Issue 42
September 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

Advancing Low-Carbon Agriculture through Energy, AI and Automation

Low-carbon agriculture is moving beyond individual technologies toward more integrated approaches that connect technology, resources, and institutions. This month's news highlights developments in agricultural waste recycling, climate finance, carbon management, and international cooperation on smart agriculture. At the same time, the latest global assessment shows that food systems remain far from their 2030 climate goals, underscoring the need to accelerate action across technology, policy, and investment.

This month's featured journal articles focus on how energy, AI, and automation are reshaping agricultural production. From electric machinery, agrivoltaics, and renewable-energy microgrids to AI-based energy forecasting, smart water-energy management, autonomous robots, and intelligent greenhouse control, these studies show how farms can produce and use cleaner energy while managing resources more efficiently and precisely. Together, they point toward a more integrated, low-carbon, and resilient agricultural future, although challenges in cost, infrastructure, and real-world application remain.

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NEWS

01 THEME: ICT in Agrifood Sustainability

Taiwan and Thailand expand AI partnership for smart agriculture

12 August 2026 | CNA |

Taiwan and Thailand are accelerating AI use in agriculture. Recent bilateral exchanges focused on AI, digital twins, GIS, satellite remote sensing, and image recognition, exploring how satellite, drone, and ground-level data can improve farmland monitoring, crop surveys, and early detection of abnormalities. Building on more than 20 years of agricultural cooperation, the two sides will seek pilot sites to test AI, big data, IoT, and geospatial technologies, moving their smart agriculture partnership from knowledge exchange toward practical applications while addressing climate change, food security, and agricultural labor shortages.



Content adapted from CNA | Image reproduced from CNA

02 THEME: Measurement, Reporting, Verification

Taiwan's rural conservation projects cut carbon emissions by 16.55% in 2025

10 August 2026 | Agency of Rural Development and Soil and Water Conservation, Ministry of Agriculture,Taiwan (ARDSWC) |

Taiwan's Rural Development and Soil and Water Conservation Projects achieved a 16.55% carbon reduction rate in 2025, surpassing the original 15% target across 1,562 completed projects. The assessment also identified construction materials as the largest source of emissions, accounting for 83.89% of the total, with concrete and steel among the major contributors. To further reduce emissions, Taiwan will promote low-carbon and recycled construction materials, reduce transportation distances, improve material-efficient design, and reuse excavated soil and stone on-site. Carbon management is also being integrated throughout project approval, design, construction,



and completion, making emissions reduction part of routine rural infrastructure management.

Content adapted from ARDSWC| Image source: ARDSWC

03 THEME: GHG Emission Reduction

Black soldier fly organic fertilizer: An integrated approach to soil health, low-carbon agriculture, and pest management

12 August 2026 | Rice Today (IRRI) |

Black soldier flies may be small, but they could play a surprisingly big role in more sustainable farming. By breaking down organic waste, they can turn by-products into nutrient-rich fertilizer that supports healthier soils while potentially helping crops defend themselves against pests and diseases. In a recent IRRI greenhouse experiment with India's specialty Kalanamak rice, seeds treated with 2% Black Soldier Fly-derived fertilizer showed up to a 42.85% increase in early germination, along with stronger seedling growth. By turning waste into a useful agricultural resource, Black Soldier Fly technology could help farmers improve soil health, reduce reliance on synthetic inputs, and move toward more circular and low-carbon farming systems.



Content adapted from Rice Today (IRRI) | Image source: Rice Today (IRRI)

04 THEME: GHG Emission Reduction

From waste to resource: how livestock manure can help to close Europe's nutrient loop

15 July 2026 | European Commission – Agriculture and Rural Development |

Livestock manure could become part of Europe's answer to rising fertilizer costs and import dependence. The EU-funded FertiCovery project is exploring how to recover nutrients from manure, biowaste, and wastewater and turn them into bio-based fertilizers. After screening more than 150 technologies, the project selected 25 promising nutrient recovery value chains for further assessment. By recycling nutrients back into farmland, these solutions could reduce greenhouse gas emissions, replace part of mineral fertilizer use, improve soil health, and strengthen Europe's agricultural resilience.



