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LATEST NEWS

Recent developments in cropping systems and the use of cover crops

Modern agriculture has achieved remarkable productivity gains through the adoption of intensive tillage, synthetic fertilizers and pesticides, irrigation, and increasingly simplified cropping systems (Rockström et al. 2017). However, these practices have also contributed to soil degradation, biodiversity loss, and greater dependence on external inputs, reducing the resilience of agricultural systems to climate change.

To address these challenges, there is growing interest in more sustainable cropping systems that combine productivity with the delivery of ecosystem services. Diversified crop rotations, conservation agriculture, reduced soil disturbance, and the integration of cover crops are increasingly recognized as key components of this transition.

Cover crops contribute to agricultural sustainability through several mechanisms. Their root systems improve soil structure, increase water infiltration, and reduce the risk of erosion caused by rainfall and wind. Aboveground plant residues protect the soil surface, while the root system contributes to soil organic matter accumulation, thereby supporting long-term soil fertility. Another key benefit is nutrient cycling. Cover crops capture nutrients that might otherwise be lost through leaching, particularly nitrogen, and return them to the soil after decomposition. Some species are also able to mobilize nutrients that are otherwise poorly available to crops, improving nutrient-use efficiency and reducing dependence on mineral fertilizers.

Cover crops also promote soil biological activity. Their residues provide energy sources for microorganisms, stimulating microbial activity and enhancing the biological processes responsible for nutrient mineralization and soil organic matter formation. In addition, many cover crop species suppress weeds, interrupt pest and disease cycles, and provide habitats

for beneficial insects and pollinators, contributing to greater biodiversity within agricultural landscapes. These multiple functions make cover crops an important tool for improving both the environmental sustainability and the long-term resilience of cropping systems.

Among the different cover crop families, legumes have received particular attention because of their ability to biologically fix atmospheric nitrogen through symbiosis with rhizobia. Their contribution to increasing soil nitrogen availability and reducing the need for synthetic nitrogen fertilizers in subsequent cash crops has been extensively documented, making legume-based cover crops a cornerstone of sustainable nutrient management strategies.

More recently, however, research has expanded beyond legumes to investigate the potential of non-legume cover crops. Species such as rye, oats, tillage radish, and mustard are increasingly being studied for their capacity to improve soil structure, enhance carbon sequestration, mobilize and recycle nutrients, suppress weeds, and stimulate soil microbial communities. Rather than focusing solely on nitrogen supply, current research is exploring how different cover crop species can provide complementary ecosystem services and how these benefits vary according to soil type, climate, and management practices.

One cover crop receiving increasing attention is tillage radish (*Raphanus sativus* L. var. longipinnatus), a species characterized by rapid biomass production and a deep taproot capable of improving soil structure and nutrient dynamics. The management of tillage radish typically involves seedbed preparation, sowing, and, in some cases, termination through mechanical or chemical means. However, in conservation agriculture systems, soil preparation may be unnecessary because these crops can be directly sown into crop residues. Furthermore, tillage radish is frost-sensitive that naturally dies when exposed to freezing temperatures. This characteristic eliminates the need for mechanical or chemical termination, thereby reducing management costs and labor requirements.

Recent studies have investigated its effect on soil health under different cropping systems. In a cereal-based rotation, the effects of tillage radish were evaluated under conventional and reduced tillage, revealing that soil management strongly influenced cover crop biomass production and, consequently, its effects on soil properties (Pescatore et al. 2025a). In particular, tillage radish increased soil phosphorus availability in soils with low phosphorus availability, highlighting its potential to improve nutrient cycling. However, these benefits were closely related to the amount of biomass produced, suggesting that maximizing cover crop growth is essential to fully exploit its ecosystem services.

Under conservation agriculture, the effects of tillage radish on soil properties varied according to pedoclimatic conditions (Pescatore et al. 2025b). Sites that supported greater cover crop biomass production exhibited greater improvements in soil health indicators, suggesting that biomass production is a major driver of the ecosystem services provided by tillage radish. These findings further confirm that cover crop biomass is a key driver of nutrient cycling and the ecosystem services provided by tillage radish.

The growing body of evidence indicates that cover crops are becoming an essential component of modern cropping systems. When appropriately managed, cover crops

represent a key strategy for improving soil health, enhancing nutrient cycling, and increasing the resilience and sustainability of modern cropping systems.

For more information, see,

Unveiling the impact of tillage radish on soil chemical, biological, and physical soil properties under reduced and conventional tillage. By Pescatore et al. (2025a)

Tillage Radish as Cover Crop Improves Soil Health Indicators Depending on Pedoclimatic Conditions. By Pescatore et al. (2025b)

Sustainable intensification of agriculture for human prosperity and global sustainability. By Rockström et al. (2017)

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