Issue 39
June 30, 2026

# NEWSLETTER

## Smart & Net-Zero Project

*The Smart Net-Zero (SNZ) project team under the Food and Fertilizer Technology Center (FFTC) for the Asian and Pacific Region regularly collects and shares information related to sustainable agri-food systems and climate-smart agriculture, including research, news, policy, data and event updates around the world on the project website.*

## Overview

### *From Cover to Carbon:*

### *Integrating Cover Crops and Precision Weed Management for Climate-Smart Agroecosystems*

Cover crops can improve soil health, carbon sequestration, and weed control, but their effectiveness depends on climate and management conditions. A global meta-analysis of 6,010 paired observations across 106 countries found that cover crops increase soil organic carbon, microbial biomass, and aggregate stability while reducing $N_2O$ emissions and nitrate leaching, especially when legume or grass-legume mixtures are used in dryland and tropical systems. Region-specific studies further show their mitigation and productivity benefits: long-term European trials report a net GHG mitigation effect of 0.68 tonnes $CO_2e$/ha/year; evidence from the Brazilian Cerrado shows weed suppression and soybean yield gains of up to 22%; and California research finds carbon sequestration of 0.23 tonnes/ha/year. Autonomous weeding robots may further reduce herbicide use by 50–95%, though scalability remains uncertain.

**Content**

# RESEARCH

**01 THEME:** Carbon Sequestration; GHG Emission Reduction

## Optimizing cover crop practices as a sustainable solution for global agroecosystem services

November 14, 2024 | Nature Communications |

**Introduction:** Cover crops offer multiple agroecosystem benefits including higher yields, soil carbon storage, and erosion control, but their net value is constrained by GHG trade-offs and variable outcomes across environments. A Chinese researcher team led by the Chinese Academy of Sciences analyzed 2,302 field observations from 219 studies spanning 1978 to 2020 to identify the optimal cover crop management portfolio and quantify its potential benefits for global agroecosystems.

**Key findings:** Historical cover crop use increased yields by 2.33%, soil organic carbon stocks by 6.46%, and soil aggregate stability by 14.3%, but also raised $N_2O$ and $CH_4$ emissions by 29.5% and 42.3% respectively. A biculture of legume and non-legume cover crops, terminated 25 days before the next planting and followed by residue mulching, emerged as the optimal combination. Long-term implementation of five or more years, paired with no-tillage, converts these trade-offs into synergistic gains. Optimized practices are projected to increase agroecosystem multiservice by 1.25% globally, equivalent to annual gains of 97.7 million metric tons in crop production, 21.7 billion metric tons in $CO_2$ sequestration, and 2.41 billion metric tons in soil erosion reduction. Benefits are largest in arid regions and least-developed countries, where adoption remains limited by farmer knowledge gaps and insufficient policy incentives. The authors call for international assistance and targeted subsidy schemes such as nitrogen credit systems and green manure planting programs to accelerate adoption in countries where cover crop potential is highest but institutional support is weakest.

