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TAIWAN AGRICULTURAL RESEARCH INSTITUTE
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TARI ANNUAL REPORT 2024



Taiwan Agricultural Research Institute

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Cover photo TARI has developed a series of colored-leaf rice varieties (lines) for use in paddy field art. Currently, five varieties (lines) are available: brick-red leaves, deep purple leaves that appear nearly black, reddish-purple leaves between red and purple, warm and elegant yellow leaves, and white-striped leaves with purple stems.

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Foreword from the Director General

The Taiwan Agricultural Research Institute (TARI) engages in R&D work on technologies related to agriculture and food products. It develops technical expertise based on agricultural sciences and the needs of the agricultural sector. Focusing on core bottlenecks in agricultural development, it conducts in-depth theoretical analysis, promotes forward-looking and application-oriented research projects, and transforms research results into systematic and practical innovative agricultural technologies. TARI is dedicated to being a leader in agricultural technology innovation and a provider of comprehensive technical solutions for the agro-industry. In 2024, TARI implemented 220 research projects with outstanding results. Not only did it successfully achieve all of its objectives, but it also received the highest performance evaluation among all Ministry of Agriculture research institutes for the third consecutive year.

In 2024, TARI publicly released and licensed eight new technologies: a fast immunostrip detection for Shallot latent virus; the *Bacillus amyloliquefaciens* T33SR2 strain used in biofertilizer and its mass production technology; sacha inchi oil processing technology; a technology package for accelerated seed ginger production; a flavor jam production technology from coffee by-products; a formulation and preparation method for *Bidens pilosa* beverage; a carbon emission hotspot inventory program for *Phalaenopsis* production; and reproduction and seed collection technology for the rice 'Tainung Sen No. 23'.

TARI also selected the top ten agricultural technologies of the year, which included: a uniform post-production operating system for optimizing the flavor and quality of coffee; the nighttime green light technology for suppressing beet armyworm and boosting green onion production; an implementation of a gardening therapy program for seniors; the breeding of the *Solanum lycopersicum* L. 'Tainung No. 2-Sugar Bunny', a new variety with high-quality and heat-tolerant; the use of RGB imaging to construct high-precision 3D models of plants; an integrated climate-smart agricultural practices to enhance soil carbon sequestration; a smart LED pest control technology in mushroom cultivation facilities; the refinement of the passion fruit production chain by applying the integrated pest management (IPM) technology; a design and applied technology for a programmable module that can link with environmental sensors; and a technology for using waste mushroom cultivation bags to make growth medium for facilities agriculture.

Plant variety rights were obtained for two new cultivars: the tomato 'Tainung No. 1' and the Oncidium 'Tainung No. 9-Green Perfume'. TARI also registered a new crop variety: rice 'Tainung Sen No. 23'. In addition, a joint invention patent was granted for the "Method and System for Intelligent Light Supplementation for Plants," and a utility model patent was awarded for "Solid-State Fermentation Equipment". TARI facilitated 33 cases of agricultural technology transfer and promoted the licensing of 51 technologies to 55 businesses or farmers, generating NT$7.33 million in licensing fees and NT$768,000 in royalties.

International cooperation and engagement remained robust in 2024. In February, TARI, in collaboration with the International Society for Horticultural Science and the Taiwan Society for Horticultural Science, hosted an international conference on sustainable development trends in the global horticultural industry. In June, TARI organized an international forum on the plant-feed-based insect farming industry and its diverse applications, along with an international symposium on biocontrol and sustainable crop management. In November, TARI conducted academic exchanges with the Alliance of Bioversity International. Throughout the year, TARI staff delivered a total of 25 participants gave oral presentations or presented posters at international academic conferences, 7 attended international meetings, 1 pursued advanced study in the United States, and 50 took part in visits and exchanges with foreign research institutions. No effort was spared to advance TARI's international networking.

I extend my heartfelt appreciation to all TARI colleagues for their dedication and hard work throughout 2024. Looking ahead, the Institute will continue to uphold its commitment to scientific research and innovation. In alignment with the goals of the "National Hope Project," TARI will prioritize the needs of farmers and the agricultural industry, invigorate its R&D momentum, strengthen its service capabilities, and remain a key pillar supporting the sustainable and resilient development of agriculture in Taiwan.



Hsueh-Shih Lin

Hsueh-Shih Lin Ph.D.

June, 2025

Important Events in 2024

01 JANUARY

On 3 January, held a conference on cultivation with constant moisture maintaining.

02 FEBRUARY

On 23 February, held a conference on trends in sustainable development in the global horticultural industry.



