



Transforming **U**nsustainable
management of soils in key
agricultural systems in EU and China

Developing an **i**ntegrated platform of
alternatives to reverse soil degradation

Agroforestry as a tool in soil conservation



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Short description

Soil degradation, driven by overgrazing, deforestation, and unsustainable farming practices, leads to the loss of soil fertility, increased erosion, and reduced agricultural productivity. Agroforestry, a land-use system that combines trees with crops and livestock, offers an effective solution for soil protection and restoration. Trees improve soil structure by preventing erosion, enhancing water infiltration, and contributing organic matter. Their deep roots help stabilize the soil, while canopy cover reduces wind and water erosion. Agroforestry also fosters biodiversity, improves microclimates, and promotes carbon sequestration, making it a sustainable approach to restoring degraded soils and ensuring long-term agricultural resilience.

Target area

The history of agroforestry dates back thousands of years, with its roots in traditional agricultural practices across different cultures. Agroforestry is not a modern innovation, but rather a long-standing practice where trees and shrubs are integrated into agricultural landscapes to improve productivity and environmental health. Agroforestry is especially beneficial in arid and semi-arid climates, where water scarcity and climatic extremes like droughts or heavy rainfall exacerbate soil erosion and fertility loss. It also targets regions



with fragile ecosystems, where soil health is critical to maintaining productivity. It has applicability in areas with monoculture crops, mixed farming systems, or agro-pastoral systems.

Problem identification

Problems can be identified by using the TUDI DSTs available at dev-tudi.web.app.



Detailed description of restoration strategy

By leveraging agroforestry strategies, degraded soils can be revitalized, ensuring long-term agricultural productivity and environmental sustainability.

One of the most effective agroforestry strategies for soil restoration is **alley cropping**, which involves planting rows of trees or shrubs between crops. This practice helps stabilize the soil by reducing erosion, improving water retention, and enhancing nutrient cycling. Certain nitrogen-fixing trees further contribute to soil fertility by enriching the soil with essential nutrients. Additionally, tree roots penetrate deep into the ground, bringing up minerals from lower soil layers, thereby reducing the need for chemical fertilizers.

Another widely used technique is **silvopastoral systems**, which integrate trees, pastures, and livestock. This approach benefits the soil by increasing organic matter through leaf litter and animal manure while preventing soil compaction from excessive grazing. The presence of trees in silvopastoral systems also provides shade and wind protection, which helps maintain soil moisture and reduces evapotranspiration, making the land more resilient to drought conditions.



Agro-silvicultural systems, which combine trees with agricultural crops, further enhance soil conservation by improving soil structure and moisture retention. Trees act as natural nutrient pumps, drawing minerals from deeper soil layers and making them available for crops. The incorporation of organic residues from trees and crops also increases soil organic matter, which improves soil fertility and microbial activity.

To mitigate soil erosion, agroforestry practices such as **contour hedgerows and windbreaks** play a crucial role. Contour hedgerows involve planting trees or shrubs along contour lines to slow down water runoff and prevent topsoil loss. Windbreaks, on the other hand, are tree barriers planted along field edges to protect the soil from wind erosion. These techniques are particularly effective in regions prone to desertification and help maintain the integrity of agricultural landscapes.



Riparian buffer strips provide another important agroforestry strategy for soil conservation. These vegetative buffers, planted along rivers and streams, help prevent soil erosion by stabilizing riverbanks and filtering out sediments and pollutants. The deep-rooted trees in these buffers enhance soil structure and improve water infiltration, thereby protecting aquatic ecosystems from agricultural runoff.

Pros/Cons of technique, obstacles to implementation

Agroforestry offers numerous benefits, such as improved soil fertility, reduced erosion, and increased biodiversity. However, some techniques require significant initial investment, longer maturation periods, and intensive management. While trees enhance long-term productivity, they may compete with crops for nutrients and water if not properly managed.

Challenges to adopting agroforestry include high initial costs, lack of technical knowledge, land tenure insecurity, and resistance from traditional farmers. Additionally, policy gaps and insufficient financial incentives hinder widespread adoption, requiring government and institutional support for successful implementation.