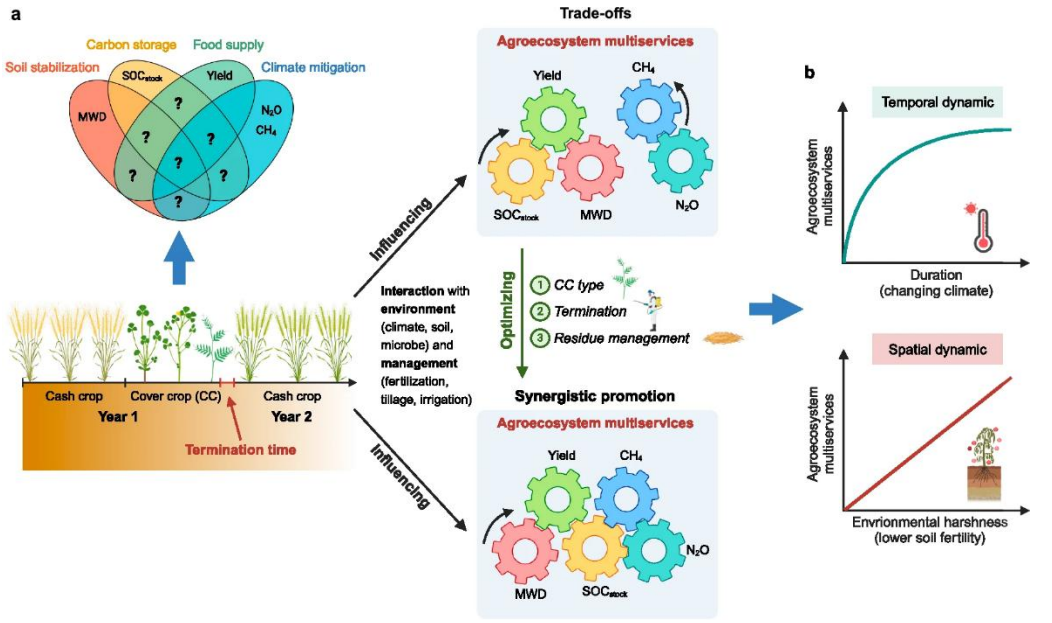



**Figure** | Hypothetical synergy of optimizing CC practices on multiple agroecosystem services, and its underlying benefits in different scenarios.

**02 THEME:** GHG Emission Reduction; Carbon Sequestration

# Cover crops support the climate change mitigation potential of agroecosystems

May 8, 2024 | PLOS ONE |

**Introduction:** Assessments of cover crop climate value typically quantify carbon sequestration and $N_2O$ emissions, but omit land-use effects, specifically the carbon savings that arise when yield gains on existing cropland reduce pressure to convert natural land elsewhere. Focused on Central European maize cropping systems, researchers from Weihenstephan-Triesdorf University of Applied Sciences and Leibniz University Hannover in Germany conducted a systematic literature review to build a comprehensive framework for calculating the net climate change mitigation impact (NCCMI) of cover crops in this regional context.

**Key findings:** Cover crops generate a net climate change mitigation impact of 3.30 Mg $CO_2e$ $ha^{-1}$ $yr^{-1}$. The largest contributor is carbon land benefit, which represents the avoided land-use emissions from higher maize yields, accounting for 34.5% of total benefits, followed by soil carbon sequestration at 33.8%. Climate costs, dominated by seed production emissions and foregone land-use benefits from seed area, represent only 15.8% of benefits. All four scenario variants tested returned a positive NCCMI. Scaling to the full EU-27 maize area, universal adoption of cover crops before maize would deliver 49.80 million Mg $CO_2e$ $yr^{-1}$ in climate mitigation, equivalent to 13.0% of the EU's total agricultural emissions. The study notes that its framework is specific to Central European maize rotations and that extrapolation to other crop systems and regions will require adjusted parameters.