03 MARCH

On 12 March, held a symposium on applications of agricultural cyber-physical systems.



On 14 March, held an exhibition of the achievements in dissemination of integrated cultivation management technology for healthy seedlings for green onions.



On 20 March, held the annual exhibition of achievements in R&D for the previous year.



On 26 March, held an event to announce the breeding of the new tomato 'Tainung No. 2-Sugar Bunny'.



04 APRIL

On 24 April, held a hands-on demonstration of achievements in the application of collective R&D into common bacteria strains to banana cultivation management.



05 MAY

On 10 May, held a business recruitment meeting at the Agricultural Innovation Incubation Center.



06 JUNE

On 12 June, held a forum on trends in the application of high throughput phenotyping from the perspective of sustainable agriculture.



On 24 June, held an international forum on the plant feed-based insect farming industry and its diverse applications.



On 25 June, held an international symposium on biocontrol and sustainable crop management.

07 JULY

On 5 July, held a ceremony to mark the signing of a Memorandum of Understanding on cooperation with National Chiayi University along with an exchange symposium.



On 19 July, participated in the “Chiayi Education Exposition: Science 168” event.

10 OCTOBER

On 15 October, held an exhibition of achievements in agricultural R&D as well as a technology matchmaking meeting.



On 25 October, held a hands-on demonstration of rice 'Tainung No. 88'.



11 NOVEMBER

Invited Nobel laureate Dr. Bruce McCarl to give a special lecture on 4 November.



Held a press conference on diverse technologies for agricultural and food sustainability on 15 November.



On 16 November, marked the 129th anniversary of the founding of TARI.



On 20 November, hosted a visit by Alliance Biodiversity International and the International Center for Tropical Agriculture.

On 26 November, held a press conference on a uniform post-production operating system for optimizing the flavor and quality of coffee.



12 DECEMBER

An educational activity on food and agriculture, focusing on peanut harvesting, was held on December 31.



Selected New Varieties in 2024

Rice 'Tainung Sen No. 23'

This new Indica rice variety characterized by stable yields and exceptional agronomic traits. This variety exhibits strong resistance to cold, lodging, and major diseases. It also features a low sprouting rate and excellent threshing performance, making it highly compatible with mechanized harvesting systems. The grain appearance is pale and translucent, and when cooked, the rice displays a glossy sheen, soft texture, moderate chewiness, and a refined aroma. Its outstanding eating quality makes it well-suited for a wide range of culinary applications, including shredded turkey or chicken rice, fried rice, pilaf, and clay pot rice. Additionally, it demonstrates high potential for value-added processing into rice cakes, frozen desserts, and fermented rice-based products.





Anthurium 'Tainung No. 11-Purple Garden'

This cultivar features medium-sized plants with oval leaf blades and divergent shoulders. The leaf tips are broad and pointed, with medium-length stems. The spathe is predominantly deep purple, oval in shape with visible shoulders, with a leaf protruding over 10 centimeters. The spadix is of medium length, with both the base and upper portion turning purple during color change. This variety offers excellent vase life and is one of the few standard purple-colored anthuriums currently available on the market.

Oncidium 'Tainung No.9-Green Perfume'

This Oncidium variety produces large flowers with a yellow-green base color complemented by gray-purple markings. The lip petals are white, and the plant exhibits upright growth, with an overall height of approximately 86 cm and inflorescences reaching about 60 cm. Pseudobulbs measure approximately 10.9 cm in length and 5.3 cm in width, typically producing one or two flower spikes each. The blooming period extends for about one month, with a vase life of 7 to 10 days. Each inflorescence bears approximately 51 fragrant flowers, each about 5.8 cm in length and 5.4 cm in width. The floral display is concentrated at the upper portion of the plant, with a balanced height-to-inflorescence ratio. This cultivar is well-suited for both potted plant production and cut flower markets.





