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Nature's Drainage: Bio-Solutions for Soil Salinity and Waterlogging

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Introduction:

Large tracts of land have been utilized for intensive agriculture over the past 100 years all over the world after being cleared of deep-rooted tree vegetation or after irrigation was introduced into desert zones. Many of these domains, especially those with poor natural drainage and salty aquifers beneath them, have deteriorated due to salinity and water logging, despite decades of lucrative returns. Conditions became saline and soggy as a result of sustained surface rainwater or irrigation water seeping into the saline water table, upsetting the hydrological balance. Hence, an environmentally sound and sustainable solution to soil salinity and waterlogging problems—two major problems that have a global impact on ecosystem health and agricultural productivity—was bio-drainage. Utilizing the innate capacities of plants and bacteria to control excess water and salts in the soil, bio-drainage differs from conventional drainage systems, which frequently rely on mechanical structures and ongoing maintenance. By strategically utilizing deep-rooted, salt-tolerant plants known as halophytes and encouraging the growth of advantageous microbial communities, bio-drainage not only enhances soil fertility and structure but also lessens the negative impacts of salinity and waterlogging.

Conventional drainage vs. Bio-drainage: An Analogy

Criteria	Conventional Drainage	Bio-drainage
Techniques Used	Surface drainage, horizontal sub-surface drainage, vertical drainage	Plant-based systems, microbial activities
Cost	High (installation, maintenance, and sustainability)	Low
Environmental Impact	Effluent control issues; saline effluent pollution	Ecologically friendly

Efficiency	Effective in reducing waterlogging and salinity	Effective to some extent; slower water table lowering
Salinity Management	Water and salts leach into drains; conjunctive use in saline zones	Limited evacuation of salts
Irrigation Potential	Water can be reused for irrigation or canal augmentation	Requires separate irrigation; limited irrigation potential
Land Requirement	Minimal	Requires land for tree plantations
Maintenance	Regular maintenance required	Low maintenance
Suitability for Small Holdings	Less suitable due to high costs and maintenance	Suitable due to low cost and flexibility
Recharge and Discharge Zones	Not specifically designed; can impact surrounding areas	Requires a clear understanding; of specific recharge and discharge zones
Vulnerability to Saline Conditions	Not vulnerable	Trees can be vulnerable in highly saline conditions

Bio-drainage: Addressing challenges in problematic areas

Managing Deep rooted vegetation in high rainfall areas:

Australia's pristine deep-rooted health and tree vegetation lies on top of ancient salt reserves and brackish water aquifers. This occurred as a result of the local vegetation absorbing and transpiring the yearly rainfall. This tree vegetation had to be cleared to make room for intensive agriculture, which replaced it with annual crop plants with shallow roots. Because the vegetation's yearly water consumption was lower than that of the rainfall, water seeped into the saline groundwater table beneath it, gradually raising it. There emerged the double threat of salinity and water logging. Hence, suitable development of agroforestry systems incorporating trees is expected to reduce the salinity as the water table recedes from the root zone of commercially important annual crops *(Heuperman A F, 1995)*

The model of 'ecosystem mimicry' *(Hatton et.al, 1999)* intends to obtain a plant-water use scenario that closely imitates the pre-clearing situation. The most extensively studied disturbed agroecosystem that demonstrates the necessity of striking a balance between aquifers and vegetation's water use is the Australian system.

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The Australian eucalyptus forest shown in the above image was removed for wheat cultivation, which resulted in soil degradation once the crop was farmed.

Irrigation introduced into desert and semi-arid zones:

The deep underlying saline groundwater in northwestern India's semiarid region had little effect on the conventional rain-fed crops. This equilibrium was thrown off when intensive agriculture and canal irrigation were introduced. Soils became soggy and saline due to the gradual rise in the saline water table brought on by the excessive irrigation water use seeping through.

For instance, between the 1930s and the beginning of the 1950s, the average depth of the water table in the western zone of Haryana remained constant at roughly 28 meters below the earth. The Bhakhra canal system was put into service in 1956, and by 2002, the water table had risen to just 6 meters below the surface of the earth.

In the Rohtak district of Haryana State, north India, there is a high water table location where eucalyptus (Eucalyptus tereticornis) has a bio-drainage system. During the monsoon season, paddy is the principal crop.

About half of the southwest region of Haryana has experienced severe flooding in the last 20 years, with the water table rising to less than 3 meters below the surface of the ground.

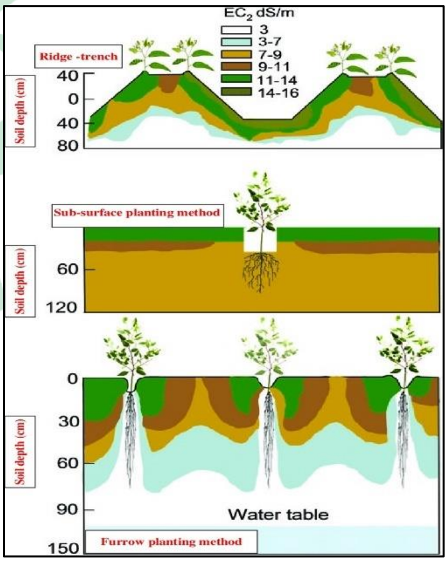
In the Hisar region of Haryana, north India, there is a high-water table location where (*Eucalyptus tereticornis*) are used as bio-drainage atop bunds. The primary crop grown in the winter is wheat.

