Scaled-up experiments for composing cultivation media from degraded soils and waste amendments

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The possibility of using industrial or municipal waste materials to improve the texture, nutrient content and productivity of bad quality soils is getting more and more attention recently, as the problems generated by soil loss are getting worse, and the costs of waste deposition reaches higher levels. Waste utilization for soil improvement offers possible solution for several soil problems, meanwhile gives an alternative for waste landfill. Even so, successful researches and industrial solutions focusing on this topic are still individual attempts without an overall concept or clear guidelines to take into consideration for safe and effective application. When managing the risk of waste utilisation on soil we have to understand that the hazard associated with the waste differs from the land-use specific risk of waste utilisation on soil. Even if there is some risk it can be fully controlled and, the value-based benefits may overcompensate the risks. Smart, risk-based compromise may lead to the acceptance of a low-risk utilisation of waste on soil compared to a high risk or very high cost waste disposal or other physico-chemical waste treatments.

Gruiz et al. (2010) proposed a comprehensive, risk-based management concept of waste utilization for soil improvement, based on successful applications from literature and their own experience. The steps of the management scheme (information collection on the concerned waste materials and soils; creating the risk scenario for risk calculation; hazard, benefit and exposure assessment; risk characterisation; risk and value-based decision and communication of the results) ensure that the benefits of the technology would overwhelm its potential adverse effects.

The experiments presented in this paper demonstrate the usefulness of these principles in technology development, proving that several waste materials with substantial hazard might have a positive effect on soil properties without considerable risk when mixing with soil in the proper ratio. Scaled up experiments were performed in laboratory microcosms and filed plots with the aim of in-situ production of fertile cultivation media from the waste soil of the temporary cover of the landfill slope by mixing it with organic and inorganic waste materials. Prior to mixing the components, values and hazards of the all utilized wastes were assessed by physical-chemical and biological-ecotoxicological methods. As a preliminary experiment, 3 types of municipal sewage sludge, and 2 types of combustion ashes (fly ash and wooden ash) were mixed in 4 different waste soils originated from the slope of the same landfill block, in altogether 24 soil microcosms. Based on the results of this experiment, 16 blocks of small field plots were constructed and monitored for 1.5 years. The changes in soil nutrient content, texture and toxicity were followed by integrated physical-chemical and biological-ecotoxicological monitoring methodology.

Our results show that the application of composted sewage sludge and coal combustion fly ash successfully enhanced soil organic content (Humus%) and the quantity of plant available Nitrogen, Phosphorus and Potassium-content. After 1.5 years of field application 300% growth in soil microbial activity and 700% growth in biomass production was recorded compared to control treated with only artificial fertilizers, by using only waste-origin amendment, without any adverse effects observed.