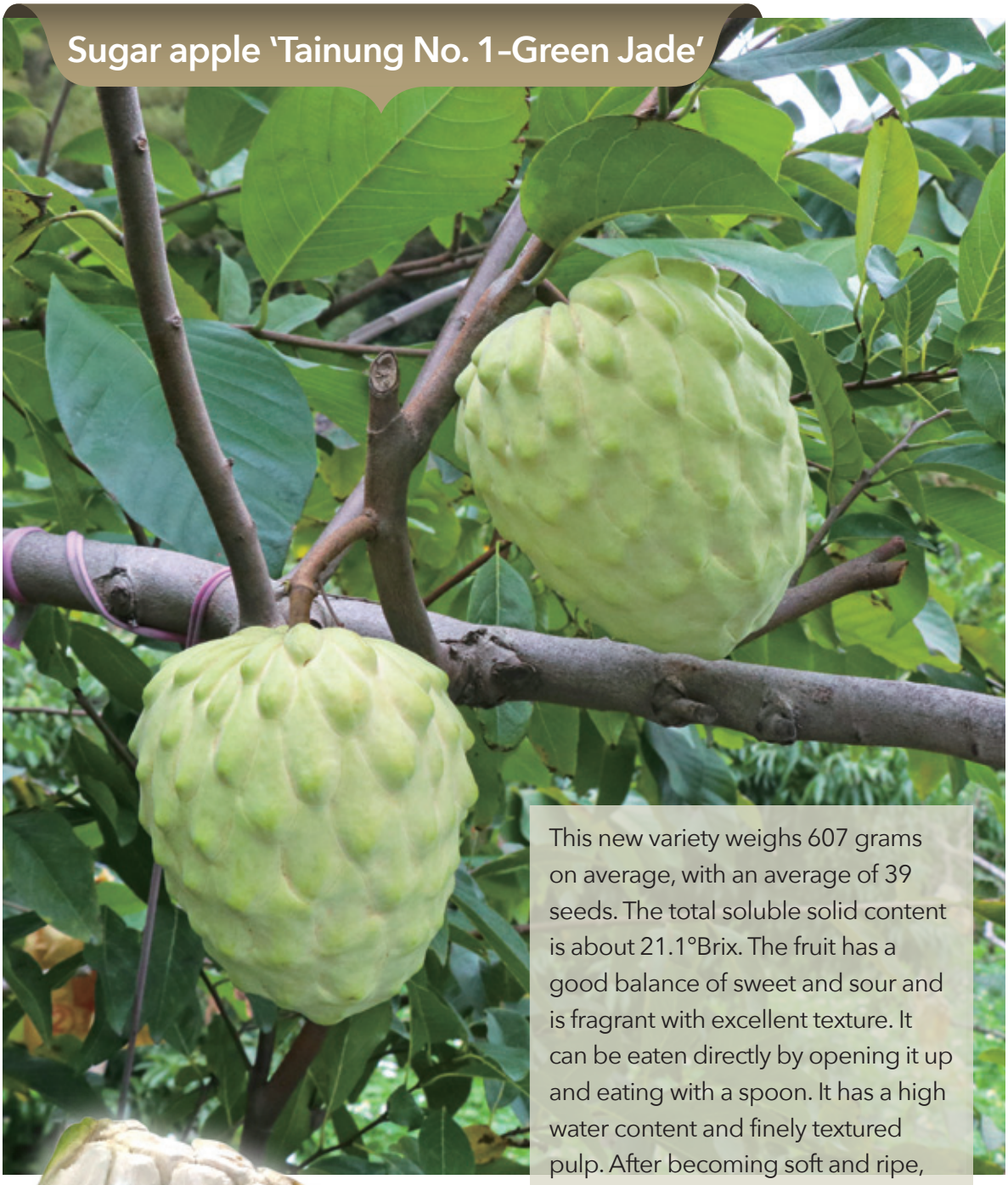
Tomato 'Tainung No. 1'



This tomato cultivar exhibits indeterminate growth. The hypocotyl and stem display anthocyanidin pigmentation and have short internodes. The fruit is extremely small, ellipsoid in shape, and yellow in color, characterized by a soft texture and a high sweetness level. Under high-temperature conditions, the plant demonstrates a degree of natural fruit set. The inflorescence is primarily a multiple-pedicle compound type with a high flower count, and the plant has strong seed-producing capability, making it a promising parent line for hybridization. However, it lacks resistance to major tomato diseases and the fruit is prone to cracking. Therefore, during cultivation, careful management of moisture and disease/pest control is essential to maintain fruit quality and yield.



Sugar apple 'Tainung No. 1-Green Jade'





This new variety weighs 607 grams on average, with an average of 39 seeds. The total soluble solid content is about 21.1°Brix. The fruit has a good balance of sweet and sour and is fragrant with excellent texture. It can be eaten directly by opening it up and eating with a spoon. It has a high water content and finely textured pulp. After becoming soft and ripe, it can be refrigerated and then has a smooth mouthfeel. With a thin peel and fewer seeds, so a higher proportion is edible compared to the Ta-mu variety of sugar apple.

