AGRICULTURAL LAND MANAGEMENT OPTIONS FOLLOWING LARGE-SCALE ENVIRONMENTAL CONTAMINATION

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The recent events at the Fukushima Daiichi Nuclear Power Plant have raised questions about the accumulation of radionuclides in soils, the transfer in the food chain and the possibility for restricted land use in the foreseeable future. Following a large-scale nuclear accident, the application of countermeasures is a key issue in the emergency, post-emergency and late phase. This presentation summarizes what is generally understood about the application of agricultural countermeasures as a land management option to reduce the radionuclides transfer in the food chain and to facilitate the return of potentially affected soils to agricultural practices.

Numerous countermeasures were developed or improved since the Chernobyl accident and applied on large scale in Belarus, Ukraine and Russia, and some also in contaminated regions of Europe. To the extent possible, a global analysis of countermeasure effectiveness and feasibility against the background of the Fukushima-Daiichi nuclear accident and the characteristics of the agricultural areas affected is made.

Ploughing (shallow ploughing, deep ploughing, skim and burial ploughing) may reduce doses up to 80-95% but may affect soil fertility and integrity and is not applicable on stony or slopy soils. Effectiveness of agrochemical countermeasures is based on (1) either increasing the level of stable analogue nutrient (e.g. K for Cs and Ca for Sr) in soil and soil solution while guaranteeing a decreasing radionuclide:analogue ratio; or on (2) the fixation of the radionuclide in an available or less available form. The net effect of these changes depends largely on soil texture, clay mineral content and composition, organic matter content, buffer capacity and base saturation. K-fertilizer or liming may lead to 3 decreases in Cs transfer. Effectiveness of amendment application depends on the difference in adsorption potential and mass balance between soil and amendments. Reported changes in transfer range from no to 10-fold reduction. Change in crop type (other variety, other species, industrial food crops, …) may result in 10 fold dose reductions or more.

Some areas affected by the accident in the Fukushima Daiichi Nuclear Power Plant may remain for long time too contaminated to allow for crop production. When agricultural production cannot be continued because of irremediably high activity levels in food products, industrial crops not used for
food production may be an alternative. Crops for sugar and oil production may be proposed, the contamination in the final product being more than ten times lower than in the harvested product. Biofuel crops (combustion fuel, bio-ethanol and bio-diesel) may be a possible alternative be it that the biofuel market in Japan is not strongly developed due to land shortage for food production. Fibre crops (kenaf, jute, ramie, hemp) are generally sturdy crops, are the basis for a lot of endproducts (paper, clothing, building and insulation material, …) and Japan has a historical expertise in culturing and converting these fibre crops. However, little is known on transfer of radionuclides during production of fibre crops and conversion to useable end products. If viewed as potential alternative for valuating contaminated land, the feasibility of establishing these crops both at the production as at the associated conversion side, should be carefully analysed on radioecological, dosimetrical, technical and economic grounds thereby not neglecting social aspects.

We highlighted in short the potential of phytoextraction which is often put forward as a cost-effective clean-up strategy. It was shown that 20 to more than 100 years are needed to decrease $^{137}\text{Cs}$ or $^{90}\text{Sr}$ soil levels 10-fold, whereby the major contributor to the decline in soil concentration is natural decay.

Planning to reduce the consequences of a nuclear accident in the medium-to-long term should be carefully investigated thereby also considering the local ecosystems, agricultural practice and social aspects. Detailed mapping of contamination and soil characteristics would allow identifying areas most vulnerable to high soil-to-plant transfer and areas where agrochemical countermeasures would be feasible and effective.