

編者言

當 AI 走入農田：臺灣智慧農業的全球合作新局

從依靠經驗傳承的傳統農耕，到綠色革命帶來的化肥與機械化，再到今日的數位科技浪潮，農業始終隨著時代演進不斷革新。進入 21 世紀，人工智慧（AI）、物聯網（IoT）、大數據分析與感測系統等新科技工具，正逐步走進農田與溫室，從作物管理到供應鏈追蹤，重新定義了「種得好」與「賣得好」的模式。這股智慧農業的浪潮，不僅帶動農業價值鏈升級，也為全球糧食安全與氣候調適提供了全新解方。

當前智慧農業已在精準栽培、病蟲害預警、用水效率管理與市場透明度等方面展現突破性潛力，更被視為協助開發中國家提升糧食自給、降低風險的重要工具。AI 農機自動化、區塊鏈供應鏈追溯、雲端農情數據平臺等應用，正在全球快速擴散。然而，科技真正「走入農田」的同時，挑戰也隨之而來，包括小農的數位落差、系統導入成本、農民教育訓練，以及政策與制度配套不足，都是智慧農業推廣過程中必須面對的現實課題。

在這股浪潮中，臺灣扮演著獨特而關鍵的角色。憑藉堅實的 ICT 產業基礎、卓越的農業技術研發能量，以及長期深耕的國際合作經驗，我國不僅在國內推動智慧農業，也透過國合會積極協助友邦導入智慧解決方案。例如在泰國推動的「園藝作物智慧栽培系統」，不僅輸出技術，更藉由標準作業流程在地化、培訓種子人員、建立成本效益模型，協助合作國逐步建立自我運作能力，展現「技術援外結合在地深化」的合作模式。

全球趨勢同樣印證此一方向。聯合國糧農組織（Food and Agricultural Organisation, FAO）、世界銀行與多國政府皆已將智慧農業視為因應糧食安全與氣候挑戰的核心策略。唯有兼顧創新與公平，智慧農業才能成為推動永續農業發展的助力。臺灣經驗正顯示，技術輸出不僅是硬體與系統，更涵蓋知識共構、人才培育與制度合作的長期承諾。

本期《當季專論》特別收錄臺大生物機電工程學系林達德教授的〈從田間到市場－智慧農業如何重塑農業價值鏈與糧食系統〉，以宏觀視角解析全球趨勢與臺灣經驗；工研院中分院李士哇副執行長的〈AI 時代的新農業：人工智慧協作永續生產與國合推動契機〉，從人工智慧應用出發，檢視農業創新的契機與風險；農業部農業試驗所前研究員兼副所長蔡致榮博士在〈全球智慧農業發展趨勢與開發中國家的機會與挑戰〉，則剖析數位落差下的國際援助與合作需求；最後，國合會駐泰國技術團則以〈我國智慧農業國際合作案例：技術援外如何實現在地深化，以「泰國應用智慧農業系統提升園藝作物栽培能力計畫」為例〉一文，具體呈現臺灣智慧農業如何落實於國際援助場域。

《焦點企劃》單元則以〈臺灣智慧農業發展及國際策略〉為題，專訪農業部資訊司郭坤峯

司長、科技司李紅曦司長，以及國合會史立軍副秘書長，分別從我國政府在智慧農業的政策制訂、農業科技的研發，以及國合會如何運用臺灣科技優勢及智慧工具推動農業援外，在面對氣候變遷、糧食危機及數位轉型之際，如何協助夥伴國家提升農業生產效率與氣候韌性，並分享在推動過程中遭遇的困難及挑戰。

展望未來，智慧農業的推動將不僅止於技術導入，而是進一步與政策治理、在地需求及國際合作緊密結合。唯有持續深化「科技、永續與合作」的核心價值，智慧農業方能轉化為強化糧食安全與農業韌性的長久動能。期盼透過本期專文與案例的分享，引發更多思考與交流，讓臺灣在全球智慧農業的浪潮中，持續扮演不可或缺的夥伴角色。

當期論文摘要

全球智慧農業發展趨勢與開發中國家的機會與挑戰

（蔡致榮，農業部農業試驗所前研究員兼副所長、臺灣農業設施協會理事長）

智慧農業（smart agriculture）代表著農業生產模式的典範轉移，透過整合先進科技如物聯網（IoT）、大數據、人工智慧（AI）、機器人技術和精準農業（precision agriculture），旨在提升農業生產效率、資源利用率，並實現永續發展。隨著全球人口持續成長，對糧食的需求不斷上升，以及氣候變遷帶來的嚴峻挑戰，智慧農業被視為解決未來糧食安全問題的關鍵。然而，儘管其潛力巨大，智慧農業的推廣和應用在全球各地，特別是開發中國家，面臨著獨特的機會與挑戰。本文將深入探討全球智慧農業的發展趨勢、技術應用、政策推動，並著重分析開發中國家在擁抱智慧農業過程中所面臨的機遇與困境，最後提出相關建議。