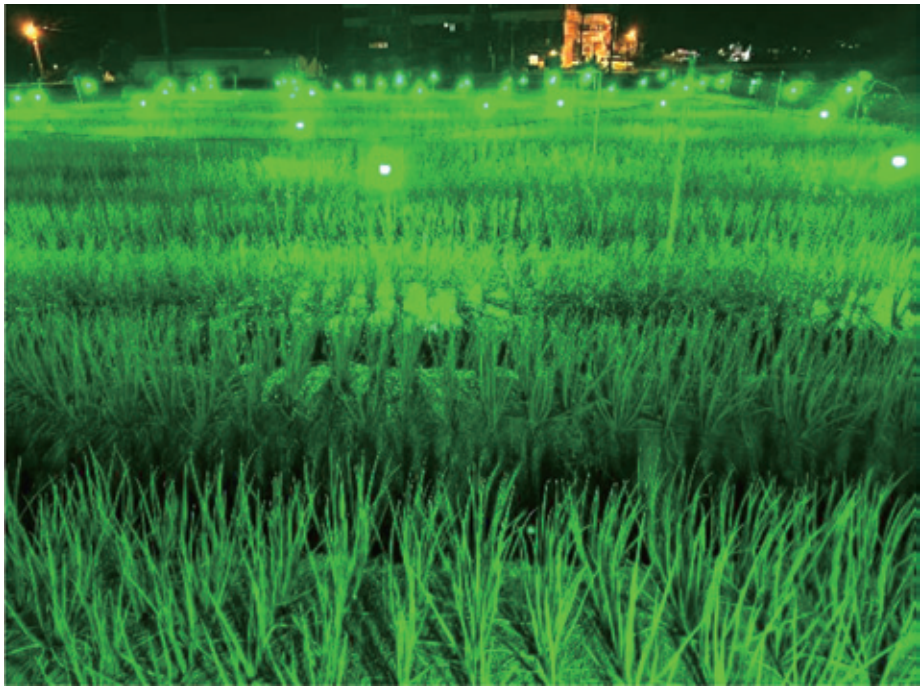
Outstanding New Agricultural Technologies for 2024

1 A uniform post-production operating system for optimizing the flavor and quality of coffee

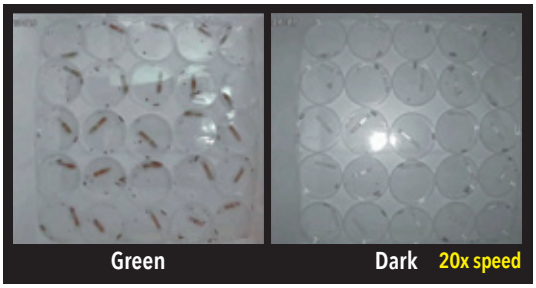
The use of a uniform post-production processing system for domestically produced coffee beans can, in comparison to different processes used by individual famers, enhance the post-roasting fragrance, flavor, aftertaste, acidity, and body of coffee produced in low-altitude areas. It can also reduce the negative qualities such as a grainy aroma and astringency while raising the cupping score. Such a system, which is in line with international coffee production processes, can provide a stable supply of premium grade coffee beans to meet the quality requirements of sales channels.

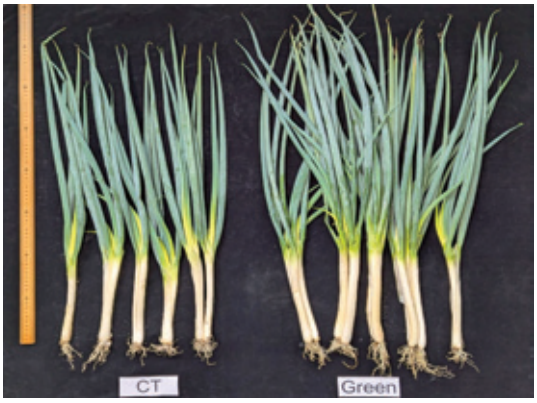






2 Nighttime green light technology for suppressing beet armyworm and boosting green onion production





The application of nighttime green LED lighting to Welsh onions significantly suppressed beet armyworm activity through a light-adaptation mechanism. This treatment reduced stem damage by 40%, thereby lowering pesticide requirements. In addition to pest control, the green light also promoted plant growth, resulting in a 20% increase in yield. Notable improvements were observed in tiller count, leaf number, plant height, and pseudostem length.

3 Implementation of a gardening therapy program for seniors

The curriculum was designed to incorporate physiological, psychological, cognitive, and social dimensions through hands-on and practical horticultural activities. Four hands-on gardening courses have been completed to date, covering bonsai, floral design, ethnobotany, and creative plant arrangements.











