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Use of Urban Waste in Agriculture: Potential and Threat

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Introduction

About 31% human population of India lives in cities and towns, and generates large quantities of wastes (both effluent and solid wastes) which affect the quality of different environmental components. According to Central Pollution Control Board (CPCB) report, sewage water generation from cities was 38,254 million liter per day (MLD), out of which only 11,554 MLD (32%) were being treated (CPCB, 2007). The untreated sewage water (USW) is causing deterioration in quality of aquatic ecosystems due to various undesirable contaminants present in it. Further, municipal authorities of Indian cities and towns are also greatly concerned with the disposal of huge quantity of municipal solid wastes (MSW). More than 90% of these urban wastes are used for land filling or uncontrolled dumping outsides the towns and cities. This unscientific dumping causes serious environmental implications in global warming through greenhouse gases (GHGs) emission, spread of diseases, contamination of land and water. Therefore, the management of effluent and solid wastes is a major concern for environmental safety. Agriculture sector is also facing tremendous pressure to feed growing population from shrinking land resources and declining availability of irrigation water. As a result, farmers are forced to adopt any farming practice that reduce cost of cultivation and generate appreciable income. Thus, use of sewage effluent for irrigation purpose and solid waste as soil amendment is increasing in peri-urban agriculture in spite of concern for public health. About 1.0-1.5 million hectares area in India is irrigated annually with sewage waters (mostly untreated or partially treated).

Nutrient potential of urban wastes

India has the potential of producing 5-14 Mt of compost from MSW annually that can provide about 1.2 to 2.5 lakh tones of N, P_20_5 and K_2O for agriculture use. However, concerns are raised due to high contents of heavy metals and other pollutants present in MSW. The sewage water contains about 20-85, 4-36, 7-20 and 10-50 mg N, P, K and S l^{-1}, respectively along with other nutrients. The C/N ratio in sewage effluents is low and release

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of mineral N from organic substances is increased. As a result, yield of most crops in sewage irrigated fields are considerably higher as compared to ground water irrigated fields. Continuous use of untreated sewage water results in increasing P content in the below root zone depth due to its percolation through the soil profile. Hence, selection of crops and cropping system in sewage irrigated area is important for beneficial acquisition of P built-up in soil profile. Application of USW also significantly increased the availability of micronutrients (Zn, Fe and Mn) in soil due to complex formation with sewage borne organic compounds. Recoveries of N, P and K by aboveground biomass are significantly higher with USW as compared to fertilizers and manures.

Pollution potential of urban wastes

Significant higher loss of N take place from USW irrigated plots as compared to fresh water irrigated fields. Nitrogen form sewage waste is easily mineralized and moves down the soil profile along with percolating water resulting in higher leaching losses. Sewage effluent have high BOD value, thus reduces the oxygen level in the soil and consequently de-nitrification losses may be enhanced. Contamination of food and fodder with toxic heavy metals and metalloids is another health concern with the use of sewage waters for irrigation purpose. Although heavy metal contents in municipal sewage water are lower as compared to industrial waste water, however, long term intensive use of these water for irrigation may add more heavy metals than crop removal which may result in the build-up of these metals in soils. However, extent of heavy metals build up depends on frequency and period of application of sewage water. Continuous application of sewage water might result in migration of Cd, Co, Cr, Cu, Ni and Zn downward from cultivated layer due to increased mobility through complexation by dissolved organic carbon. The USW contain numerous synthetic organic compounds which may be highly carcinogenic. Detergent is the most common organic compound of household USW and linear alkyl-benzene sulfonates (ABS) are widely used chemicals for making detergents. These ABS increases the de-nitrification losses in soil. Several other organic pollutants and pesticides are also found in waste water, which are highly resistance to microbial degradation. In sewage irrigated area, contaminations of vegetables and fodders is major concern, however, grains generally remain uncontaminated. Transfer of heavy metals from soil to plant also depends on chemical nature of metals, degree of their accumulation as well as soil properties, particularly clay content,

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organic matter content and soil pH. Transferability among various heavy metals followed the order as Cd > Ni > Cr > Cu > Pb, indicating that Cd is easily transported from the soil to the plants in comparison to other metals. Risk to human health depends on their dietary intake which is computed in form of 'Hazardous Quotient' (ratio of average daily dose of a metal and its 'reference dose for toxicity' per kg body weight). Inhabitants of the urban area are more exposed to the associated risks as vegetables and animal products produced from sewage farming are mostly marketed in nearby cities and towns. Heavy metals content in MSW compost are generally higher as compared to those prepared from cattle dung and farm waste. The repeated application of MSW compost in agricultural land may increase the heavy metal concentration in soil. Organic toxins might also be the part of MSW compost which are highly chlorinated and persist long time in the environment. Persistent organic pollutants may introduce into grazing animal food chain if contaminated organic waste is applied to pasture land.

Way forward

India has enacted different laws on environmental protection, which provided the instruments for controlling and regulating the acquisition, use and conservation of natural resources. Although BIS standard for irrigation water quality is existing, it does not mention permissible limits of toxic elements and heavy metals. The Fertilizer (Control) Order 1985 (FAI 2007) prescribed maximum permissible concentration of heavy metals and metalloids in MSW composts in synchrony with 'Municipal Solid Wastes (Management and Handling) Rules, 2000' of MoEFCC. Issues on waste management need to be addressed comprehensively with the objective of reducing burden of pollutants on environment and maximizing beneficial waste recycling for its sustainable productivity. Successful and sustainable management of urban waste must address the social, economic, environmental and public health concern of all the stakeholders *i.e.* waste generators, management authority, private organizations, policy makers, researchers farmers and consumers *etc*. Research has indicated that practically it is impossible to eliminate the pollutants completely from sewage. Primary treatment involves only the settling of sediments and removal of floating materials and secondary treatment aims to remove sediments, organic loads and partial removal of organic pollutants. However, operational and management costs of treatment are high. Moreover, secondary treatment involving aerobic digester also generate considerable amount

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of methane and nitrous oxide. Thus, responsibilities of different stakeholders for minimizing risks of urban wastes in agriculture are as follow:

- Urban residents should have the priority of recycling and reuse of non-biodegradable wastes. Awareness is required about beneficial role and harmful effects of all types of wastes on human health and environment.
- Municipal authorities should establish the effective linkages of urban residents with various agencies involved in recycling/disposal of non-biodegradable hazardous waste.
- Private organization/NGOs can play effective role in creating awareness among public about importance of reduce-reuse-recycling of waste.
- Policy makers should ponder over formulating soil protection policy in consultation with various relevant expert organizations.
- Researchers should address the issue of appropriate soil and crop management relied on urban waste so as to minimize the risk to soil biodiversity and food quality.
- Peri-urban farmers should be aware on their social responsibility of growing safe food crop and fodder, must avoid growing vegetables and fodder crops using USW. Escaping application of USW after a gap of every 3-4 years may rejuvenate the soil quality through degradation of toxic organic pollutants.