



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

Using cover crops for mitigating erosion



This project receives funding from the European Union's Horizon 2020 Research and Innovation action under grant agreement No 101000224.

Short description

Using cover crops is an ancient practice gaining global attention for its role in sustainable agriculture. Cover crops, including legumes, grasses, and broadleaves, enhance soil health by improving nutrient cycling, reducing erosion, and increasing organic matter. Studies highlight their benefits in soil aggregation, fertility, and pest control. However, their effectiveness varies based on climate, soil type, and water availability. In arid regions, cover crops may compete with cash crops for water, posing challenges to adoption. Selecting appropriate species is crucial for maximizing benefits. Research continues to address uncertainties in species selection, soil impact, and nutrient management for diverse agricultural systems. Cover crops, such as legumes, grasses, and brassicas, provide an effective strategy for mitigating soil erosion. Their roots stabilize the soil, reducing runoff and wind erosion, while their canopy protects the soil from raindrop impact. Cover crops improve soil structure, enhance organic matter content, and increase microbial activity, promoting long-term fertility. Additionally, they help retain soil moisture and prevent nutrient leaching. By integrating cover crops into agroforestry or cropping systems, farmers can enhance soil health, reduce erosion, and support sustainable agriculture while improving biodiversity and climate resilience.

Target area

Using cover crops to mitigate erosion are typically regions with high rainfall, sloped terrain, or areas prone to wind and water erosion. These regions often have sandy, loamy, or clay-rich soils that are vulnerable to degradation. In such areas, crop production systems can benefit from integrating cover crops like clover, rye, or vetch. These crops protect the soil by reducing surface runoff, improving soil structure, and enhancing organic matter. Their roots anchor the soil, minimizing erosion while improving water infiltration, nutrient cycling,



and overall soil health, ensuring sustainable agricultural practices.

Problem identification

The evaluation of erosion risk in the locality can be supported by the Tudi DST soil erosion app available at dev-tudi.web.app.



Detailed description of restoration strategy

Cover crops help mitigate soil erosion through several key mechanisms. One of the most important ways they function is by stabilizing the soil with their root systems. The roots of cover crops bind soil particles together, reducing the likelihood of erosion caused by wind or water. Root structure helps create a more stable soil environment, preventing the loosening and displacement of topsoil, which is particularly vulnerable to erosion. Additionally, the above-ground biomass of cover crops provides a physical barrier against the direct impact of raindrops and wind. This protective layer shields the soil from surface sealing, a phenomenon that occurs when raindrops compact the soil, reducing its ability to absorb water and increasing surface runoff. When water runs off the surface, it has the potential to carry away soil particles, contributing to erosion. Cover crops prevent this by ensuring better water infiltration and reducing the speed and volume of surface runoff.

In addition to these immediate benefits, cover crops also improve soil organic matter over time. As they decompose, they contribute



organic material to the soil, enriching it and enhancing its structure. Increased organic matter improves water retention, reduces soil compaction, and fosters beneficial microbial activity. These improvements make the soil more resilient to future erosion. The combination of root systems, surface protection, and organic matter creation provides a holistic solution to erosion, ensuring long-term soil stability.



Different types of cover crops can be selected based on the specific needs of the region and the type of erosion risk. Grasses such as rye, oats, and wheat are commonly used for their fibrous root systems that effectively bind the soil and provide dense coverage. Grasses are especially beneficial in areas where both wind and water erosion are concerns. Leguminous crops, such as clover, vetch, and peas, are also used as cover crops due to their deep, penetrating roots that help improve soil structure while fixing nitrogen in the soil. These



legumes are particularly useful in promoting soil fertility alongside erosion control. Crops with deep taproots e.g., radishes and mustard break up compacted soil layers, allowing water to infiltrate and further reducing erosion risks. Finally, a mix of different cover crop species

can be used to maximize benefits. A diverse mix of grasses, legumes, and brassicas can address various environmental challenges and ensure the most effective erosion control while improving soil health.

The successful implementation of a cover crop strategy for erosion control requires careful planning and management. Timing is crucial, as cover crops should be planted after the main crop has been harvested and before the rainy or windy season begins. This timing allows cover crops to establish themselves and provide protection during the critical periods of erosion risk. The selection of appropriate species is also important, as it depends on the region's climate, soil type, and the specific erosion risks present. Local agricultural extension services often provide valuable guidance on selecting the best species for a particular area. Regular monitoring and management are also necessary to ensure that the cover crops thrive. This may involve ensuring proper planting depth, watering, and addressing any pest or disease issues that might affect growth.

Pros/Cons of technique, obstacles to implementation

Using cover crops to mitigate erosion has several advantages and challenges. Cover crops improve soil structure, reduce runoff, enhance organic matter, and increase water infiltration and promote biodiversity and soil fertility.

On the other hand, implementing involves additional costs for seeds and labor, potential competition with cash crops for nutrients, and the need for proper management.

