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Ex-Situ Bioremediation Techniques of Soil for Sustainability

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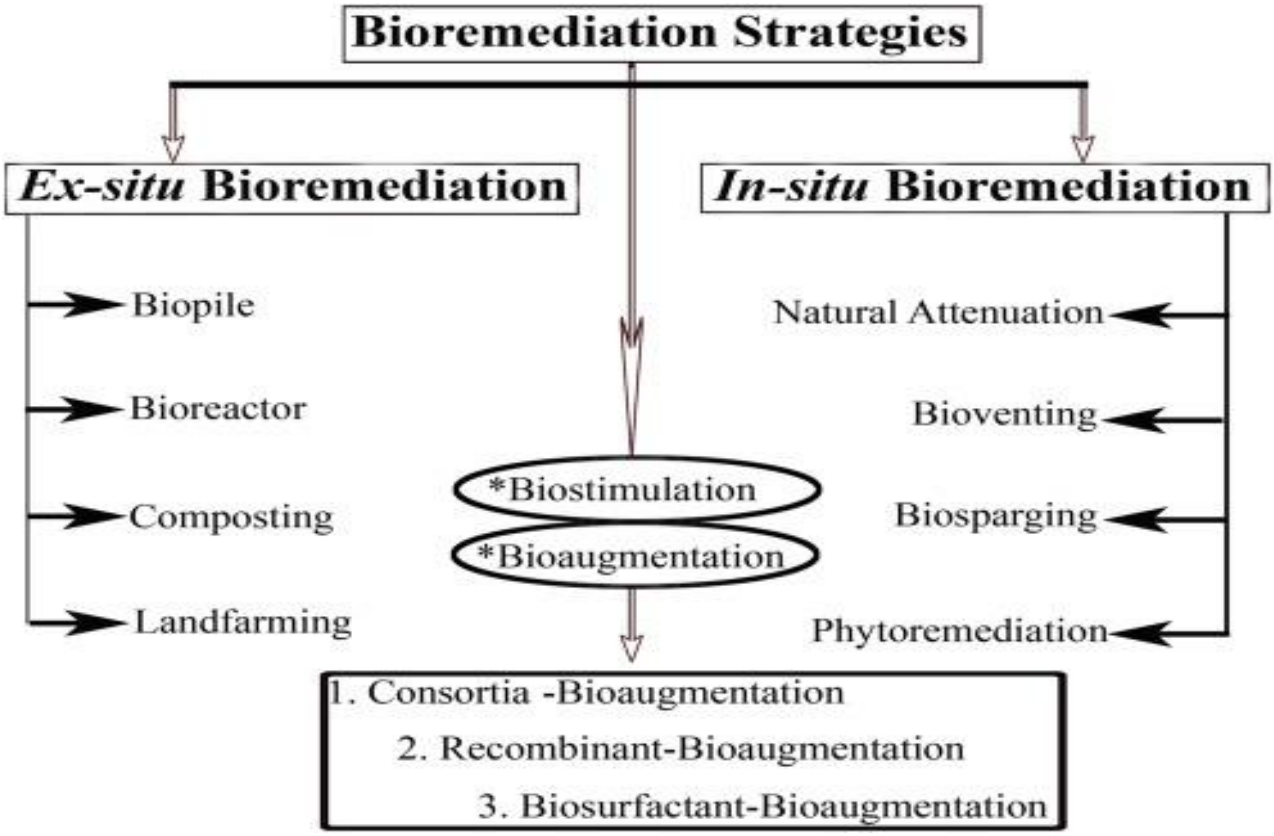
SUMMARY

In the current situation increasing the human activities in relation to energy reservoirs, faulty agricultural practices and rapid industrialization in past few decades leads to the pollution of environment, uneconomical and threaten to sustainability. Pollutants are harmful for biodiversity, environment and human health due to the presence of hydrocarbons, greenhouse gasses, heavy metals and nuclear wastes. Remediation of pollutants with the use of microbes are effective and reliable due to eco-friendly features.

