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Challenges of Investigating Heavy Metal Contamination of Water and Food Crops in Zambia: A Comparison of Laboratories

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This paper describes some of the challenges in investigating heavy metal concentrations in contaminated irrigation water and food crops in Zambia, Southern Africa; in particular, we contrast and compare publicly accessible Zambian laboratories capable of measuring heavy-metals by using a known hay standard. We first describe urban agriculture in Zambia, and then our comparative Zambian laboratory study.

Urban agriculture is an important component of agricultural production in Zambia. Because of high unemployment there are more and more people turning to urban agriculture for survival. Agricultural production is in mainly two seasons, rainy and dry. In the rainy season the crops grown are mainly maize and pumpkins and the crops are rain fed, while in the dry season the main crops are rape and other vegetables and these are irrigated. The irrigation water in most urban centres is from different industries and it is contaminated with heavy metals that are known to be hazardous to human beings. For this reason, it is important to monitor the heavy mental content not only in irrigation water but also in the food crops produced with this water. In developing countries such as Zambia, laboratory facilities capable of analysing heavy metals are not readily available, with only a dozen Atomic Absorption Spectroscopy (AAS) machines in the country, and a couple Inductively Coupled Plasma (ICP) machines. Zambian legislation for heavy metals in waste water discharge and food crops sold stipulate that the water and food crops must be tested using AAS.

We conducted a comparative study of different public-use laboratories in Zambia. The reference sample IAEA-V-10 used is a hay standard prepared by the International Atomic Energy Agency (IAEA). We compared five different digestion methods. The equipment used for reading the metals was AAS in every case, except for one ICP. Six heavy metals (Zn, Cu, Pb, Co, Cr and Ni) were investigated. Our conclusions are: (i) most laboratories in Zambia capable of measuring heavy-metals face a big challenge of maintaining the equipment in good working condition; (ii) there is a very large discrepancy (commonly several orders of magnitude) between laboratories in terms of the heavy metal levels obtained in the same reference sample; (iii) the more easily analysed heavy metals by the different laboratories were Zn, Cu, Co, in that order; (iv) many laboratories provided results of heavy-metals detected that were 'below' those capable for that machine's detection limits. Almost all the laboratories in this study are important in the monitoring of heavy metals and therefore, the recommendations being made are that more comparative work should be encouraged, standard samples or reference samples must be obtained by all laboratories for better quality assurance, and that detection limits for individual metals examined by AAS and ICP be provided to the user by the laboratory.