Obstacles to implementation could include lack of farmer awareness, delayed economic benefits, and regional climate limitations. Some areas may struggle with establishing cover crops due to drought or extreme weather. Despite challenges, proper planning and support can maximize the benefits of this sustainable erosion control technique.

Case studies

Cover crops are increasingly employed across Europe as an effective strategy to mitigate soil erosion, enhance soil health, and promote sustainable agriculture. By providing ground cover during periods when main crops are not growing, cover crops protect the soil from erosive forces such as wind and water. Numerous studies have demonstrated cover crops efficacy in reducing soil loss and improving soil structure.

Case Study: Belgian Loess Belt

In Belgium's loess belt, a region prone to significant soil erosion, implementing cover crops during winter and spring has proven beneficial. A study revealed that integrating cover crops and retaining crop residues on fields led to a 35% reduction in soil loss. Specifically, cover crops alone contributed to a 22% decrease by protecting bare soil during critical erosion periods.

More literature

Smit, B., Janssens, B., Haagsma, W., Hennen, W., Adrados, J. and Kathage, J., Adoption of cover crops for climate change mitigation in the EU, Kathage, J. and Perez Dominguez, I. editor(s), EUR 29863 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11312-6, doi:10.2760/638382, JRC116730.

Keke Li, Zhanhang Zhou, Zhen Wang, Yi Zeng, Klaus Hubacek, Pasquale Borrelli, Cai Li, Wenting Zhang, Zhongci Deng, Jingyu Wang, Zhihua Shi, 2025. Opportunity for mitigating soil loss by water erosion in cropland through crop switching and improved management in China. *Geography and Sustainability*, 100262, <https://doi.org/10.1016/j.geosus.2025.100262>.

Case Study: European Vineyards

Vineyards across Europe, often situated on sloped terrains, face heightened erosion risks. Research indicates that the use of cover crops in these vineyards can significantly reduce soil erosion. For instance, a study found that cover crops decreased soil loss by improving soil organic carbon and aggregate stability, which are crucial for maintaining soil structure and preventing erosion. [Digital CSICScienceDirect](#)

Case Study: Scotland's Agricultural Lands

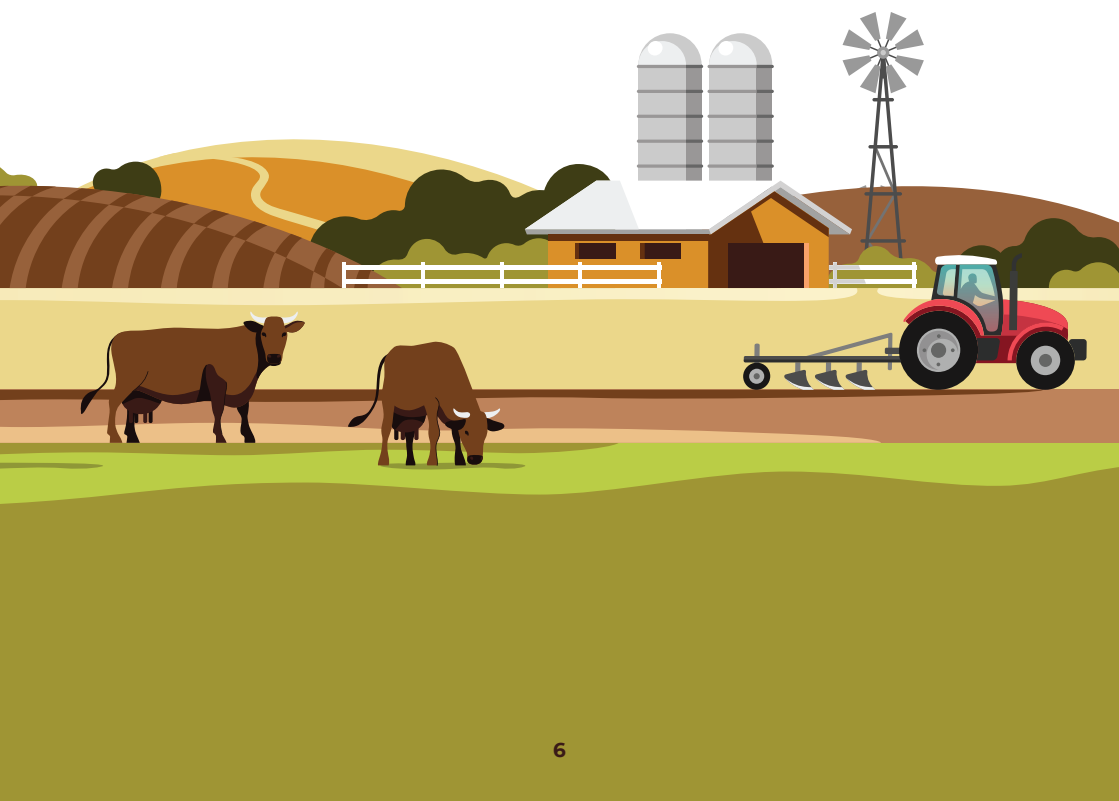
In Scotland, the adoption of cover crops has been shown to protect soils from erosion and enhance soil organic matter. Cover crops not only reduce nitrate leaching but also provide protection against soil erosion on lands draining directly into watercourses. [NatureScot](#).



