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Low-Cost Agricultural Practices to Reduce Heavy Metal

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ABSTRACT *Agriculture soil may become contaminated by the accumulation of heavy metals through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline, paints and land application of fertilizers. Gradually increasing pollution of agricultural land, leads to accumulation of toxic products. The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation .The application of soil amendments is another very effective measure to reduce the concentration of heavy metals in crops. Both organic (e.g., farmyard manure) and inorganic amendments (e.g., lime, zeolites, and iron oxides) were found to decrease the metal accumulation. Further effective methods to reduce metal transfer into food chain include crop rotation and cultivation of industrial or bio-energy crops.*

KEYWORDS : Heavy metal contamination, soil pollution, agricultural practices

Introduction
Soil pollution is a widely recognized global environ-mental threat. Contamination of soil by heavy metals is of major concern because of their toxicity. Sources of heavy metals are traffic dust emitted into the atmosphere, residues of sewage sludge and other waste materials discharged into soil, mineral, mainly phosphorus, fertilizers and some plant protection chemicals (Fergusson, 1990).

Heavy metals cannot be chemically degraded and need to be physically removed or be immobilized. Traditionally, remediation of heavy metal contaminated soils involves either on-site management tor excavation, or subsequent disposal to a landfill site.Phytoremediationis a promising method to remove or stabilize soils contaminated with heavy metals. It has been widely accepted as a cost-effective and environmental-friendly clean up technolology.

In recent studies, organic matter has been implicated for alleviating bioavailability of heavy metals in soils. Some researches showed that amendment of contaminated soils with organic matter reduced bioavailability of heavy metals (Khan et al., 2000).Organic matter is known to form strong complexes with heavy metals (Krogstad, 1983). The content of organic matter affects speciation of heavy metals in soil (Lo et al., 1992).

Pollution sources of heavy metals in agricultural soils
Most heavy metals in the air derive from dust particles released by human activities, including electricity generation, mining, smelting, and chemical manufacturing. High concentrations of mealsare present in waste-water discharged from metal plating factories, coating and paint factories. Fertilizer input is an important source of heavy metal contamination in many countries, including Asian countries. Soil contamination is located in areas of large industrial activities, where surrounding agricultural areas are affected by atmospheric deposition of heavy metals. Agricultural practice, for example application of sewage sludge or phosphate fertilizers, has lead to increased metal concentration in soils.

Apart from the metals like Cd, Cr, Pb, Co, Ag, Se, and Hg essential elements such as Fe, Mn, Zn, Cu, Mg, Mo, and Ni also keep accumulating in soils by means of wastewater irrigation, sewage sludge application, use of chemical fertilizer. With the continuous addition of undesirable metals into the environment, remediation of contaminated soils receives attention.

Common Agricultural methods for toxicity alleviation in contaminated soil
Metal uptake by crops could effectively be minimized through alteration of some physical and chemical characteristics of soil such as pH, redox potential, cation exchange capacity, composition and concentration of humic substances etc., which have influence on immobilization of toxic elements in soil (Tlustoš et al., 2006)

According to Cooper et al. (2011), season and crop management practices too are involved in determining the metal content in crops. The interactions of soil-plant roots-microbes play important roles in regulating heavy metal movement from soil to the edible parts of the crops. Several promising methods have been developed for remediating Cd contamination in soils and plants, such as soil dressing, phytoextraction (Murakami et al., 2009), soil washing (Makino et al., 2006), soil amendment, and planting of a low-Cd-absorption crop variety (Takeda et al., 2007).

Crop rotation
Crop rotation with hyper-accumulator species as a component before being establishment of main crop is also recognized as being viable technique (Murakami et al., 2009) and of non-food crops or proven lesser absorptive crops on the contaminated land have also received considerable attention (Takeda et al., 2007) Rhizosphere effects of plants may affect the heavy metal bio-availability to the following cropping cycle example;lupins are known to release citric acid, which may increase the Cd availability. Oliver et al. (1993) reported from two different locations that Cd concentration in wheat is highest when grown after lupins.

Use of inorganic amendments
Inorganic amendments are very effective in decreasing the metal bio-availability due to the introduction of additional binding sites for heavy metals and due to pH effects.The use of organic and inorganic amendment to accelerate the attenuation of metal mobility and toxicity in soils is one of the important technology. The primary role of immobilizing amendments is to alter the original soil metals to more geochemically stable phases via sorption, precipitation, and complexation processes (Hashimoto, et.al. 2009). The mostly applied amendments include clay, cement, zeolites, minerals, phosphates, organic composts, and microbes (Finžgar, et al.2006).

Application of lime increases pH and thus decreases availability of metals, Repeated application (every 2–5 years; 2–10 t/ha) is necessary to maintain metal immobili-zation and therefore larger quantities are necessary compared to other inorganic amendments (Knox et al. 2001).

Use of organic amendments
Increased heavy metal accumulation induced by application of inorganic fertilizers (especially phosphate fertilizer) has been reported from many places. This pollution is due to high levels of heavy metals in these commercial fertilizers (Nacke et al., 2013).Organic amendments like compost, farmyard manure (FYM), bio-solids or bio-solid compost may effectively reduce the bio-availability of heavy metals in soils due to its high content of organic matter and high concentra-

tions of P and Fe (Brown et al. 2003).The general approach for stabilization treatment processes involves mixing organic stabilizers such as bitumen, composts, and manures or a combination of organic-inorganic amendments to the contaminated soils.(Farrell,et al 2010) Addition of compost, farmyard manure (FYM) and organic wastes etc., is often practiced in immobilization of heavy metals and soil amelioration of contaminated soils (Clemente et al.,2005).

Application of brown coal preparations as a source of organic matter is a well-known practice to improve soil properties (Kwiatkowska et al., 2005). Organic matter from brown coal undergoes slow mineralization and that is why it is very good material as a source of organic matter in soil especially, light soil. This is very important because a high content of organic matter in contaminated soil is one of the ways to exclude heavy metals

Liming

Liming has long been used as a proven inorganic soil amendment which can elevate soil pH rendering metals less-bioavailable for plant uptake (Ciecko et al., 2004,)Depending on the acid-neutralizing capacity, different liming materials such as limestone ($CaCO_3$), burnt lime (CaO), slaked lime [$Ca(OH)_2$], dolomite [$CaMg(CO_3)_2$], and slag ($CaSiO_3$) etc., are available for use (Bolan and Duraisamy, 2003). Despite the effectiveness of liming has repeatedly been reported using field as well as pot experiments, the effect of liming on metal uptake may vary with the crop, the metal of concern and with soil characteristics (Puschenreiter et al., 2005).The effectiveness of red mud in reducing heavy metal uptake by oilseed rape, pea, and wheat was also proved by Lombi et al. (2002). Red mud may however contain Cr and As, thus attention must be paid when large scale application is planned (Friesl et al., 2004)**.**

ConclusionRemediation of heavy metal contaminated soils is necessary to reduce the associated risks, enhance food security and scale down land tenure problems arising from changes in the land use pattern. There are several low-cost agricultural methods available to reduce the transfer of heavy metals into human food chain and are effective to allow safe agriculture on moderately contaminated soils.

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