

Plant–Animal Integrated Bioremediation System for Chemical Waste Management: Mechanisms, Advantages, and Applications

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Abstract: *The rapid expansion of industrial activities and intensive agricultural practices has led to the accumulation of toxic chemical wastes in soil and water, posing serious risks to ecosystems and human health. Bioremediation has emerged as an environmentally friendly and sustainable approach to address such contamination. Among the various techniques, plant–animal integrated systems have gained attention as an effective strategy in which plants and selected animals work together to remove, transform, or stabilize pollutants. Plants contribute through processes such as phytoextraction, phytodegradation, and phytostabilization, while organisms like earthworms and aquatic fauna enhance soil quality, stimulate microbial activity, and support nutrient cycling. This cooperative interaction accelerates pollutant breakdown and ecological restoration. Compared to conventional remediation methods, this approach is economical, scalable, and environmentally sustainable. This paper discusses the mechanisms, benefits, and applications of plant–animal bioremediation systems and emphasizes their role in sustainable environmental management.*

Keywords: Bioremediation, Plant–Animal Interaction, Phytoextraction, Soil Contamination, Sustainability, Chemical Waste Treatment