The Power and Potential of Bio-drainage Strategies:

Ridge versus pit planting:

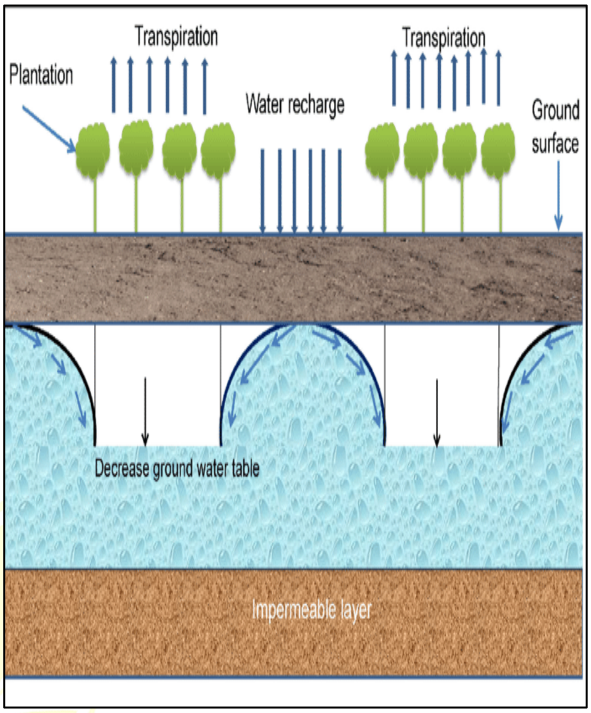
Because anaerobic soils are saturated to the surface or below, the traditional pit planting method is impractical. In such problematic locations soil ridges raised to 0.5 m above the surrounding soil surface are recommended (*Ram J et.al.,2007)*. Because it makes seedlings more resistant to the anaerobic conditions brought on by extended water logging or ponding, this promotes better seedling establishment and subsequent growth on wet soils. India's Punjab and Haryana State Forest Departments are effectively using the ridge planting technique.

Ridges are constructed of field soil; hence their salinity is the same. Thus, it is advised to use species that can withstand salt. It was found that poplars and bamboo could not survive while eucalyptus, Pongamia, Casuarina, Terminalia, etc., could grow in that soil. Sand coverings can be applied on ridges to prevent capillary fringe and prevent an overabundance of salts from accumulating after surface evaporation.



Block plantations:

In a wet environment, a block of suitable trees is planted, resulting in a cone-shaped depression in the water table beneath the plantation. Nonetheless, it has been demonstrated that the groundwater table declines to vary degrees from a radius of 40 m *(RIRDC, 1999)* to 730 m *(Ram J et.al.,2007)* encircling the surrounding recharge area of that particular zone. The discharge plantation block's size and other features, the soil's hydraulic conductivity, the cropping strategy, and the recharge of the surrounding area can all be blamed for the stark disparities.



Strip plantations:

Although block plantations are effective, they are impractical in situations where land holdings are small and dispersed and bio-drainage cannot be implemented. The only other option in this case is to go for strip plantations along field boundaries.

An agroforestry model has undergone successful pilot testing in the vicinity of Putthi village, located in the Hisar region of Haryana. The model is considered as best option from the point of view of: i) technological adoption by the farming community, ii) lowering of the water table to about 1 m over 5 years, and iii) remuneration to the farmers as timber *(Ram J, 2009).*

Conclusion:

In conclusion, bio-drainage provides a long-term, environmentally responsible solution to problems with waterlogging and salt in the soil. This system efficiently controls water levels

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and lessens salt buildup in the soil by utilizing the inherent qualities of plants and microbes. By using this method, agricultural productivity is increased, biodiversity is supported, and soil health is improved. Bio-drainage systems can also be included in a variety of land-use systems, such as forestry, urban areas, and agriculture, and they require less maintenance than conventional drainage techniques. Using this technique can be extremely important in creating resilient and sustainable landscapes for future generations, as the difficulties posed by climate change and land degradation become more pressing. To effectively address soil salinity and waterlogging, governments, academics, and farmers must work together to advance the widespread implementation of bio-drainage.

References:

Hatton, T J & Nulsen, R.A. (1999). Towards Achieving Functional Ecosystem Mimicry with Respect To Water Cycling To Southern Australian Agriculture. Agroforestry Systems, 45, 1-3.

Heuperman, A.F. (1995). Salt And Water Dynamics Beneath a Tree Plantation Growing on A Shallow Water Table. Internal Report Department of Agriculture, Energy and Minerals, Victoria, Tatura Centre, Institute of Sustainable Irrigated Agriculture

Ram, J (2009) Biodrainage Potential of Eucalyptus for The Reclamation of Waterlogged Areas. Ph D. Thesis, Nanital India, Kumaon University.

Ram, J, Garg, V K, Toky, O P, Minhas, P S, Tomar, O S, Dagar, J C & Kamra, S K (2007) Biodrainage Potential of Eucalyptus Tereticornis for Reclamation of Shallow Water Table Areas In North-West India. Agroforestry Systems, 69, 147-65.

Rirdc (1999) The Ways Trees Use Water. Water And Salinity Issues in Agroforestry No. 5, Publication No. 99/37, Wembley, Rural Industries Research and Development Corporation (RIRDC), pp 1-78.