從田間到市場－智慧農業如何重塑農業價值鏈與糧食系統

（林達德，國立臺灣大學生物機電工程學系特聘教授）

隨著全球人口快速成長與氣候變遷風險日益加劇，傳統農業正面臨產能、資源與環境永續的多重挑戰。智慧農業，作為以數位科技驅動的現代農業模式，正逐步成為各國強化糧食安全與農業韌性的重要解方。透過物聯網（Internet of Things, IoT）、人工智慧（artificial intelligent, AI）、大數據、區塊鏈、自動化機具等技術的整合應用，智慧農業能實現更精準的資源管理與決策支援，從而提高生產效率、降低環境衝擊，並促進整體價值鏈的透明與效率提升。本文探討全球與臺灣智慧農業的發展現況與實踐經驗，聚焦其在提升農業價值鏈效率與資訊透明度、強化糧食體系的永續與風險調適能力方面的貢獻，並延伸探討臺灣在國際智慧農業合作與援助上的潛力與角色。最後，本文也檢視智慧農業發展面臨的挑戰，強調在政策支持、技術普及與多方協作下，打造包容性、永續性與具韌性的農業未來所需的努力與方向。

AI時代的新農業：人工智慧協作永續生產與國際合作推動契機

（李士蛙，工業技術研究院中分院副執行長）

AI時代來臨，讓全世界的智慧農業發展加快了速度。在面對傳統農林漁牧產業的技術傳

承，人工智慧系統逐步發揮了其高學習效率、反應速度快與精準的優勢。成為目前全世界面對從業人口老化、環境變遷影響農業生產質量，以及應對地緣風險、保障糧食安全的重要解方。由物聯網（Internet of Things, IoT）到人工智慧互聯網（Artificial Intelligence of Things, AIoT）、從無人機（Unmanned Aerial Vehicle, UAV）到農工機器人（Agri-bots），通訊系統（wifi、5G 到低軌衛星）所需的技術都需要 AI 與晶片（Chip）的協作，而臺灣目前就站在發揮軟硬整合能量的浪尖上。

本文由科技與農業生產融合的觀念，帶入人工智慧協助韌性生產上扮演的角色，輔以工業技術研究院（工研院，Industrial Technology Research Institute, ITRI）在協助跨部會推動農工合作下的智慧系統整合案例，說明永續生產現況與未來解方。最後，再透過國際合作推動方法，對未來科技農工的國際輸出合作模式提出建議。

我國智慧農業國際合作案例：技術援外如何實現在地深化
以「泰國應用智慧農業系統提升園藝作物栽培能力計畫」為例
（洪訢睿，財團法人國際合作發展基金會駐泰國技術團團長；
林岡諭，財團法人國際合作發展基金會駐泰國技術團計畫經理）

本文以臺泰合作的「泰國應用智慧農業系統提升園藝作物栽培能力計畫」為案例，探討在氣候變遷與勞力短缺下，智慧農業如何由單向技術輸出轉型為「在地共構、系統整合、人才培育、公私協力」的新模式。臺灣憑藉資通訊優勢，推動感測、決策與環控串接，並於泰國皇家計畫基金會清邁總部與多個工作站導入系統，透過「建置一應用一評估」逐步提升在地操作與數據管理能力。執行過程中，技術適應、人力銜接、商品化與效益驗證為主要挑戰，對應做法包括場域評估、在地化介面、人才體系建構、共製技術文件及依農民回饋調整配置。

在此基礎上，本文提出四項擴展方向：建立開源栽培模式與資料迭代機制；將人才與服務嵌入農業推廣體系；以「臺灣供技術、泰國做服務」模式推動國際企業結盟；並結合金融工具，降低農民導入門檻。研究總結，智慧農業援外應視為知識與治理的共創過程，國合會技術團可作為海外驗證與市場回饋樞紐，推動可複製、可擴張的合作模式，進而促成臺灣成為區域技術樞紐，並與夥伴國共享永續成果。

When AI Enters the Fields: A New Era of Global Cooperation in Taiwan's Smart Agriculture

From traditional farming that relied on experiential knowledge, to the Green Revolution that introduced fertilizers and mechanization, and now to the digital technology wave of today, agriculture has always evolved with the times. In the 21st century, emerging technologies such as artificial intelligence (AI), the internet of things (IoT), big data analytics, and sensing systems are steadily entering fields and greenhouses. From crop management to supply chain traceability, these tools are redefining what it means to grow well and sell well. This wave of smart agriculture is bolstering agricultural value chains while offering innovative solutions to global food security and climate adaptation.