Content adapted from European Commission – Agriculture and Rural Development | Image source: European Commission – Agriculture and Rural Development

05 THEME: Policy Incentives, Financing, Pricing

Can climate finance deliver more equitable rice systems?

17 August 2026 | Rice Today (IRRI) |

Climate finance can do more than fund irrigation systems, climate-smart rice varieties, and digital technologies—it can also determine who has the capacity to adapt to climate change. Building more resilient and equitable rice systems requires investment in farmers' access to climate information, decision-making power, local institutions, and knowledge networks, particularly for women who often face barriers to land, finance, extension services, and technology. One emerging priority is climate intelligence, which helps farmers turn locally relevant weather and climate information into practical decisions on planting, irrigation, fertilization, pest management, and extreme weather preparedness. By investing in people and institutions alongside technology, climate finance can strengthen farmers' ability to anticipate, respond to, and recover from climate shocks.



Content adapted from Rice Today (IRRI) | Image source: Rice Today (IRRI)

06 THEME: ICT in Agrifood Sustainability

When an old fix needs an upgrade: inside CSIRO's search for cotton's next resistance gene

4 August 2026 | CSIRO |

Even a resistance gene that has protected crops for decades can eventually fail. Australian cotton has long relied on genetic resistance against bacterial blight, but when that protection unexpectedly broke down in the United States in 2011, CSIRO began searching for a second line of defense. Researchers have since identified a different resistance gene and are expanding beyond the traditional single reference genome by developing a cotton pangenome that captures genetic diversity across multiple plants. Combined with AI-assisted prediction and gene editing, this approach could help breeders identify valuable traits for disease resistance, fiber quality and yield—and prepare new varieties before existing protections fail.



Content adapted from CSIRO| Image source: CSIRO

07 THEME: Measurement, Reporting, Verification

World off-track on nearly every food system goal, latest assessment reveals

10 Augus 2026 | FAO |

Global food systems are falling far behind their 2030 goals. The 2026 Food Systems Countdown initiative, covering 197 countries and 44 indicators, finds that progress remains insufficient across health, environment, food security, governance, and resilience. Most strikingly, no country is projected to meet the 2030 target for food system greenhouse gas emissions at the current pace, with the global average still 75% away from the goal. While 2030 targets are increasingly out of reach, 2050 remains achievable if countries accelerate emissions reductions, improve food affordability, and strengthen governance and accountability.



Content adapted from FAO | Image source: FAO

RESEARCH

01 Theme: GHG Emission Reduction

Off-road electric vehicles and autonomous robots in agricultural sector: Trends, challenges, and opportunities

August 2022 | Vehicles | Volume 4

Introduction: Agriculture is under growing pressure to increase productivity while reducing greenhouse gas emissions, fossil fuel dependence, soil degradation, and labor shortages. Electrification and autonomous machinery are emerging as important solutions to these challenges. This review examines recent developments in battery-electric, hybrid-electric, and hydrogen fuel-cell agricultural machinery, as well as autonomous robots, and explores how these technologies could integrate with renewable energy, energy storage, AI, and IoT to support more sustainable, energy-independent farming systems.

Key findings: Electrification and autonomous technologies could play an important role in reducing the environmental footprint of agricultural machinery. Electric and hybrid powertrains offer lower direct emissions, improved controllability, and reduced maintenance needs, with some hybrid multifunctional tractors achieving emission reductions of around 17%. However, high battery costs and long charging times remain major barriers, while hydrogen fuel cells offer faster refueling but still face cost and infrastructure limitations. Integrating solar, wind, biomass, and small-scale hydropower with battery or hydrogen storage could enable farm-scale microgrids that directly power electric tractors, autonomous robots, and other equipment. Combined with AI, IoT, autonomous navigation, and smart scheduling, these technologies could also improve the precision use of fertilizers, pesticides, and irrigation water while reducing soil compaction. The study therefore points toward an integrated farming system where renewable energy, electrified machinery, autonomous operation, and digital technologies work together to support low-carbon and increasingly energy-independent agriculture.

