A soil health initiative for revegetation and orchards

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June 27, 2025

Lynette Abbott from The University of Western Australia highlights an innovative soil health initiative for revegetation and orchards

The strategic placement of biological amendments derived from waste nutrient resources can be used in permeable biomass wells and walls to improve establishment of trees and shrubs planted during restoration of degraded vegetation on farms, or in orchards. Soil biological processes are involved in these restoration processes, which improve soil health.

Permeable biomass wells (Figure 1) and walls (Figure 2) have been investigated at a field demonstration at The University of Western Australia's farm, in the grainbelt east of Perth, Western Australia. The trial showed how up-scaling of novel soil restoration practices initiated on a small scale near Brookton, Western Australia, can restore degraded areas of farmland by improving soil health.

In addition, the practices can fast-track restoration of degraded salt-affected soil and minimise ongoing erosion and poor seedling establishment. The field demonstration site was established on degraded pasture, which had previously been planted with Australian native Greening Australia, as part of their participation in Australian Government's 20 Million Trees program.

In addition, these practices can be applied to support soil health in other tree-planting situations, such as orchards and urban community gardens with fruit tree plantations.

There were two novel components of the field demonstration on UWA Farm: (1) the establishment of permeable biomass wells (post-holes) adjacent to previously planted shrubs, and (2) the establishment of permeable biomass walls (trenches) in severely degraded areas where shrubs planted previously were not successfully established. Both the permeable biomass wells and walls were filled with a combination of biological amendments to initiate biological activity and improve soil health conditions.

This process makes ongoing use of local 'waste' biological resources, and contributes to the circular economy by re-use of carbon-based materials from a range of sources. For the UWA Farm demonstration, the permeable biomass wells (post-holes approximately 40cm deep) were placed adjacent to trees and permeable biomass walls (parallel trenches 40cm deep, 150cm wide, and many metres long) were placed strategically to intercept surface shallow saline water flow that was emerging from a seep on the hillside above the site. The mixtures of carbon-based materials used included locally sourced compost, biochar, straw, worm juice and wood vinegar. Any other potential soil biological amendments can be stockpiled for application to the wells and walls from time to time as the organic materials degrade.

FIGURE 1. a. Drilling of the permeable biomass wells, b. new well before application of organic materials, c. well filled with organic materials adjacent to a tree, and d. The contents of a well after several months show that roots have penetrated the organic materials.

Permeable biomass wells

The permeable biomass wells provide a nutrient resource pool accessible by roots from the adjacent shrubs and trees. The proliferation of roots (Figure 3) in the wells containing biological amendments enables the plants to gain access to a perpetual nutrient resource released due to the activity of soil organisms (earthworms, other soil fauna, fungi and bacteria). Strategic placement of soil biological amendments in wells adjacent to developing or mature trees, increases the potential to improve productivity of trees and shrubs by supporting their establishment and survival. This practice avoids the ineffective use of organic materials that may occur when they are applied to soil beyond the reach of roots.

FIGURE 2. a and b. Drilling the permeable biomass walls, c. walls filled with organic materials, including biochar, and d. wall filled with organic materials, including straw.

Permeable biomass walls

In contrast to the permeable biomass wells, permeable biomass walls are trenches dug approximately 40cm deep and 150-200cm wide and up to a length that suits the location (e.g. 1.5m to 20m). As for the permeable biomass wells, the walls are filled with a range of biological waste materials. Several walls are placed parallel to each other and perpendicular to the slope of the land or the drainage line of discharge water from a salt seep or watercourse.

After some months, roots from trees adjacent to the wells or walls grow into the organic biomass materials and proliferate among communities of soil organisms. An additional advantage of both the wells and walls is that they retain water after rain, and provide longer-term access to water than would usually be available, especially in the sandy soils in this Mediterranean environment which is subjected to reducing levels of rainfall due to climate change.