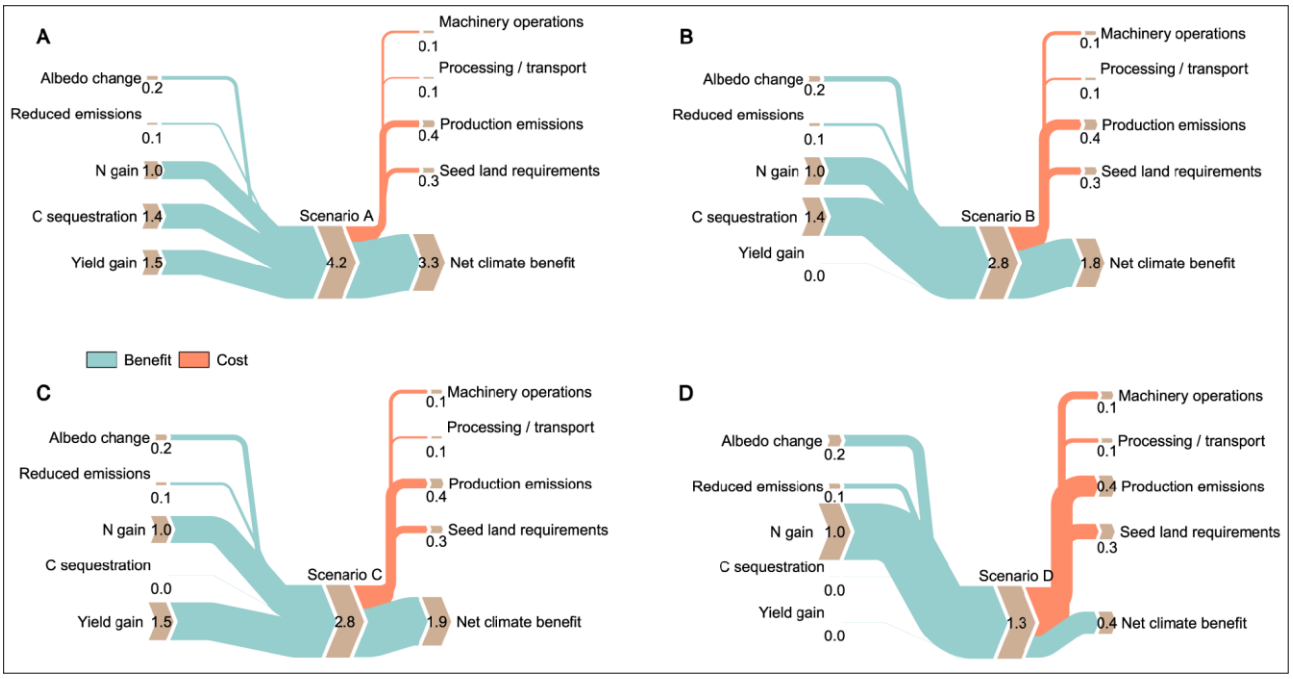



**Figure |** Sankey plots describing gains and losses of different scenarios for the NCCMI. (Numbers are given as Mg $CO_2e$ $ha^{-1}$.)

**03 THEME:** Carbon Sequestration

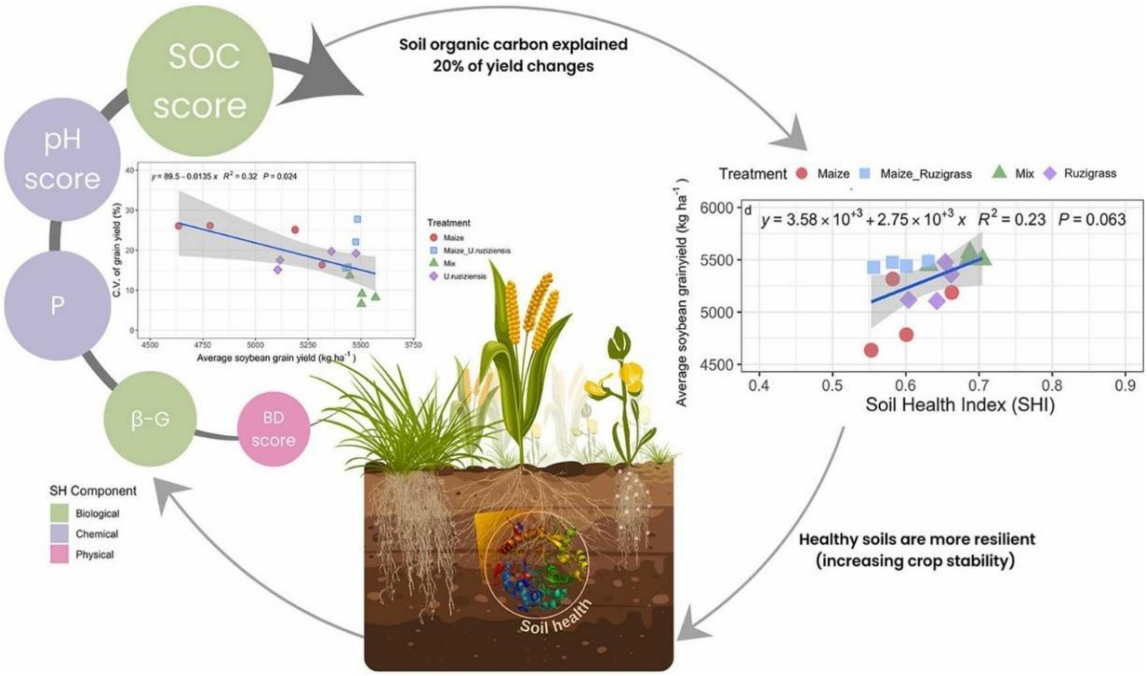
# Cover crops enhance soil health, crop yield and resilience of tropical agroecosystem