Content adapted from Amin Ghobadpour et al.

02 Theme: GHG Emission Reduction

Drawing transformation pathways for making use of joint effects of food and energy production with biodiversity agriphotovoltaics and electrified agricultural machinery

June 2023 | Journal of Environmental Management | Volume335

Introduction: Agricultural land does not have to choose between producing food, generating renewable energy, and protecting biodiversity. Schneider and her interdisciplinary research team explored a more integrated pathway by combining biodiversity agriphotovoltaics with electrified agricultural machinery. Using a survey of 116 farmers, a GIS-based assessment in Lower Saxony, Germany, and field-scale energy simulations, the study examined whether solar electricity generated alongside biodiversity-oriented flower strips could directly support electric farm machinery. The results point toward a future in which farms could simultaneously produce food and renewable electricity, strengthen ecological connectivity, and reduce their dependence on fossil fuels.

Key findings: The study found that only a relatively small share of farmland may be needed to support agricultural electrification. In the field-scale scenario, allocating about 3% of agricultural land to agriphotovoltaics could provide much of the energy required for most crop-production operations. At the regional scale, combining solar installations with flower strips showed a theoretical technical potential of approximately 78 GWp (gigawatts-peak) in Lower Saxony while improving connectivity between fragmented habitats. Mobile battery storage could further improve the match between solar generation and machinery demand, although energy-intensive harvesting remains difficult to fully electrify. Importantly, farmers who associate agriphotovoltaics with greater energy self-sufficiency also showed stronger intentions to adopt the technology, suggesting that directly linking renewable energy production to farm operations could help accelerate its uptake.

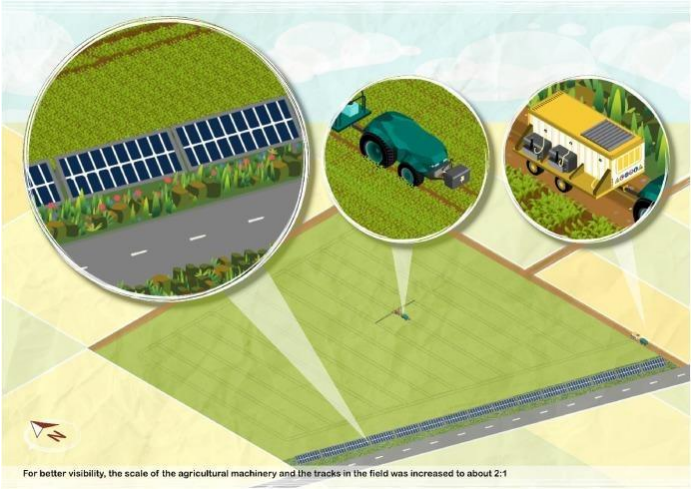


Figure | The local scenario of the energy-food-biodiversity nexus: A 9 m strip of biodiversity agriphotovoltaics is located at the field path. The tractor in this illustration is battery powered. Mobile battery replacement systems can be found at the edge of the field.

Content adapted from Schneider et al. | Image reproduced from Schneider et al.