Effects and results

Studies have shown that agroforestry significantly improves soil health. For example, research in sub-Saharan Africa has demonstrated that alley cropping with nitrogen-fixing trees increases crop yields by up to 50% while reducing soil erosion by 30-50% (Sanchez, 1995). In Latin America, silvopastoral systems have improved pasture productivity and enhanced carbon sequestration, contributing to climate change mitigation (Murgueitio et al., 2011). In India, the adoption of agroforestry practices has

restored degraded lands, increasing water infiltration and reducing soil salinity (Nair, 2012). In Europe, agroforestry has been successfully implemented in France, where hedgerow planting and silvoarable systems have reduced soil erosion and improved soil organic matter content, particularly in wheat and barley farming systems (Dupraz & Liagre, 2008). These cases highlight the effectiveness of agroforestry in enhancing soil conservation, improving agricultural sustainability, and providing socio-economic benefits to farmers.

More literature

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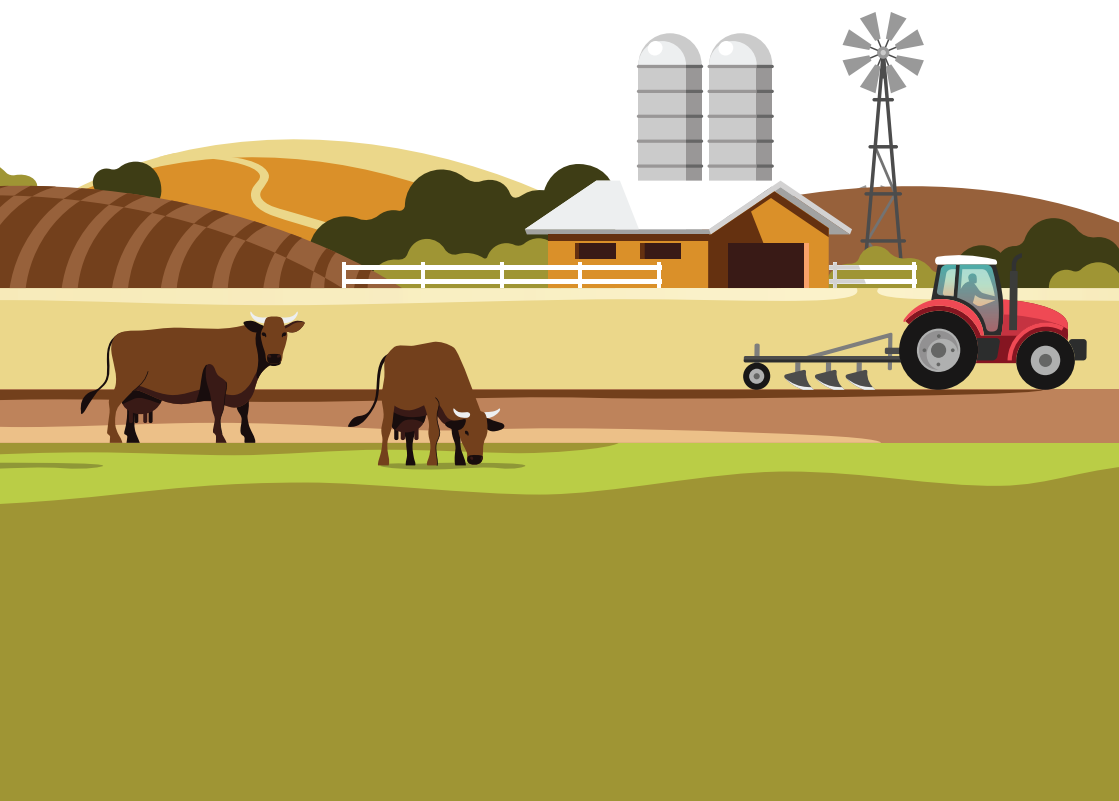
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Summary

Agroforestry presents a holistic and sustainable approach to soil conservation and restoration. By integrating trees into agricultural landscapes, these strategies mitigate soil degradation, enhance biodiversity, and