March 1, 2025 | Field Crops Research |

**Introduction:** The benefits of cover crops for soil health and yield are well documented in temperate systems, but evidence from tropical, highly weathered soils remains limited. Brazilian research team led by the University of São Paulo (ESALQ/USP) conducted a five-year field study in the Brazilian Cerrado to evaluate how cover crop biodiversification affects soil health, soybean yield, and crop resilience to climate-related stresses.

**Key findings:** Cover crop mixtures (ruzigrass, millet, and sunn hemp) and single ruzigrass plantings after soybean enhanced soil biological health and the composite soil health index (SHI) at the 0–10 cm and 0–30 cm layers compared with maize and ruzigrass-intercropped maize. Healthier soils were associated with higher soybean yields and greater yield stability across seasons. Soil organic carbon explained 20% of yield variation, while β-glucosidase activity, a biological indicator, explained 35% of yield resilience to climate stress, underscoring the role of soil biology in buffering weather shocks. These gains were observed after five consecutive years of cover crop management, reinforcing that long-term practice is required to realize meaningful improvements in soil health and resilience on highly weathered tropical soils such as those of the Cerrado. The study concludes that biodiversification through cover crops, particularly grasses or grass-legume mixes, offers a practical pathway to more productive and climate-resilient agricultural systems in tropical regions, with implications for smallholder farming across the Global South.

**Graphical Abstract**



**04 THEME:** ICT in Agrifood Sustainability; Carbon Sequestration

# The role of autonomous mechanical weeding robots in climate-smart soil management: A scoping review

March 11, 2026 | European Journal of Soil Science |

**Introduction:** Autonomous field robots are gaining attention as a tool for sustainable crop management, with mechanical weeding currently their dominant application. Yet their effects on soil health beyond weeding efficiency remain poorly understood. Researchers from the Leibniz Centre for Agricultural Landscape Research (ZALF) and the Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB) in Germany conducted a scoping review to synthesize evidence on how autonomous mechanical weeding robots affect soil functions and their role in climate-smart soil management.

**Key findings:** Of 22 studies reviewed, 18 focused on productivity-related outcomes such as weeding efficiency, while only five quantified effects on soil physical, hydrological, or biogeochemical functions. The review proposes a framework in which robots affect soil functions through two pathways: altered machinery intensity and traffic patterns, and repeated shallow soil disturbance from mechanical weeding interventions. Lighter robot axle loads relative to conventional tractors reduce compaction risk, but the second pathway, cumulative repeated shallow soil disturbance, poses underexamined risks to aggregate stability, carbon sequestration, and water regulation that could offset gains from reduced machinery weight. These effects remain largely unquantified across existing studies. Autonomous robotic systems could support diversified cropping systems and precision soil management, but current evidence is skewed and fragmented. The authors identify multiannual evaluation of soil property changes and continuous soil monitoring as research priorities needed to align robotic weeding with EU soil health targets and global sustainability goals.