INTRODUCTION

In the modern technology era there are race among the nation and within the nation for higher energy production, researches, industrialization and faulty agricultural practices. Exploitation of natural resources, anthropogenic pollutants (pesticides, heavy metals etc.) for higher crop production to insure food security, nation growth and higher income generation without much concerning the natural biodiversity, environmental sustainability are leads to endanger the many species of plants and animals with poor soil health, threaten the productivity and becoming uneconomical in long term. Bioremediation is a branch of biotechnology which employs the use of living organism like microbes and bacteria for removal of contaminants/pollutants or toxicant from soil, water and other environments. In the bioremediation process living organism are act as cleaning the soil, water and environment which are being polluted. In the past two decades, advancement in bioremediation technology with the concerns of effectively restores the polluted environment in an eco-friendly approach and at a very low cost.



Ex Situ Techniques

In this techniques involvement to excavate pollutants from the site of pollution and subsequently transporting them to another site for treatment. The consideration of these techniques on the basis of: treatment cost, type of pollutant, depth of pollution, degree of pollution, geographical location and geology of the polluted site. Performance criteria, which also determine the choice of ex situ bioremediation techniques, have been described (Philp and Atlas 2005).

Types of Ex-Situ Bioremediation

Biopile

In this bioremediation involves the pilling excavated soil on the ground followed by nutrient amendment and sometimes aeration for enhancing the microbial activity for rapid remediation process. Aeration, irrigation, nutrient, leachete collection systems and treatment beds are the component of biopile bioremediation. Due to its constructive features are being cost effective, which facilitate the effective biodegradation on the condition that nutrient, temperature and aeration are effectively controlled. Reducing the volatilization of low molecular pollutants; well performance even in low temperature (Dias *et al*. 2015); there is flexibility to shorten remediation duration by incorporation of heat for enhancing the microbial activity; treat large volume of polluted soil in a limited space; saving for bioremediation space than the other method (land farming, robust engineering) are the advantages of biopile. At the same time there are some limitation of biopile- operation and maintenance cost, need of power for operate air pump for uniform distribution of air and sometime over heating of air leads the drying of soil and inhibit the microbes action and promote volatilization.

Windrow

In windrows rely on periodical turning of piled polluted soil to enhance bioremediation by increasing degradation activities of indigenous and/or transient hydrocarbonoclastic bacteria present in polluted soil. The periodic turning of polluted soil, together with addition of water bring about increase in aeration, uniform distribution of pollutants, nutrients and microbial degradative activities, thus speeding up the rate of bioremediation, which can be accomplished through assimilation, biotransformation and mineralization. Higher rate of hydrocarbon removal than the pilled bioremediation; however, the higher efficiency of the windrow towards hydrocarbon removal was as a result of the soil type, which was reported to be more friable (Coulon *et al*. 2010). Nevertheless, due to periodic turning associated with windrow treatment, it may not be the best option to adopt in remediating soil polluted with toxic volatiles.