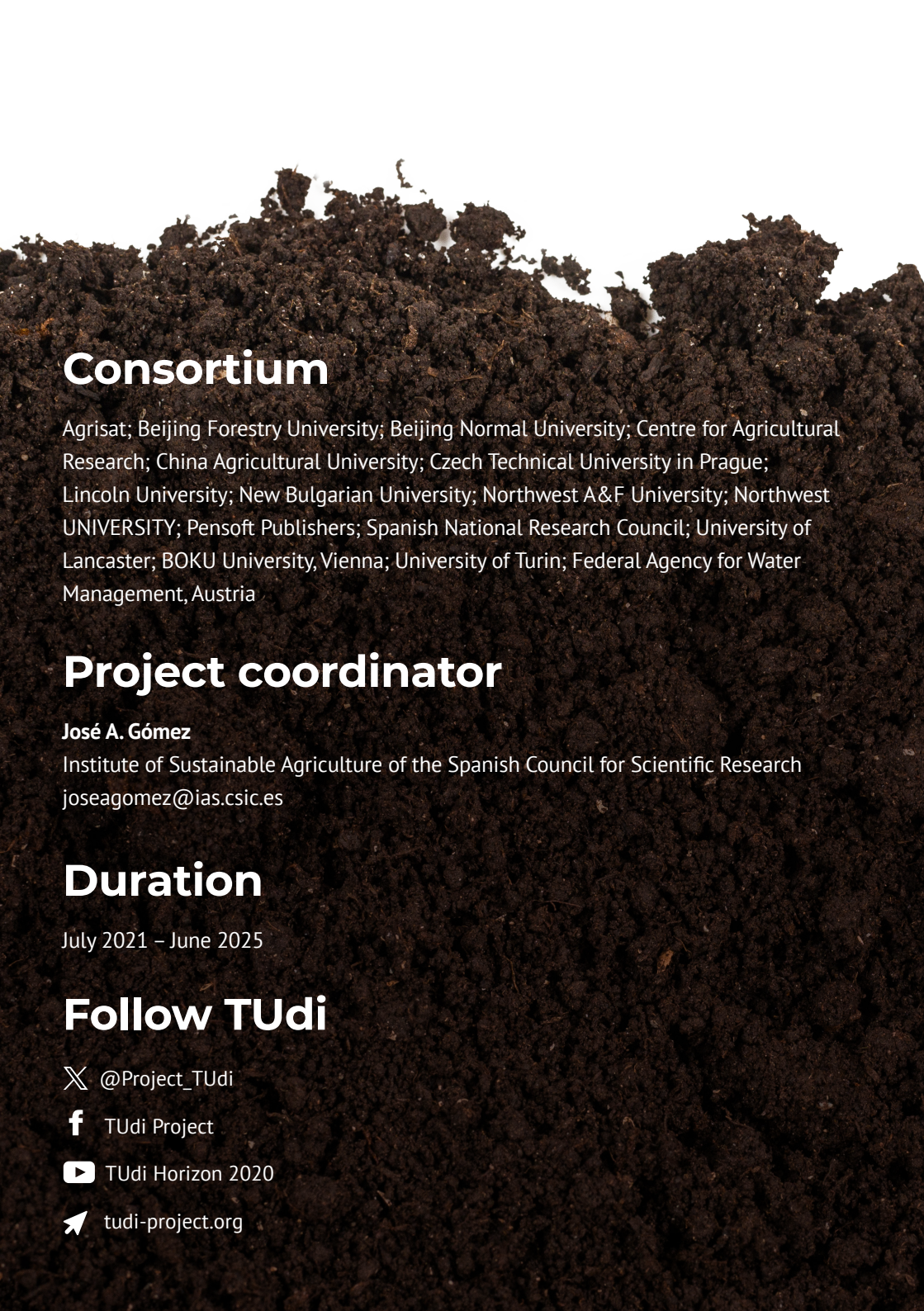
improve resilience to climate change. Through the adoption of agroforestry practices, farmers can ensure long-term productivity while maintaining ecological balance, making it a crucial tool for global soil conservation efforts.



Summary table

	Rating	Comments
Soil health overall	***	
Water budget	**	
Soil structure	*	
Erosivity	-	
Nutrient balance	-	
Soil life	-	
Practicability	-	
Economy	-	





Consortium

Agrisat; Beijing Forestry University; Beijing Normal University; Centre for Agricultural Research; China Agricultural University; Czech Technical University in Prague; Lincoln University; New Bulgarian University; Northwest A&F University; Northwest UNIVERSITY; Pensoft Publishers; Spanish National Research Council; University of Lancaster; BOKU University, Vienna; University of Turin; Federal Agency for Water Management, Austria

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