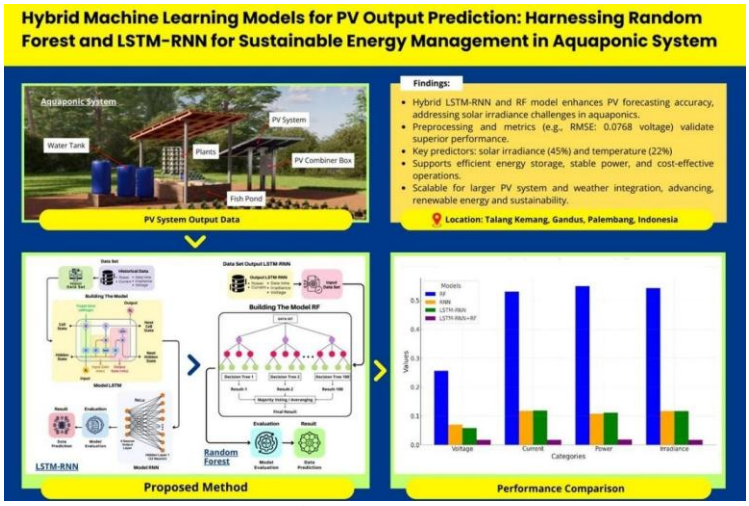
03 Theme: GHG Emission Reduction

Hybrid Machine learning models for PV output prediction: Harnessing Random Forest and LSTM-RNN for sustainable energy management in aquaponic system

April 2025 | Energy Conversion and Management | Volume 330

Introduction: Dewi and her research team demonstrated how hybrid machine learning could improve solar energy forecasting and support more reliable energy management in aquaponic production systems. Solar-powered aquaponics requires continuous electricity for water circulation, aeration, lighting, and other essential equipment, yet fluctuating solar irradiance can make renewable power supply difficult to manage. To address this challenge, the team combined a Long Short-Term Memory Recurrent Neural Network (LSTM-RNN) with Random Forest (RF), using LSTM-RNN to capture temporal patterns in photovoltaic (PV) data and RF to refine predictions and identify influential variables. The hybrid approach links accurate PV forecasting with smarter energy storage and distribution, helping aquaponic systems maintain stable operation while improving renewable energy utilization.

Key findings: The hybrid LSTM-RNN-RF model outperformed standalone models, achieving an overall RMSE of 3.12% and MAE (mean absolute error) of 2.67%, with parameter-specific RMSE (root mean square error) values of 0.0768 for voltage, 0.037 for current, 0.041 for power, and 0.0363 for irradiance. Random Forest identified solar irradiance as the most influential predictor, followed by temperature, while the hybrid framework also supported detection of abnormal PV performance such as shading and degradation. More accurate forecasting enables aquaponic systems to better coordinate battery storage and electricity use—storing energy during periods of strong sunlight and maintaining power for critical equipment when solar availability declines. The findings show how AI-based forecasting can improve renewable-energy utilization, operational reliability, and energy management in controlled agricultural production systems.



Content adapted from Dewi et al. | Image reproduced from Dewi et al

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04 Theme: GHG Emission Reduction

Enhancing sustainable and climate-resilient agriculture: Optimization of greenhouse energy consumption through microgrid systems utilizing advanced meta-heuristic algorithms

July 2024 | Energy Strategy Reviews | Volume 54

Introduction: Greenhouse farming can support stable crop production under controlled conditions, but maintaining suitable temperatures can require substantial energy for heating and cooling. This creates challenges for regions seeking to expand greenhouse agriculture while reducing fossil-fuel dependence and improving climate resilience. Focusing on Nigeria, this study evaluated greenhouse energy demand under different regional climatic conditions and explored how hybrid renewable energy systems combining solar PV(solar photovoltaic), wind turbines, and energy storage could meet these needs. The researchers also applied the Teaching–Learning-Based Optimization (TLBO) algorithm to identify technically reliable and economically suitable system configurations for greenhouse operations.

Key findings: Greenhouse energy requirements varied considerably across Nigeria because of differences in temperature and solar radiation, with cooling demand playing a particularly important role in the country's warm climate. The study found that solar PV combined with energy storage (PV–ESS) was generally the most attractive configuration across the evaluated regions because Nigeria's abundant solar resources reduced storage requirements and system costs. The estimated levelized cost of electricity (LCOE) for PV–ESS ranged from approximately US$0.073/kWh in Kano to US$0.853/kWh in Adamawa, illustrating the importance of location-specific renewable resources and energy demand. The TLBO optimization algorithm helped minimize net present cost while maintaining reliable energy supply. Overall, the study suggests that appropriately designed renewable-energy microgrids could reduce greenhouse farming's reliance on conventional energy while supporting more climate-resilient agricultural production.