Smart agriculture is already demonstrating breakthrough potential in precision cultivation, pest and disease forecasting, water efficiency management, and market transparency. It is increasingly recognized as an essential tool for developing countries to enhance food self-sufficiency and reduce risks. Applications such as AI-driven farm automation, blockchain-based supply chain traceability, and cloud-based agricultural data platforms are spreading rapidly worldwide. However, as technology truly enters the fields, challenges inevitably arise: the digital divide for smallholder farmers, the costs of system implementation, farmer training, and insufficient policy and regulatory support remain practical obstacles to scaling up smart agriculture.

In this global wave, Taiwan plays a unique and pivotal role. Leveraging its robust ICT industry, strong agricultural research capacity, and long-standing international cooperation experience, Taiwan is advancing smart agriculture domestically and abroad, supporting partner nations through the TaiwanICDF. For instance, in Thailand it transferred technology, localized standard operating procedures, trained seed personnel, and established cost-effectiveness models through the Raising Capability on Horticultural Crop Cultivation in Thailand through the Application of Smart Farming Systems project. This approach enables partner countries to gradually build independent operational capacity, embodying a model of integrating technical assistance with deepened local engagement.

Global trends further validate this direction. The Food and Agriculture Organization (FAO), the World Bank, and numerous governments have identified smart agriculture as a core strategy for

addressing food security and climate challenges. Only by balancing innovation with inclusiveness can smart agriculture truly drive sustainable agricultural development. Taiwan's experience demonstrates that exporting technology goes beyond hardware and systems—it requires long-term commitments in knowledge co-creation, talent cultivation, and institutional collaboration.

Several cases of Taiwan's contributions to global agricultural development are highlighted in this issue. Professor Ta-Te Lin of the Department of Bio-Industrial Mechatronics Engineering at National Taiwan University presents “From Field to Market: How Smart Agriculture Reshapes the Agricultural Value Chain and Food Systems,” offering a macro perspective on global trends and Taiwan's engagement with those trends. Dr. Shih-Chi Lee, Deputy Executive Director of the Central Taiwan Branch at the Industrial Technology Research Institute, contributes “New Agriculture in the AI Era: Opportunities for AI-Enabled Sustainable Production and International Cooperation,” examining both the opportunities and risks of agricultural innovation driven by AI applications. Dr. Chih-Jung Tsai, former Researcher and Deputy Director at the Taiwan Agricultural Research Institute, explores trends through “Global Development Trends in Smart Agriculture: Opportunities and Challenges for Developing Countries,” analyzing international cooperation needs amid the digital divide. Finally, the Taiwan Technical Mission in Thailand presents “Global Development Trends in Smart Agriculture: Opportunities and Challenges for Developing Countries,” which concretely illustrates how Taiwan's smart agriculture practices are implemented in international development settings.

Meanwhile, the special report, titled “Taiwan's Smart Agriculture Development and International Strategy,” features interviews with key officials, including Kun-Feng Kuo, Director-General of the Ministry of Agriculture's Department of Information Management; Hung-Hsi Li, Director-General of the Ministry of Agriculture's Department of Science and Technology; and Alex L.J. Shyy, Deputy Secretary-General of the TaiwanICDF. They share insights on Taiwan's policy formulation, agricultural technology R&D, and ways that Taiwan leverages its technological strengths to support agricultural development in partner countries—especially in enhancing production efficiency and climate resilience amid global challenges.

Looking ahead, the advancement of smart agriculture will extend beyond technological adoption. It must integrate closely with policy governance, local needs, and international cooperation. Only by deepening the implementation of the core values of technology, sustainability, and collaboration can smart agriculture be transformed into a lasting force that strengthens food security and agricultural resilience. Through the sharing of experiences and case studies in this issue, we hope to spark further reflection and exchange, ensuring Taiwan continues to play an

indispensable role in the global wave of smart agriculture.