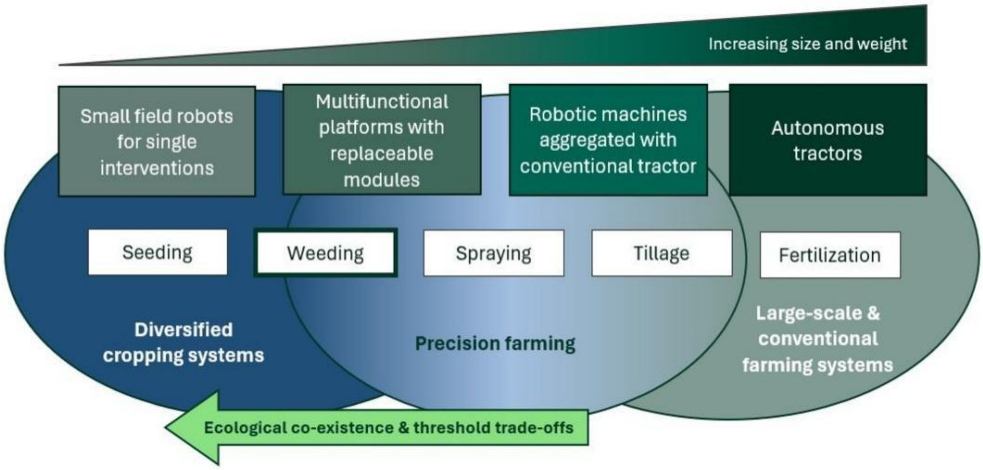



**Figure** | Conceptual classification of available agricultural robotic technologies (green boxes) in arable farming and their respective feasible management interventions (white boxes), embedded in their potential operational area for different cropping systems (circles).

**05 THEME:** Carbon Sequestration; MRV (Measurement, Reporting, Verification)

# Quantifying the impact of climate smart agricultural practices on soil carbon storage relative to conventional management

January 15, 2024 | Agricultural and Forest Meteorology |

**Introduction:** Claims that climate-smart agricultural practices sequester atmospheric carbon more effectively than conventional approaches lack robust empirical grounding, partly because most studies rely on soil core sampling alone and rarely confirm that observed carbon gains reflect actual atmospheric uptake rather than erosion reduction. To address this, researchers from the USDA Agricultural Research Service combined eddy covariance flux towers, which continuously measure net carbon exchange between the field and the atmosphere, with deep soil cores extending to 1 meter to compare soil organic carbon (SOC) change between an aspirational field (no-till corn-soybean-wheat-hay rotation with cover crops) and a business-as-usual field (conventional tillage, corn-soybean-soybean rotation) from 2016 to 2022.

**Key findings:** Both measurement methods confirmed that the aspirational field accumulated more soil organic carbon than the business-as-usual field. Soil core estimates showed a ΔSOC of 1.9 ± 1.7% $yr^{-1}$ at the aspirational field versus −0.7 ± 1.3% $yr^{-1}$ at the conventional field; eddy covariance estimates were more conservative at 0.80 ± 0.09% $yr^{-1}$ and 0.12 ± 0.06% $yr^{-1}$ respectively, reflecting different measurement scopes. Unharvested cover crops added carbon during fallow periods that would otherwise represent net losses. No-till management and expanded rotations also contributed positively to the carbon budget. Critically, sampling to 1 meter depth was essential to capturing net SOC change: shallow sampling to 30 cm, the most common approach in the literature, would have underestimated carbon gains in the aspirational system where conservation practices redistribute carbon deeper in the profile. The study illustrates that combining soil sampling with eddy covariance provides a more complete picture of carbon dynamics, and underscores the value of this dual approach for verifying climate-smart practice outcomes, relevant to emerging MRV frameworks for agricultural carbon.

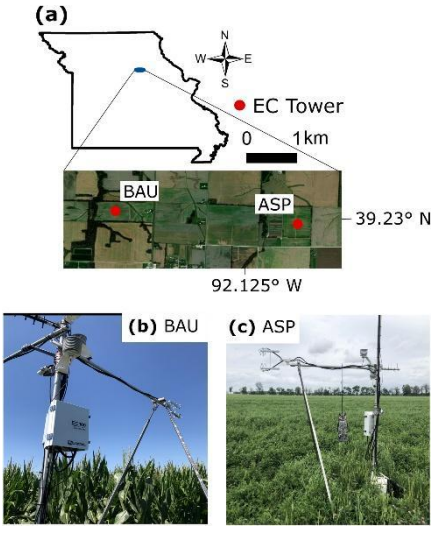



**Figure** | The (a) two study fields located within central Missouri, USA are instrumented with eddy covariance systems at the (b) business-as-usual (BAU) field (July 24, 2020) and (c) spirational (ASP) field (May 25, 2021).