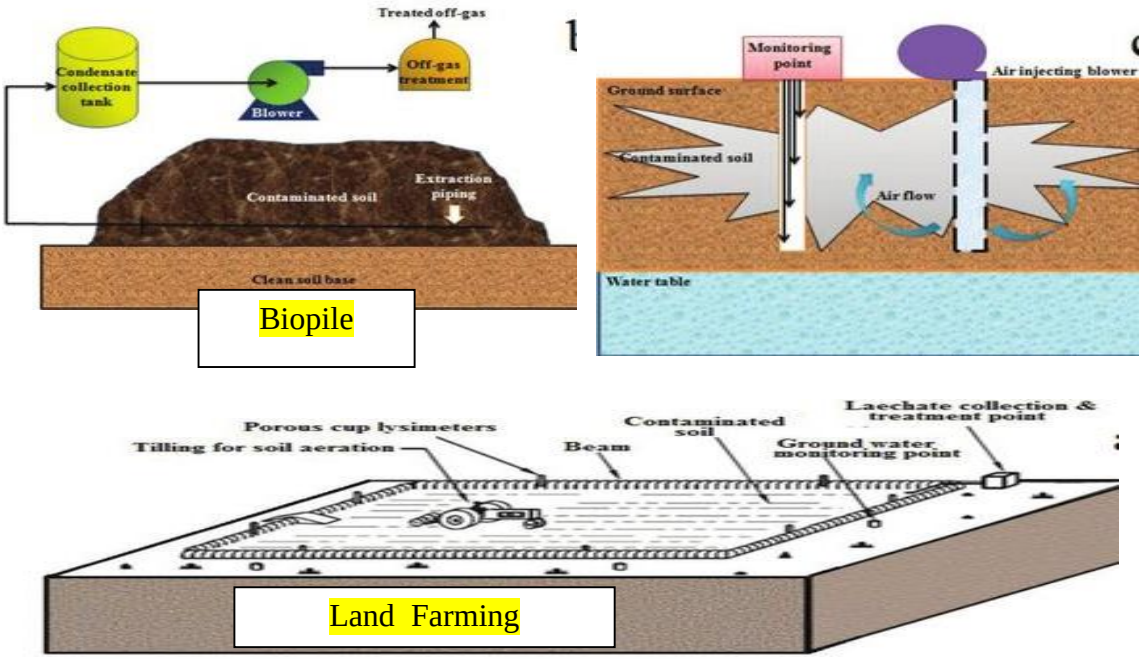
Bioreactor

In a vessels, there are application of raw materials are get converted to specific product by a series of biological; reactions. There are various operating modes of bioreactor, which include- batch, sequencing batch, fed-batch, continuous and multistage. Selections of operating modes are directly linked with the capital expenditure and market economy. Conditions in a bioreactor support natural process of cells by mimicking and maintaining their natural environment to provide optimum growth conditions. There is application of polluted sample into bioreactor as the dry matter or slurry. There are well regulations of bioprocess regulations parameter (temperature, agitation and aeration rates, pH, inoculums and substrate solution) are leading advantage of ex-situ bioremediation through bioreactor. This facilitates the regulation of time in management of contaminates. There is also allowing the use of various substances like bio-augmenting or bio stimulants agent.

Land Farming

It is being simple techniques of ex-situ management of contaminated soils by low cost and less equipment required in land farming practices of soil gaining. It considered as both ex-situ as well as in-situ management practice but mostly considered as ex-situ management. Depth of pollutants is considering the important role as it will be ex-situ or in-situ practices of land faring bioremediation of contaminated soils. In land farming, one thing is common, polluted soils are usually excavated and/or tilled, but the site of treatment apparently determines the type of bioremediation. Generally, excavated polluted soils are carefully applied on a

fixed layer support above the ground surface to allow aerobic biodegradation of pollutant by autochthonous microorganisms. Tillage, which brings about aeration, addition of nutrients (nitrogen, phosphorus and potassium) and irrigation are the major operations, which stimulate activities of autochthonous microorganisms to enhance bioremediation during land farming. Nevertheless, it was reported that tillage and irrigation without nutrient addition in a soil with appropriate biological activity increased heterotrophic and diesel-degrading bacterial counts thus enhancing the rate of bioremediation; Dehydrogenase activity was also observed to be a good indicator of bio-stimulation treatment and could be used as a biological parameter in land farming technology (Silva-Castro *et al*. 2015). Even being the simple techniques having some limitations like requirement of large space, unfavorable environmental condition are reducing the microbial activities, additional cost due to excavation, and reducing the efficacy of inorganic pollutant removal. These limitations and several others make land farming based bioremediation time consuming and less efficient compared to other ex situ bioremediation techniques.



CONCLUSION

In the current situation of industrialization and faulty agricultural practices are leads to huge disposal of contaminants which are impart the quality of natural system and limits the production, resulting as threaten the food security for growing population and sustainability of resources. By the ex-situ bioremediation process the removal of soil contaminants by eco-friendly and economically for sustaining the system and mitigate the challenges of contaminants.

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