Figure | External view of (a) greenhouse, (b) heat pumps, and (c) water storage tank.

Content adapted from Yakub et al. | Image reproduced from Yakub et al.

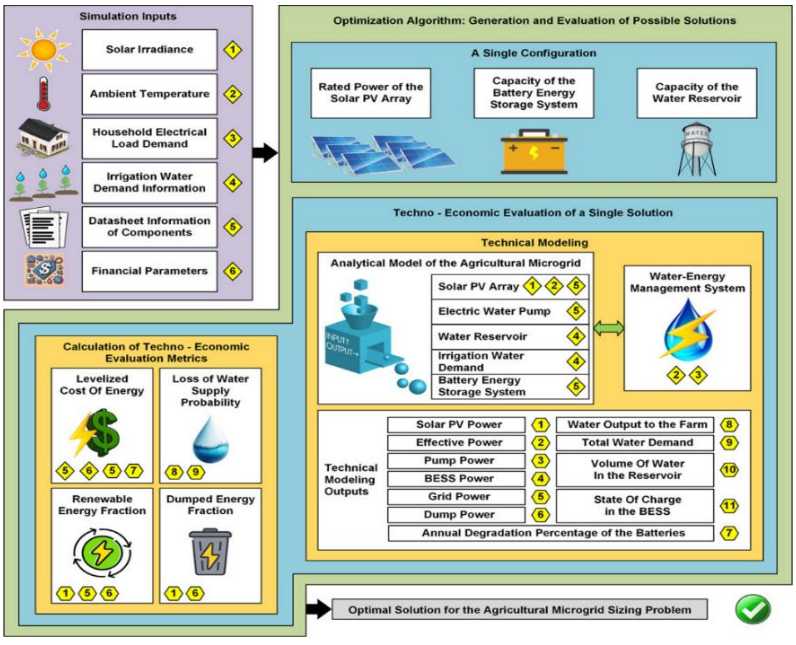
05 Theme: GHG Emission Reduction

Optimal sizing of a grid-connected DC microgrid for agricultural applications with water-energy management system considering battery cycle life

June 2025 |Energy Nexus |Volume 18

Introduction: Agricultural irrigation is becoming increasingly costly and carbon-intensive as farms continue to rely on grid electricity and diesel-powered pumping. While solar-powered irrigation offers a cleaner alternative, standalone systems often generate large amounts of unused electricity when solar production does not align with irrigation demand. Mokhtare and Keysan addressed this challenge by developing a grid-connected DC agricultural microgrid that integrates solar PV, battery storage, an electric water pump, household electricity demand, and an elevated water reservoir. A Water-Energy Management System (WEMS) coordinates electricity use, water storage, and irrigation timing, while also considering battery degradation and temperature constraints to reduce unnecessary water evaporation.

Key findings: Using real farm data from Ankara, Türkiye, the researchers found that the optimized system—combining a 6 kWp PV array, 7.5 kWh battery, and 20 m³ water reservoir—could fully meet irrigation demand while reducing the Levelized Cost of Energy from USD 401 to USD 223/MWh, a 44% decrease. Solar energy supplied 76.69% of the farm's energy needs, while wasted solar electricity fell by 62.4% compared with a standalone solar pumping system. The results also showed that solar pumping alone is not necessarily economical: integrating nearby electrical loads and battery storage allows farms to use surplus solar power more effectively while maintaining reliable irrigation.



Content adapted from Mokhtare and Keysan | Image reproduced from Mokhtare and Keysan.