# NEWS

01 **THEME:** Policy Incentives, Financing, Pricing

## Fertilizer scarcity will affect next harvests and food supplies, FAO warns

May 7, 2026 | Food and Agriculture Organization of the United Nations (FAO) |

Disruptions to maritime traffic through the Strait of Hormuz are tightening global fertilizer markets and raising energy costs, with consequences that FAO Director-General warned will carry into harvests through late 2026 and into 2027. Speaking at a Ministerial Meeting of the MED9++ Countries on *"Supporting Food Security and Access to Fertilizers,"* co-chaired by FAO, Italy and Croatia and held in Rome, he stressed that fertilizers must be applied within specific crop-cycle windows; delays force farmers to reduce or forgo application entirely, directly cutting yields. Import-dependent countries in Africa, Asia, and the Middle East face the greatest exposure, particularly those already dealing with food insecurity or climate shocks. FAO called for immediate action to maintain supply chains and avoid export restrictions, medium-term diversification of fertilizer and energy sources, and long-term structural investment in sustainable agriculture and innovative fertilizer solutions.

02 **THEME:** Policy Incentives, Financing, Pricing

## FAO report calls for robust risk assessment for recycled plastic food packaging

May 13, 2026 | Food and Agriculture Organization of the United Nations (FAO) |

A new FAO report highlights the chemical safety risks posed by the growing use of recycled plastics in food packaging and calls for globally harmonized standards to govern their use. The report, *Food safety implications of recycled plastics and alternative food contact materials*, notes that the global food packaging market, valued at $505.27 billion in 2024 and projected to reach $815.51 billion by 2030, is shifting toward recycled materials for sustainability reasons, yet less than 10% of plastic waste has been recycled to date. Key concerns include potential chemical migration from packaging into food, new hazards from bio-based materials derived from crops such as corn and cassava, and the absence of validated analytical methods to detect micro- and nanoplastics. FAO called for effective cleaning processes in plastic recycling, waste stream sorting systems, and international regulatory harmonization through the Codex Alimentarius Commission.

03 **THEME:** GHG Emission Reduction; Policy Incentives, Financing, Pricing

## Regenerative agriculture scales amid rising climate and trade risks

May 18, 2026 | Food Ingredients First |

Ahead of the Sustainable Foods Summit in Amsterdam, Netherlands (June 18–19), a Ecovia Intelligence representative told Food Ingredients First that regenerative agriculture is scaling rapidly to meet net-zero demand, with the Regenerative Organic Certified scheme now covering nearly 20 million acres across more than 140 crops including grains, proteins, dairy, and cotton. She identified climate change, geopolitical conflict, and US tariffs as the main forces driving supply chain disruption in recent years, with commodities such as cocoa and coffee already showing strain. The article also points to upcycled ingredients and precision fermentation as growing trends reshaping sustainable food formulation: examples include Barry Callebaut's cacao fruit upcycling and cultivated cocoa butter from Celleste Bio. Summit sessions covered regenerative agriculture for biodiversity, AI's role in sustainable food production, and approaches to measuring environmental footprints.

04 **THEME:** Policy Incentives, Financing, Pricing; GHG Emission Reduction

## Vietnam's net-zero push tests limits of state-led climate governance

May 21, 2026 | Yahoo News / UPI |

Vietnam has committed to reaching net-zero emissions by 2050, anchored in its National Climate Change Strategy, which targets a 43.5% emissions reduction by 2030 and a carbon emissions peak by 2035. The strategy spans energy transition, agricultural reform, and forest conservation, with renewable energy, energy efficiency, and carbon capture projected to account for nearly 80% of emission reductions. A nascent carbon market is already in operation, targeting major emitters in steel, cement, and thermal power. Agriculture and forests form a critical but underexamined pillar: climate-smart farming methods and maintaining forest cover at approximately 43% are central to Vietnam's sequestration strategy. However, analysts highlight a significant governance challenge: Vietnam's tightly controlled media environment limits independent verification of emissions data and environmental compliance, raising questions about whether the country's ambitious targets can be achieved without more open environmental reporting and third-party auditing. The article notes that the country's trajectory will be watched closely as a test case for state-led climate governance in emerging economies.