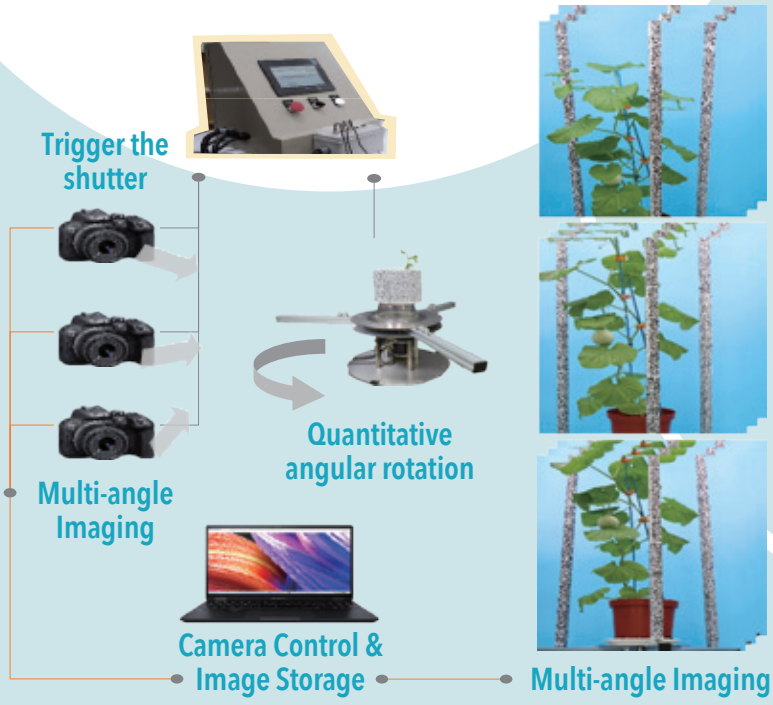
4 Breeding of the *Solanum lycopersicum* L. 'Tainung No. 2-Sugar Bunny' , a new variety with high-quality and heat-tolerant

This is a cherry tomato with yellow, high-spherical appearance. The fruit is characterized by high sugar content and a distinctive aroma. Its appearance is clearly different from the major cherry tomatoes currently available on the market, making it highly recognizable to consumers.



5 Use of RGB imaging to construct high-precision 3D models of plants

This system enables nondestructive and precise measurement of plant traits, including leaf area and biomass, providing essential quantitative data for agricultural research. By generating high-quality 3D model datasets, it serves as training data for deep learning models and facilitates the development of advanced AI-based tools for plant phenotyping.





6 Integrating climate-smart agricultural practices to enhance soil carbon sequestration







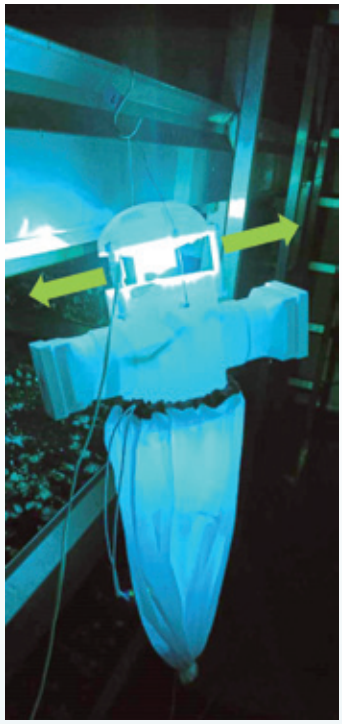
In coastal low-productivity areas, a three-season wet-dry crop rotation system is being promoted alongside a cultivation approach that minimizes agrochemical use. The main crop cultivation model consists of no-till farming of dry crops-particularly corn-in spring; direct-seeded wet paddy rice during the rainy season; and no-till farming of dry crops-especially soybeans-in autumn. This "three crops per year" system reduces resource consumption by following the principle of complementary, shareable resources, ensuring that water and nutrient availability are not depleted for subsequent crops. Consequently, it enhances the efficiency of water and fertilizer utilization.



7 Smart LED pest control technology in mushroom cultivation facilities

Using LED lights with a specified wavelength spectrum, escape-proof insect nets, and weight sensors, this system attracts insects, traps them, and prevents their escape. Since there is no food inside the nets, the insects eventually die. The sensors then measure the weight of the dead insects, and the system can notify mushroom facility managers when pest control actions are needed.