06 Theme: ICT in Agrifood Sustainability

Autonomous navigation method for agricultural robots in high-bed cultivation environments

April 2025 | Computers and Electronics in Agriculture | Volume 231

Introduction: Agricultural robots could help automate labor-intensive tasks such as harvesting, pruning, and crop monitoring, but deploying them in small-scale greenhouse farms remains challenging. Fujinaga focused on high-bed cultivation environments, where uneven surfaces, narrow passages, changing objects, and repetitive cultivation structures can make conventional self-localization unreliable. In particular, LiDAR data collected between parallel cultivation beds contain few distinctive features, increasing the risk of localization errors. To address this problem without requiring additional infrastructure such as landmarks, floor lines, or magnetic tape, the study developed a hybrid autonomous navigation method for a compact crawler-type agricultural robot. The system switches between waypoint navigation for moving across the farm and real-time, LiDAR-based cultivation-bed navigation to maintain precise movement along crop rows. The method was first evaluated in a Gazebo virtual environment and then tested in a real high-bed strawberry greenhouse.

Key findings: The hybrid navigation method enabled the robot to move accurately and stably through the strawberry greenhouse while maintaining its position within approximately ±0.05 m of the target distance from the cultivation bed and its orientation within ±5°. In contrast, conventional waypoint-only navigation became unstable in the real environment because localization errors triggered repeated rotations and reversals, increasing travel time to about 375 seconds, compared with approximately 135 seconds using the proposed method. Virtual simulations also demonstrated their value for robot development: reducing the LiDAR measurement range from 25 m to 1 m increased the maximum localization error from 0.09 m to 1.6 m. The findings suggest that combining LiDAR-based local navigation with waypoint navigation can provide a practical approach for agricultural robots operating in structured but difficult greenhouse environments, while simulation can help optimize sensors and navigation systems before costly field testing.

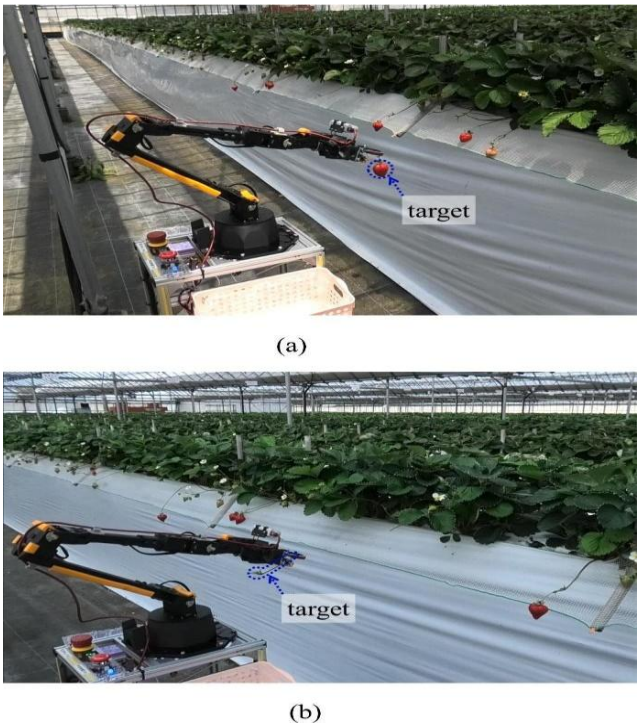


Figure |. Scenes demonstrating the multifunctional capabilities of the robot: (a) Harvesting strawberry fruits and (b) Pruning vines

Content adapted from Fujinaga | Image reproduced from Fujinaga.

07 Theme: ICT in Agrifood Sustainability

Enhancing autonomous agriculture control systems in greenhouses for sustainable resource usage using deep learning techniques

March 2026 | PLoS One | Volume 21

Introduction: Greenhouse production requires precise control of temperature, irrigation, CO_2, and other environmental conditions, but conventional fixed-control strategies may struggle to balance crop productivity with efficient resource use as conditions change. Hindi and colleagues developed an AI-based autonomous greenhouse control framework combining deep learning prediction models with reinforcement learning. Using data from the 2nd International Autonomous Greenhouse Challenge, the system predicts greenhouse climate, cherry tomato growth, and resource consumption, allowing an AI agent to dynamically optimize greenhouse control settings.