05 **THEME:** GHG Emission Reduction

## Taiwan's domestic soybean planting area has increased 5.5-Fold over the past 10 years—A highlight of low-carbon, sustainable diets

May 21, 2026 | Central News Agency (CNA) |


Taiwan's domestically grown soybean acreage expanded from approximately 680 hectares in 2014 to 4,473 hectares in 2024, a more than 5.5-fold increase, according to Ministry of Agriculture. Though domestic production still accounts for only about 0.2% of national soybean demand, with the remainder imported, the Tainan District Agricultural Research and Extension Station (TNDARES) highlighted multiple climate benefits of local soybean cultivation. Soybeans require only 30–40% of the water used by paddy rice and, through nitrogen fixation by root nodule bacteria, can reduce chemical nitrogen fertilizer use by approximately 20%, lowering $N_2O$ emissions. Shorter supply chains compared to imports also cut transport-related carbon footprints. TNDARES has developed two new varieties: Tainan No. 10 (high-protein, suitable for tofu and soy milk) and Tainan Black Soybean No. 11 (high-yield, rich in isoflavones and anthocyanins). TNDARES recommends consumers look for TGAP or organic certification labels when purchasing, and stated its intention to continue improving cultivation management techniques and mechanization to raise production efficiency and industry competitiveness.

06 **THEME:** Policy Incentives, Financing, Pricing

## Taiwan's ETS system draws on international best practices

May 14, 2026 | Commercial Times |


Taiwan's Carbon Credit Exchange and Taiwan Stock Exchange, in collaboration with National Taiwan University, hosted a seminar examining international experience with emissions trading systems (ETS) and voluntary carbon markets, as Taiwan moves toward implementing a cap-and-trade system (TW ETS) to complement its existing carbon fee mechanism. Experts from Japan, South Korea, Germany, and the International Carbon Action Partnership (ICAP) discussed how ETS design can support agricultural decarbonization. Japan's Yoshitaka Uchida highlighted J-Credit mechanisms that incentivize practices such as water management in rice paddies and biochar application. South Korea's Hakkyun Jeong recommended prioritizing cost-effective methodologies and collective management structures to lower barriers for smallholder farmers. ICAP's Baran Doda noted that Taiwan's approach of linking voluntary reduction plans to preferential carbon fee rates aligns with EU ETS design trends, and that transitioning from a carbon fee to a full ETS follows a path similar to Germany, Austria, and France.

# POLICY

**01 THEME:** Climate Smart Agriculture; Nature-based solutions

## Integrated Pest Management: Training Guide for Facilitators

Food and Agriculture Organization of the United Nations (FAO) | Source | Report |


This FAO training guide provides a structured framework for facilitators, lead farmers, and extension agents who work directly with farming communities to understand and implement integrated pest management (IPM). Developed under the EU-funded Capacity Building Related to Multilateral Environmental Agreements in African, Caribbean and Pacific Countries Phase III (ACP MEAs 3) program, the guide aims to reduce dependence on synthetic pesticides and support sustainable, biodiversity-friendly farming systems.

The guide is organized around eight IPM principles: **1) prevention and suppression; 2) monitoring; 3) decision-making based on economic and environmental thresholds; 4) prioritization of biological and non-chemical control methods; 5) targeted pesticide selection; 6) reduced pesticide use; 7) anti-resistance strategies; and 8) evaluation**. Specific approaches covered include agroforestry (e.g., nitrogen-fixing hedges, neem-based natural pesticides), intercropping with pest-repellent plants, push-pull technology, crop rotation, cover crops, biological control through natural enemies, and physical or mechanical methods such as trapping and post-harvest sanitation. Chemical control is framed as a last resort, to be applied only when other methods have proven insufficient.

