangerously high concentrations of heavy metals<sup>4</sup>. The need to take action to prevent and control contamination of the food chain by heavy metals and trace elements in Bangladesh is therefore becoming increasingly obvious.

The National Food Policy Plan of Action (2008-2015)<sup>5</sup> (area of intervention 3.6), as well as other national policies such as the National Agricultural Policy (1999), the National Fisheries Policy (1998), National Livestock Policy (2007), National Plan of Action for Nutrition (1997), the National Health Policy (2010) and the forthcoming National Food Safety Policy and Plan of Action, recognise the importance of reducing food contamination in Bangladesh in order to improve human health. However, while the extent and sources of arsenic contamination are well known, more comprehensive information on the extent to which the population of Bangladesh is exposed to food

<sup>1</sup> Jarup L (2003) Hazards of heavy metal contamination. British Medical Journal, 68: 167-182

<sup>2</sup> Islam, M.M., M.A. Halim, S. Safiullah, S.A.M. Waliul Hoque and M.Saiful Islam (2009). Heavy metal content in textile sludge in Gazipur, Bangladesh. Research Journal of Environmental Sciences, Vol 3 (Issue 3), pp. 311-315

<sup>3</sup> Awal, M. A.; W. H. G. Hale; and B. Stern | Trace element concentrations in mangrove sediments in the Sundarbans, Bangladesh | Marine Pollution Bulletin, Vol. 58, No. 12 (December), pp. 1944-1948

<sup>4</sup> Alam MGM et al (2003) Arsenic and heavy metal contamination of vegetables grown in Samta Village, Bangladesh, Science of the Total Environment, 308 (1-3): 83-96

<sup>5</sup> National Food Policy Plan of Action 2008-2015. Food Planning and Monitoring Unit (FPMU), Ministry of Food and Disaster Management, Government of the People's Republic of Bangladesh. P. xiii.

contamination by other toxic heavy metals and trace elements, namely cadmium, lead, mercury and copper is not widely available. This undermines the ability for decision makers to recognise the importance of interventions for reducing heavy metal contamination of food. Similarly some minerals and trace elements are insufficiently explored in foods in Bangladesh and newer data would be useful

This research will investigate the exposure to heavy metals in the average diet in Bangladesh, as well levels of contaminations in selected foods. Additionally, the intake and concentration of selected minerals and trace elements will be investigated. This will be done through the total diet study (TDS) approach<sup>6</sup>. This will provide information on the dietary exposure to heavy metal and trace elements contaminants, on its potential health implications as well as the potential sources of contamination and recommendations for action. Research findings will provide the necessary evidence to mobilise support for implementing national policies that commit the Government to reducing heavy metal contamination of food.

## **2. Objectives of the study**

The objectives of this research project are to:

- a. Assess the concentration of major foods and beverages consumed by poor and non-poor households for selected heavy metals, minerals and trace elements: : calcium, magnesium, sodium, potassium, iron, selenium, manganese, zinc, lead, cadmium, aluminium, mercury, antimony, nickel, copper, lithium, molybdenum, cobalt, arsenic, chromium
- b. Assess the extent of exposure to heavy metals, minerals and trace elements through food intake in Bangladesh by poor and non-poor households and the potential health implications
- c. Draw implications and to provide suggestions for actions to reduce contamination.

## **3. Scope of the study**

More specifically, the study will address the following issues:

- Preparation of a Total Dietary Study food list: Food consumption data from the 2010 Household Income Expenditure Survey from Dhaka (and other regions)

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<sup>6</sup> A TDS consists of selecting, collecting and analysing commonly consumed food purchased at retail level, processing the food as for consumption, pooling the prepared food items into representative food groups, homogenizing the pooled samples, and analysing them for harmful and beneficial chemical substances. TDSs are designed to cover the whole diet and to measure the amount of each chemical substance ingested by the population living in a country, using average and high-level consumption data. Exposure through drinking water and water used in cooking are included in the TDS assessment. The dietary exposure calculations assist in determining whether specific food chemical substances pose a risk to health. A TDS can be a cost-effective public health tool to assist in determining population dietary exposure to beneficial and harmful chemical substances in food, i.e. contaminants and nutrients including minerals. It is most suitable for collecting data on the occurrence of chemical substances that are ubiquitous in food such as heavy metals. The TDS will at least cover Dhaka and should be extended to other regions if sufficient budget is available.