Summaries

Global Development Trends in Smart Agriculture: Opportunities and Challenges for Developing Countries

(Chih-Jung Tsai, Former Deputy Director, Taiwan Agricultural Research Institute;
President, Taiwan Agricultural Facilities Association)

Smart agriculture represents a paradigm shift in agricultural production, integrating advanced technologies such as the internet of things (IoT), big data, artificial intelligence (AI), robotics, and precision agriculture. Its aim is to enhance productivity, improve resource efficiency, and achieve sustainable development. As the global population continues to grow and climate change intensifies food security challenges, smart agriculture is regarded as a key solution for the future. Yet, despite its vast potential, the promotion and application of smart agriculture face unique opportunities and challenges worldwide—particularly in developing countries. This article explores global development trends, technological applications, and policy initiatives in smart agriculture, with a focus on the opportunities and constraints faced by developing countries as they embrace digital transformation. It concludes with recommendations for moving forward.

From Field to Market: How Smart Agriculture Reshapes the Agricultural Value Chain and Food Systems

(Ta-Te Lin, Distinguished Professor, Department of Bio-Industrial Mechatronics Engineering,
National Taiwan University)

With rapid population growth and escalating climate risks, traditional agriculture faces mounting pressures as it fails to meet the needs of productivity, resources and sustainability. Smart agriculture, powered by digital technologies, is emerging as a crucial solution for strengthening food security and agricultural resilience. Through the integration of internet of things (IoT), artificial intelligence (AI), big data, blockchains, and automation, smart agriculture enables more precise resource management and decision support. This increases efficiency, reduces environmental impact, and enhances transparency across the agricultural value chain. This article draws on experiences from Taiwan and around the world to examine how smart agriculture enhances value chain efficiency, strengthens sustainability, and improves risk adaptation. It also considers Taiwan's role in international cooperation, while addressing the challenges development

partners face—such as policy support, technology adoption, and multi-stakeholder collaboration—in shaping an inclusive, sustainable, and resilient agricultural future.

New Agriculture in the AI Era: Opportunities for AI-Enabled Sustainable Production and International Cooperation

(Shih-Chi Lee, Deputy Executive Director, Central Taiwan Branch,
Industrial Technology Research Institute)

The arrival of the AI era has accelerated the pace of smart agriculture worldwide. As the traditional farming, forestry, fishery, and livestock industries confront aging workforces, environmental changes, and geopolitical risks, AI systems provide solutions through rapid learning, precise responses, and efficiency—making them indispensable to food security and production resilience. Through the use of IoT, AIoT (artificial intelligence of Things), UAVs (Unmanned Aerial Vehicles), agri-bots, Wi-Fi and 5G, and low-orbit satellite communications, AI and semiconductor technologies are driving the transformation of agricultural production. Taiwan, with its strengths in hardware-software integration, stands at the forefront of these innovations. This article discusses the role of AI in enabling resilient and sustainable production, using cases from the Industrial Technology Research Institute to illustrate system integration and cross-ministerial collaboration. It concludes with recommendations for international cooperation models in exporting agri-tech solutions.

Taiwan's Smart Agriculture in International Cooperation: Deepening Localization through Technical Assistance – A Case Study of Implementing Smart Cultivation Systems in Thailand

(Hsin-Jui Hung, Taiwan Technical Mission in Thailand chief; Kang-Yu Lin,
Taiwan Technical Mission in Thailand project manager)

This article examines Taiwan-Thailand collaboration through the Raising Capability on Horticultural Crop Cultivation in Thailand through the Application of Smart Farming Systems project. It explores how smart agriculture can evolve from one-way technology transfer into a new model of localized co-creation, system integration, talent development, and public-private partnerships. Leveraging Taiwan's ICT strengths, the project team introduced sensing, decision-making, and environmental control systems at the headquarters and field stations of the Royal Project Foundation in Chiang Mai. By following a “build–apply–evaluate” process, the project gradually enhanced local operational and data management capacity. Key challenges included technology adaptation, workforce training, commercialization, and effectiveness validation.

Countermeasures involved site assessments, localized interfaces, talent system development, co-created technical documents, and adjustments based on farmer feedback.

The article further proposes four directions for expansion: establishing open-source cultivation models and iterative data mechanisms; embedding talent and services within agricultural extension systems; forming international alliances under a model of Taiwan providing technology, while Thailand provides services; and, integrating financial tools to lower adoption barriers for farmers. Ultimately, the study argues that smart agriculture assistance should be viewed as a co-creation process, with shared contributions in the form of knowledge and governance. Taiwan Technical Missions can serve as contact points for overseas validation and market feedback, promoting scalable and replicable cooperation models. This, in turn, positions Taiwan as a regional technology hub while sharing sustainable outcomes with partner countries.