The permeable biomass walls were placed so that they intercepted surface and slightly deeper water flow from an upslope seep, which had caused hard-setting of the adjacent land, preventing the establishment of trees, damaging soil structure, and leaving the area susceptible to erosion. Cassie Howell, a UWA Honours Student, discovered that the soil was saline and alkaline and that it could be rehabilitated by the addition of compost and biochar, enabling saltbush establishment (Howell et al. 2024). Establishing plants on this very degraded patch of land would prevent erosion.

Diagram: © Munirah Arine

FIGURE 3. Graphic of how roots prolificate in the organic biomass material in the wells in parallel with the establishment of a diverse community of soil organisms involved in the degradation of the organic materials; as a result, nutrients are readily accessible to roots of adjacent plants (Illustration by Munirah Arine), b. students monitoring the wells filled with organic materials, including biochar, and c. saltbush seedlings established on the edge of permeable biomass walls; this soil had previously been highly compacted, saline and alkaline (Howell et al. 2024).

The demonstration site was established with funding from the Australian Government's National Landcare Program: Smart Farms. This government program sought to support on-farm activities that directly improved natural resources and supported the adoption of sustainable best practices.

It also supported capacity building for sustainable land management, encouraging land managers to explore novel ideas, build awareness, share knowledge and gain skills. This on-farm demonstration site has included field days with local farmers, landcare advisors, and natural resource management groups. University students were engaged in establishing the demonstration site, and during the monitoring of soil health measurements (Figure 4). Meanwhile, school students from city schools continued to be regular visitors as part of their environmental science, geography, and agriculture studies.

The permeable biomass wells have potential use in orchards and vineyards, and to increase soil biodiversity, as well as native animal and plant biodiversity. Overall, the project has supported the adoption of best practices in land management by demonstrating a novel methodology for restoring localised areas of degraded land on farms, as well as extending the use of this approach to other settings.

FIGURE 4. Volunteer students and staff participated in the establishment of the field demonstration site at UWA Farm (left), and urban landcare enthusiasts are implementing similar permeable biomass barriers at a city community food forest as part of their sustainability program within the Town of Vincent, Western Australia (right).

Extending soil health ideas from the farm to the city

The land restoration concepts demonstrated at UWA's Farm have more recently been used to improve soil health in urban settings. For example, the My Healthy Soils Project of the community group Transition Town Vincent (TTV) has adopted the innovation of biochar permeable reactive barriers to enhance water and nutrient management at their community food forest (Figure 4, right).

This initiative, led by Ian Kininmonth, incorporates the establishment of char wells and trenches filled with biochar, FOGO compost, and worm juice near existing fruit trees to intercept runoff from water-repellent sands. Members of this urban group are also implementing these methods in their gardens and verges to support tree and shrub growth while managing stormwater and greywater more effectively.

Acknowledgements

The creative approach demonstrated here was first initiated as a small-scale (1.8ha) ecological restoration program at Treōwstede (Brookton WA) in 2014 by Karry Fisher-Watts and Barry Watts. These adventurous land managers established a plantation of Australian native plants, including sandalwood trees, on a small rural block of land,

transforming a degraded, saline landscape to a productive woodland. The demonstration site at UWA Farm built on their initiative, aiming to demonstrate the potential for implementing this practice over a larger area.

Funding for the demonstration site was provided by the Australian Government's National Landcare Program: Smart Farms. Dr Sasha Jenkins, Ian Waite, Cassie Howell and Dr Zakaria Solaiman contributed to establishment, monitoring and analysis of soil and plants and Wheatbelt NRM also supported the project, especially the field days.

Reference

Howell CR, Jenkins SN, Abbott LK and Mickan BS (2024) Amelioration of a saline-alkaline soil using biochar and compost: Impacts on plant growth, soil biological and chemical characteristics. Land Degradation and Development 35, 142-155 https://doi.org/10.1002/ ldr.4905

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