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## From Soil to Sustainability: Making Cover Crops Work for the Planet



According to the CREAM's study published in *Nature Communications*, optimized cover cropping practices can help us achieve multiple sustainability goals—including enhanced food production, climate mitigation, and soil stabilization—especially in under-resourced and environmentally vulnerable regions.

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Cover crops—plants grown between regular crop cycles—are gaining recognition as a key nature-based solution to make agriculture more sustainable. When managed properly, they can improve soil health, increase carbon storage, reduce erosion, and support biodiversity. However, without careful design, they can also lead to trade-offs, such as increased greenhouse gas emissions.

In our new study published in *Nature Communications*, we carried out a comprehensive global analysis of cover crop practices using over 2,300 field observations. Our international team, led by Dr. Tianyi Qiu and including Prof. Josep Peñuelas and Prof. Jordi Sardans from CREAM and CSIC, evaluated the impact of cover crops on five major agroecosystem services: crop yields, soil organic carbon (SOC), soil structure, and emissions of nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>).

We found that, overall, cover crops boost yields (+2.3 %), enrich soil carbon (+6.5 %), and enhance soil stability (+14.3 %). However, they can also significantly increase emissions of N<sub>2</sub>O (+29.5 %) and CH<sub>4</sub> (+42.3 %) if not managed strategically. These findings underscore the importance of optimizing how cover crops are used —adapting them to the local context and applying them over the long term.

By analyzing the data, we identified an optimal approach: use a mix of legume and non-legume cover crops, terminate them 25 days before sowing the next crop, apply surface mulching, and integrate climate-smart practices like no-tillage. With this strategy, we estimate potential global annual gains of nearly 98 million tonnes in food production, 21.7 billion tonnes of carbon dioxide sequestration, and 2.41 billion tonnes of soil erosion reduction.

Cover crops are a powerful tool, but only if we manage them wisely. Our study shows that with the right choices and long-term commitment, we can reduce trade-offs and unlock the full potential of cover crops for both food production and environmental protection.

We also highlight that these optimized practices are especially effective in regions with harsh environmental conditions —such as low-fertility soils and dry climates— and can help close productivity gaps between wealthier and lower-income countries.

This research reinforces the role of nature-based solutions in addressing the global challenges of food security and climate change. By tailoring cover crop practices to local environments and promoting long-term use, we can achieve meaningful progress toward sustainability.

To make this possible, we call for greater investment in farmer training, locally adapted solutions, and supportive policy frameworks. Expanding access to knowledge and incentives is essential if we are to scale up these practices globally and fairly.

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## References

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