Key findings: Among the reinforcement learning algorithms tested, the TD3 (Twin Delayed Deep Deterministic Policy Gradient) model achieved the highest average reward and the most stable overall performance, outperforming PPO (Proximal Policy Optimization), DDPG (Deep Deterministic Policy Gradient), and SAC (Soft Actor-Critic). Compared with the average resource use of other greenhouse strategies, TD3 reduced irrigation by 24.05% and CO_2 consumption by 1.86%, while achieving stronger crop growth performance, particularly in cumulative trusses. Although electricity and heating use increased slightly, the results show that reinforcement learning can dynamically balance crop growth and resource efficiency. The system was evaluated in a virtual greenhouse environment, highlighting the need for further validation under real-world commercial conditions.

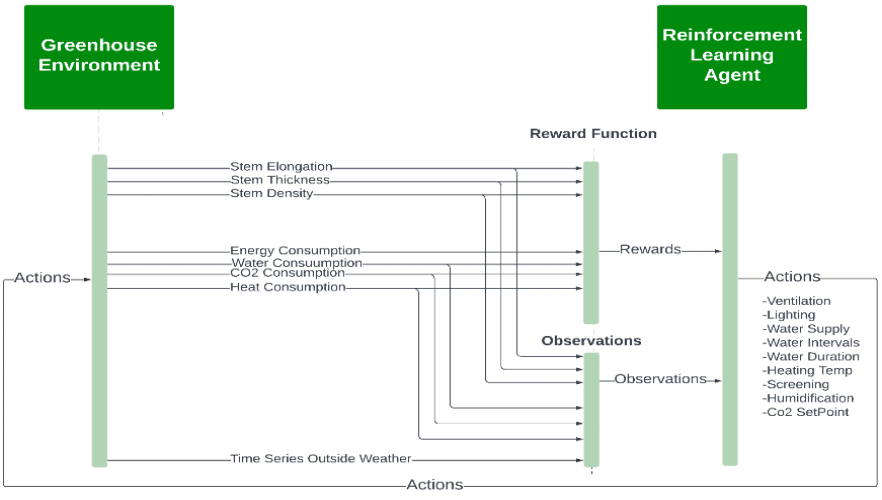


Figure | The structure of the proposed methodology for autonomous greenhouse control system.

Content adapted from Hindi et al. | Figure reproduced from the original article

EVENT

01

APFITA 2026 The 16th International Conference of Asia-Pacific Federation for Information Technology in Agriculture

4-6 November 2026 | In-person | Taipei, Taiwan |

Content adapted from APFITA| Image source: APFITA

02

2ndGlobal Agriculture Multidisciplinary International Conference – GAMIC 2027

Febraury 05-06, 2027| In-person | Hawai, USA |



Content adapted from University of Hawai'i at Hilo | Image source: University of Hawai'i at Hilo

03

Planetary Health Annual Meeting 2027 – PHAM2027

7–11 June 2027 | In-person | Tokyo, Japan |



Content adapted from AWWA | Image source: showsbee

03

AWWA Annual Conference & Expo 2027 – ACE27

13–16 June 2027 | In-person | San Diego, California, United States |

American Water Works Association | ACE ANNUAL CONFERENCE & EXPOSITION

Content adapted from AWWA | Image source: showsbee

04

IAFP 2027 Annual Meeting

18–21 July 2027 | In-person | Kansas City, Missouri, United States |



Content adapted from IAFP| Image source: IAFP

05

13th International Conference on Agricultural and Biological Sciences – 2027

17–20 August 2027 | In-person | Osaka, Japan |



Content adapted from ABS | Image source: ABS