Summary

The use of cover crops for mitigating soil erosion has shown remarkable success across various agricultural settings. Real-world results confirm that cover crops reduce soil loss, enhance soil structure, improve water retention, and support

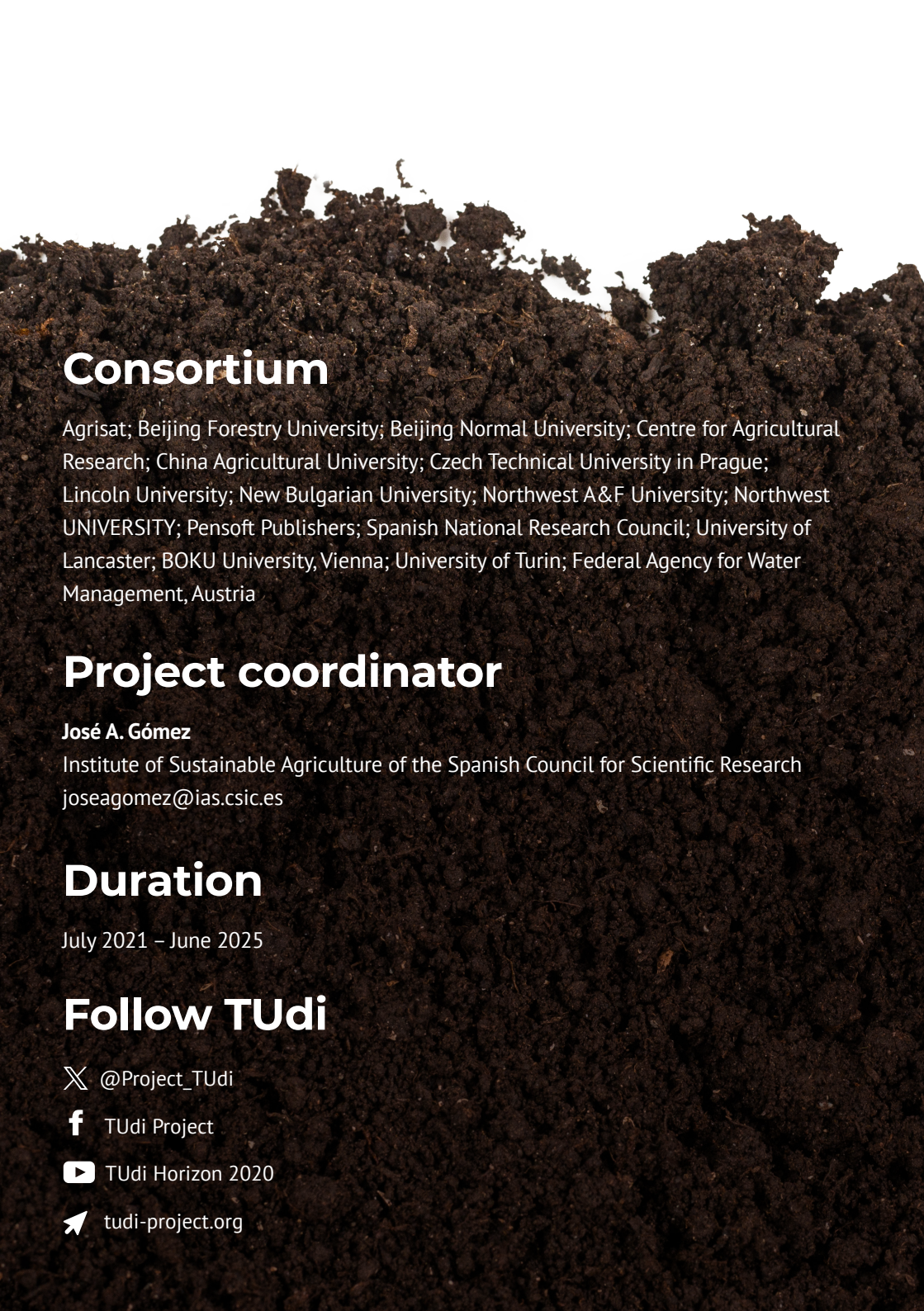
long-term sustainability. While challenges exist, such as cost and management requirements, the long-term benefits of erosion control far outweigh the obstacles, making cover crops a vital tool in sustainable agriculture.



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

Project coordinator

José A. Gómez

Institute of Sustainable Agriculture of the Spanish Council for Scientific Research
joseagomez@ias.csic.es

Duration

July 2021 – June 2025

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