# EVENT

01

## Earth Precision Agriculture Conference 2026 (EPA 2026)

August 10–14, 2026 | In-person | Calgary, Alberta, Canada |


EPA 2026 will convene researchers, innovators, investors, industry leaders, organizations, and government representatives to advance digital transformation and sustainability across the agri-food value chain. The conference features specialized tracks covering topics such as AI for agriculture, remote sensing, robotics, controlled-environment agriculture, soil health, precision livestock, irrigation and water management, sensors, IoT, and agri-food economics and policy. With a focus on connecting research breakthroughs with scalable commercial and policy applications, EPA 2026 provides a platform for cross-sector collaboration on productivity, resilience, traceability, food security, and sustainable agricultural innovation.

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02

## 14th International Conference on Sustainable Development (ICSD 2026)

September 9–10, 2026 | hybrid | Rome, Italy |


ICSD 2026 will be held under the theme *"Creating a unified foundation for Sustainable Development: research, practice and education."* Organized by the European Center of Sustainable Development in collaboration with CIT University, the conference provides a multidisciplinary forum for scholars, educators, and practitioners working across environmental, economic, and socio-cultural sustainability. Relevant streams include climate change, water and soil conservation, biodiversity conservation, sustainable agriculture, waste management, carbon-neutral strategies, circular economy, green finance, and environmental legislation.

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03

## The 2026 Conference of International Society of Paddy and Water Environment Engineering (PAWEES 2026)

October 19–21, 2026 | In-person | Chuncheon, Korea |


PAWEES 2026 will be held under the theme *"AI-Enabled Climate-Resilient Agricultural Water Systems toward a Carbon-Neutral Future."* Organized by PAWEES, the Korean Society of Agricultural Engineers, and partner institutions in Korea, the conference focuses on the role of agricultural water engineering in climate resilience, carbon neutrality, and sustainable land and water management. Main themes include soil, water and carbon for agricultural resilience; AI, digital twins and smart technologies for agro-water systems; water quality, aquatic ecosystems and nature-based solutions; and policy and governance for carbon-neutral water futures. The programme includes technical sessions, poster sessions, a student presentation competition, and a technical tour. Abstract submission will close on July 15, 2026.

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04

## 22nd RUFORUM Annual General Meeting (AGM 2026)

November 30–December 4, 2026 | In-person | Livingstone, Zambia |

The 22nd RUFORUM AGM will bring together African universities, governments, development partners, private sectors, students, innovators, and farmer organizations to examine how higher agricultural education, innovation, and research can be translated into action for Africa's agricultural transformation. Hosted by the Government of Zambia and RUFORUM member universities, the AGM focuses on human capital development, resilient and productive economies, university–partner collaboration, and capacity sharing for the next generation. The programme is particularly relevant to climate-smart agriculture, digital transitions, AI and robotics in agriculture, evidence-based investment, agrifood-system resilience, and youth-centered innovation. Scientific sessions will be conducted in a blended format with oral and poster presentations. The registration has started and abstract submissions close on July 15, 2026.

05

## AGU Annual Meeting 2026 (AGU26)

December 7–11, 2026 | Hybrid | San Francisco, California, USA |


AGU26 will convene the global Earth and space science community under the meeting theme *"Where Science Connects."* As one of the largest international gatherings for Earth and space scientists, the annual meeting provides a platform for presenting research, building collaborations, and engaging with emerging scientific evidence across climate, hydrology, biogeosciences, geoscience observation, and environmental change. While broad in disciplinary scope, AGU26 is relevant to climate-smart and net-zero agri-food systems through sessions and discussions related to climate impacts, water resources, land and ecosystem processes, remote sensing, carbon cycling, and data-driven environmental monitoring. The meeting includes scientific sessions, workshops, panel discussions, and networking opportunities. Abstract submissions close on August 5, 2026.