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Type of Solution: Management
Sector: Agriculture, Agroforestry, Forestry
Good practice(s): Water management, Soil management

Zai technique for dryland rehabilitation

Using a simple and low-cost method to restore degraded lands in the Mediterranean.

Field preparation – Farmers digging zai pits
Author: Dougbedji Fatondji | © Dougbedji Fatondji

Zai pit filled with organic matter
Author: Dougbedji Fatondji | © Dougbedji Fatondji

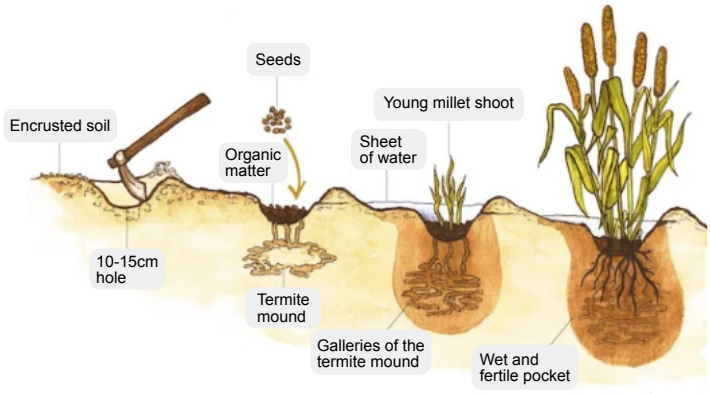
/// Context ///

The term zai refers to a simple yet effective technique where farmers dig pits in highly degraded and crusted drylands to capture water and nutrients and progressively restore the land for forestry or agriculture. This technique originates in the Sahel. Zai combines efficient water and nutrient management practices into a technique that can be used to restore degraded land, needs little external inputs, bears very low costs and requires no extra knowledge or technology, making it easily accessible to and manageable by small and poor farmers. But it can also be used in a more mechanized approach in larger farms (e.g. with machine borers). With climate change, aridification is expected to expand in the Mediterranean Basin, particularly in North Africa, Portugal, Spain and Greece. Hence, traditional rainwater harvesting and soil water conservation techniques like zai would deserve careful studies to anticipate their adaptation and use in the Mediterranean context. Soil fauna and biological processes would also need further studies to understand how they can fulfill the role that termites have in the Sahel.

/// Solution for a Resilient Future ///

Agriculture in the Northern Sahel is faced with extreme soil and climatic conditions. The region experiences very low (< 400 mm/year) and erratic rainfalls, with frequent and intense dry spells. Rapid population growth and unsustainable practices (e.g. slash and burn, overgrazing and trampling) have accelerated land degradation and forced farmers to cultivate also the least fertile lands. Prevalent soil crusting limits water infiltration, accelerates run-off and aggravates soil erosion and degradation in a vicious circle.
After the severe droughts in the 1970s and 1980s, zai (or water pocket or tassa), a traditional rainwater harvesting, soil water conservation and soil restoration practice, was rediscovered and has been progressively disseminated among Sahelian farmers. Zai consists in digging holes, 20-40 cm wide, 10-25 cm deep to collect runoff water and wind-driven organic debris; adding organic matter (crop residues or manure); and planting seeds in the pits when rain starts. Similarly, forest zai can be used to combat desertification: the goat dung added to the pits, often full of various seeds (annual plants, bushes and trees), leads to the restoration of a diversified vegetation.
Zai has many advantages. By breaking the soil crust, zai facilitates water collection and infiltration in the soil, thus contributing to limit runoff and erosion. By concentrating water and organic matter in the holes, instead of spreading it over the whole field, it reduces needed input quantities, saves costs, and increases water and nutrient availability for plants. Hence, zai allows the cultivation of highly degraded, quasi sterile lands. However, water and nutrient harvesting must go hand in hand. Improved water availability within the pits is known to increase nutrient uptake and use efficiency. In turn, adequate nutrient supply foster plant growth and root development which facilitates water circulation in the soil, thus reducing plant vulnerability to intermittent dry spells. In

the Sahel, moist and amended zai pits attract termites, which dig galleries fostering deep water infiltration, improving soil structure and facilitating plant roots development. Through comminution and via their excrements, they transform organic matter making it more easily assimilable by the plants.
Zai thus combines very efficient water and nutrient management practices into a technique that requires little external inputs, bears very low costs and requires no extra knowledge or technology, making it easily accessible to and manageable by small and poor farmers. However, one important constraint limits zai uptake and out-scaling: the amount of manual labour required (in the range of 300 hours/ha). However, in the Sahel, if the pits are dug during the dry season, when farmers do not engage in other field activities, labour might be less of a constraint. Moreover, a field experiment in Burkina Faso has demonstrated that animal-drawn mechanized zai can reduce required labour quantity to about one-tenth of the time and further increase yield by one third when compared to manual zai. The use of machine borers could be another way to reduce the workload, but would increase the costs.



The process of forming a zai pocket
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Zai pit with young millet and cowpea plants.
Author: Dougbedji Fatondji | © Dougbedji Fatondji

/// Always Moving Forward ///

Zai proved very efficient in the Sahel. By improving soil moisture and water retention capacity, fostering amendment decomposition and nutrient release, and facilitating root development, zai can multiply crop yields manifold or even allow cultivation where it was not possible. Zai is best adapted to low fertile drylands (between 300 and 800 mm/year of rain). Zai can rapidly and significantly improve soil structure, thus allowing the progressive revegetation of bare and sterile soils. Not only zai enhances food security and farmer incomes in the Sahel, but it also combats desertification through land restoration and reforestation.
With climate change, aridification is expected to expand in the Mediterranean Basin, particularly in North Africa, Portugal, Spain and Greece: soil and climate conditions in the region will likely come closer to Sahelian current ones. We thus need to adapt zai and anticipate its use in the Mediterranean context as a viable and economic way to revegetate and restore soil productivity in degraded drylands. Zai technique can be further improved through modern machinery use to reduce the workload and improved amendment practices matching better nutrient release with plant growth needs over time. Soil fauna and biological processes would also need further studies to understand how they can fulfill the role that termites have in the Sahel.

Further information

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