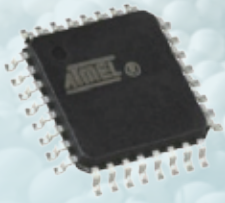






Weight sensor → Counting pests → Wireless upload to cloud database



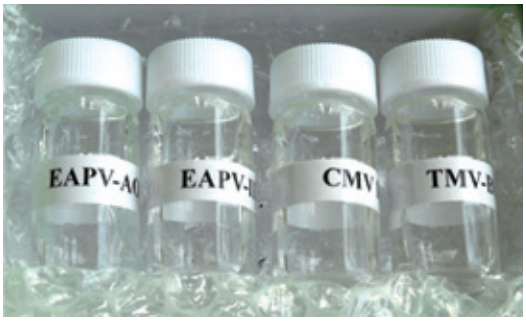




8 Refinement of the passion fruit production chain by applying the integrated pest management (IPM) technology

This technology supports the production and health inspection of high-quality passion fruit seedlings. By detecting the presence of diseases and insect pests and enhancing resistance to rootstock-related issues, it helps seedling producers improve their internal management systems. It currently serves over 70% of the market for healthy passion fruit seedlings. In parallel, our integrated pest management (IPM) coaching team assists farmers in implementing IPM practices. This eco-friendly approach effectively reduces pesticide risks and promotes the safe and sustainable development of the passion fruit production chain.

















9 Design and applied technology for a programmable module that can link with environmental sensors

This technology is built around a core of a micro control unit. Through ICT methods it receives signals from sensors and undertakes logical operations to produce signals that can control existing electronic control equipment or upload data to cloud databases. It supports 4G, Wi-Fi, and LoRa wireless ICT and wired Internet systems. The hardware is designed with open architecture to support multiple brands of sensors sold in the marketplace. It provides an integrated circuit layout that cannot be modified, which companies that have received this technology through technology transfer can use to manufacture hardware. Users can freely write application programs based on their own needs to expand the scope of applications.









10 Technology for using waste mushroom cultivation bags to make growth medium for facilities agriculture

The recycling technology for spent mushroom substrates has been non-exclusively licensed to three companies, two of which have already begun production for sale. In comparison, the carbon footprint of spent mushroom substrates was 0.0437 kg CO_2e L^{-1}, which is just 16.24% of peat moss's (0.269 kg CO_2e L^{-1}).







New Services

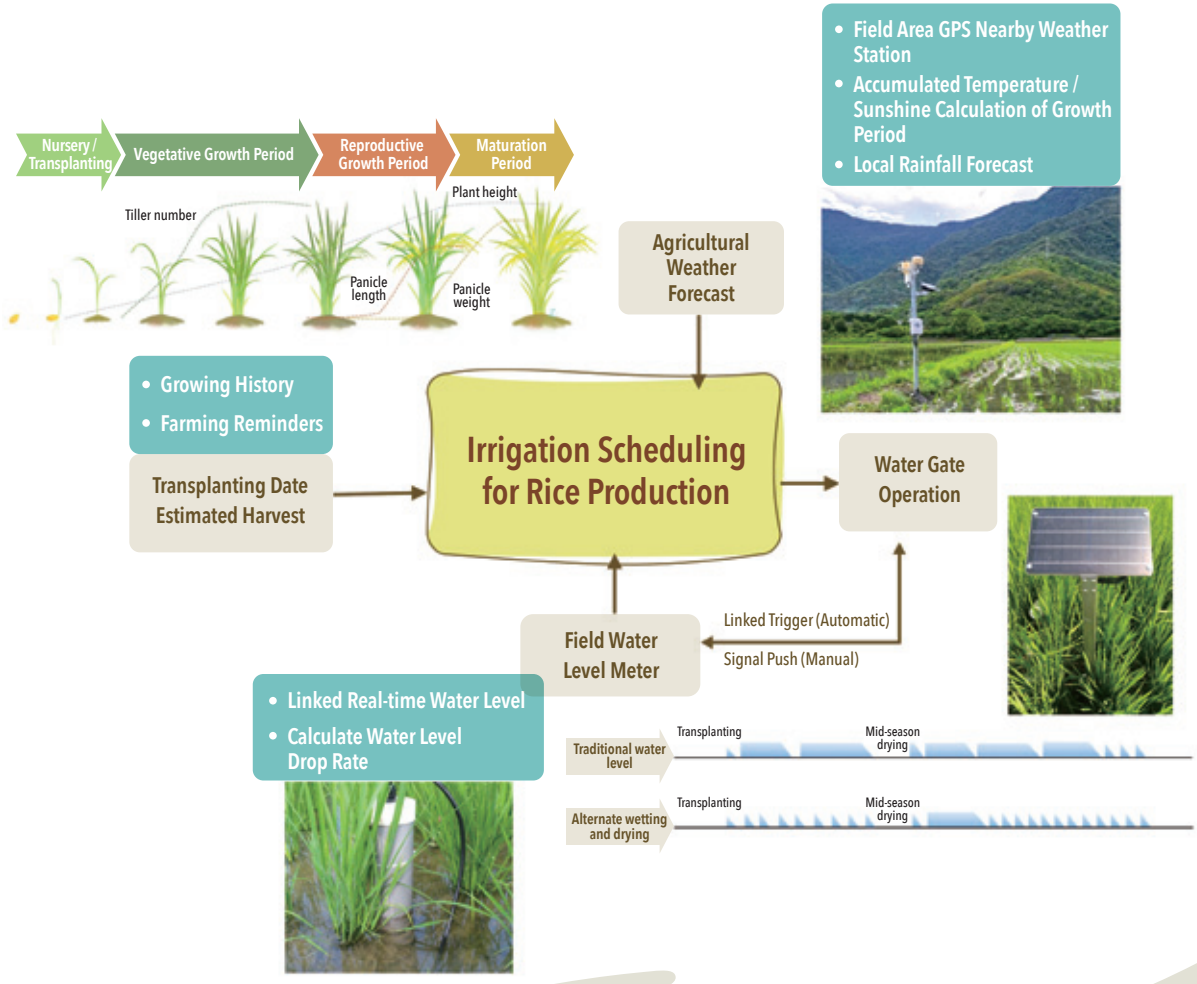
Modules for products, allocation, and trading of seedling