will be converted to represent the respective values of food intake by poor and non-poor households, expressed in edible portion as consumed per adult equivalent. The most important foods (i.e. those representing 85% of the total weight of the food intake in Dhaka (and of other regions, if possible) will be selected. From the foods that constitute the remaining 15% of food intake, foods that are likely to be an important contributor to heavy metal exposure will be selected. Tap water from Dhaka and from 3 other regions from Bangladesh will be included. The total food list will include no less than 75 foods including water to be analysed.

- Preparation of a TDS sampling plan: A sampling plan will be established for the selected foods. Care will be taken to include in the food samples foods coming from different regions and consumed by poor and non poor households.
- Preparation of the food samples for analysis: The collected food samples will be prepared, cooked and pooled as defined in the food list and sampling plan. They will then be kept in deep frozen conditions, including during transportation, until analysis.
- Analysis of foods: The pooled samples will be analyzed in a laboratory with an adequate quality assurance schemes using Inductively coupled plasma spectrometry coupled with a mass spectrometer (ICP-MS). The analysis will provide compositional data on the following heavy metals, minerals and trace elements: calcium, magnesium, sodium, potassium, iron, selenium, manganese, zinc, lead, cadmium, aluminium, mercury, antimony, nickel, copper, lithium, molybdenum, cobalt, arsenic and chromium.
- Exposure assessment: Exposure will be estimated using a combination of values of food intake (see above bullet on preparation of a TDS food list) and data on concentration (from the analysis of the 75 food and water samples).
- Comparison with reference values: Exposure estimates will be compared to health-based toxicological reference values (e.g. heavy metals to be compared with acceptable daily intakes ADI, and minerals with recommended daily intakes RDI).
- Potential health Impacts: review literature to identify potential health impacts of food contamination by heavy metals, minerals and trace element on humans (with specific reference to pregnant and lactating mothers, children and infants) and the prevalence of diseases in Bangladesh that may be associated with high levels of exposure to heavy metals, minerals and trace elements through food.
- Options for reducing heavy metals in food: Using the analytical data from the TDS, review literature from other developing countries with a focus on the Asia region to identify potential sources of heavy metals along the food chain and options for reducing exposure to heavy metal contamination and health impacts in Bangladesh.

The study will deliver:

- A draft inception report within 3 weeks from the date of signing of the contract. The inception report will detail the research programme, the literature and data requirements, methodology (including laboratory analysis) and expected outputs.
- A final inception report within 2 months from the date of signing of the contract. The NFPCSP will provide feedback to the draft inception report within 3 weeks of its submission. The research institution will then have 2 additional weeks to finalize and submit the final inception report.
- An interim report, within 5 months from the date of signing of the contract, presenting the finalized TDS food list, sampling plan and the selected laboratory to carry out the analysis
- A draft final report, within 10 months from the date of signing of the contract. The draft final report (length between 25,000 and 30,000 words -excluding an executive summary not exceeding 2,500 words, and annexes) should be based on the data analysis and program and literature review and should include:
  - Description of the purpose, relevance and background of the study and methodology used.
  - Literature review of secondary sources
  - Data analysis and laboratory techniques used
  - Descriptive statistics
  - Analysis of exposure including comparison to ADI and RDI and implications of this on human health, including an indication of the possible sources of contamination
  - Recommendations for actions to reduce heavy metal contamination, based on experiences in Bangladesh and other developing countries
- Database, 10 months from the date of signing of the contract:
  - Total dietary study food list
  - Results of food analyses
- A final report, 12 months from the date of signing of the contract. The final report will incorporate the feedback and adjustments required by the NFPCSP.

**4. Duration and funding available**

- Maximum duration: 12 months
- Maximum funding available: US\$50,000