These modules track five major operations: the source and product flow of rice seeds, as well as sales, accounting, inventory, and harvest entry. They make rice seedling businesses digitize the production, allocation, and trading of seedlings by incorporating commercial practices such as procurement, warehousing, sales, and inventory management. Users are able to use these modules via cell phone or computer, checking the seedling variety, product flow, cultivated area, location, and time of transplanting anywhere and anytime. Moreover, information could be shared for mutual benefit. These modules would revolutionize the operating methods of rice seedling businesses, systematically accumulate information about rice seedlings, strengthen management of seeds, resources, and manpower, and upgrade operational efficiency. At the same time, it would precisely track disparities between seedling numbers and regional demand, facilitating competitiveness and economies of scale.



Wet paddy smart irrigation program modules

This system utilizes accumulated temperature and cultivation management data from over the years to build a wet paddy rice growth stage prediction model. It incorporates weather parameters to make rolling predictions of critical growth periods, and, based on expert experience, arranges irrigation reminders for each growth stage. Through smart calculations, it offers modular programming for decision-making regarding automated and semi-automated irrigation operations in the field. It can link up with modules for real-time water level measurement and watergate controls in the fields, undertaking appropriate irrigation operations during the paddy rice production process. Each program module can directly coordinate with existing information platforms to undertake expansion of functions, rapidly integrating and lowering the costs of the newly built platform.



Feature Story

Smart Agriculture and Dr. Jyh-Rong Tsay



In the 1960s, Taiwan comprehensively implemented agricultural mechanization, with the paddy rice industry achieving the highest level of mechanization. In recent years, agriculture in Taiwan has faced many challenges, notably the agricultural labor shortage and extreme weather, which have already affected farming operations and the stability of supply and demand.

Jyh-Rong Tsay graduated from the Graduate Institute of Agricultural Machinery Engineering at National Taiwan University in 1983. He joined the Agricultural Engineering Division of the Taiwan Agricultural Research Institute (TARI) in 1986 and earned his doctorate in the United States in 1994. Throughout his career, Dr. Tsay has developed numerous devices, including a peanut harvester, an air-assisted agrochemical sprayer, a royal jelly harvester, and a lychee post-harvest handling machine. He has also supported the Ministry of Agriculture in promoting precision agriculture.

In 2005, he became Director of the Agricultural Engineering Division and was concurrently appointed Secretary-General of TARI in 2010. In 2014, he was promoted to Deputy Director-General of TARI, and in 2015, he was tasked with leading the team responsible for designing the "Smart Agriculture" program.

The Smart Agriculture Program was launched in 2017 and has played an important role, achieving significant progress in technology matchmaking, exhibition of accomplishments, human resource development, local application, and the popularization of smart agriculture. Key achievements include the development of crop yield estimation models and a resource planning system for agribusinesses, which currently provides crop production forecasts up to one week in advance. Additionally, smart rice farming technologies have been introduced to businesses via the rice production system to address industry challenges.

The program has also promoted the establishment of new types of Agricultural Service Providers (ASPs). This includes licensing ASPs with early warning technologies for rice blast and brown planthoppers, facilitating partnerships between ASPs and grain enterprises, and jointly building a smart rice production management ecosystem. ASPs are also encouraged to collaborate with companies in related industries, such as electronics manufacturers and unmanned aerial vehicle (UAV) firms.

Furthermore, a comprehensive database has been established for 10 commonly used pesticides in cucurbit crops and a full-spectrum spectral database of cucumber matrices, along with a predictive model for pesticide identification, currently achieving an 80% accuracy rate. Future work will focus on expanding the model to identify 40



commonly used pesticides in cucurbit crops, with the goal of improving rapid screening efficiency for continuously harvested crops and enhancing food safety in agricultural products.

In addition, TARI has developed an automated field punch-in/out system for agricultural workers by integrating low-energy beacon technology. This system simplifies the recording of field working hours by automatically detecting when a user enters a designated area. Using ICT software, it provides automated field management notifications and integrates with a scheduling module to generate work plans and perform automatic reporting.

Five years prior to his retirement, Dr. Tsay initiated several key projects, including *forward-looking technology scanning, ecological network linkages*, *strategic partnership operations*, and *the upgrading of R&D capabilities*. He also actively promoted the development of a macro-level ecosystem for smart agriculture. On the eve of his retirement, he was honored with the Grade 2 Professional Medal for Agriculture, personally presented by Minister of Agriculture Junne-jih Chen.

International and Academic Cooperation

TARI's international cooperation primarily involves bilateral meetings, arranged by the Ministry of Agriculture, and cooperation agreements with foreign academic and research institutions to foster technical exchanges and collaboration. In 2024, TARI partnered with the International Society for Horticultural Science to host an international forum focusing on sustainable development trends in the global horticulture industry. TARI also collaborated with the Food and Fertilizer Technology Center on two events: a workshop titled "Tropical Fruit Consortium: Addressing Climate Change Impacts on Tropical Fruit Production and Strategies for Adaptation and Mitigation," and an international conference on "Strategy and Actions to Incentivize GHG Emission Reductions and Carbon Offset within Sustainable Agrifood Systems." Furthermore, six TARI staff members participated in the "27th International Congress of Entomology" in Tokyo, contributing two posters and four oral presentations.







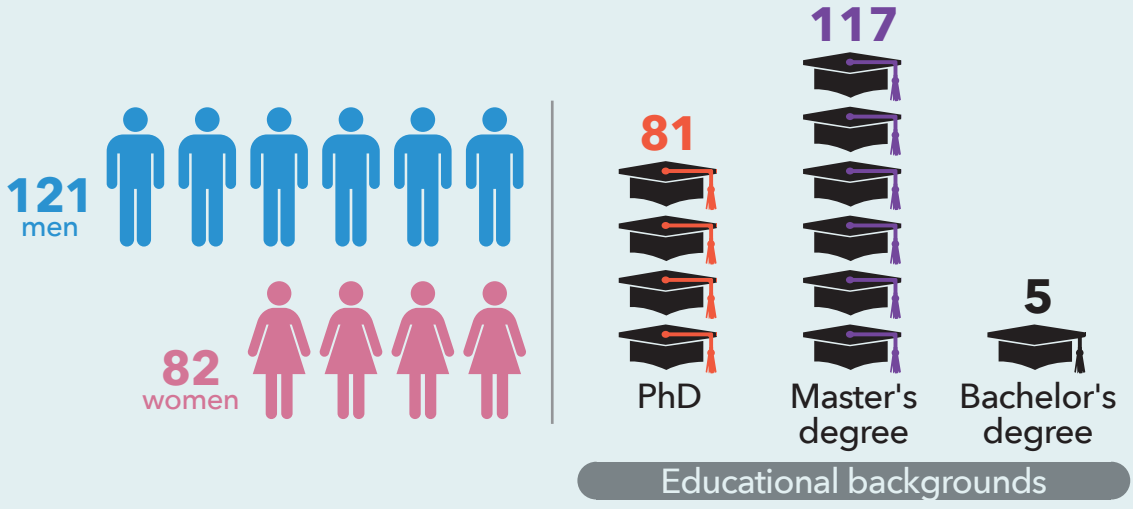


TARI also partners with domestic universities on academic projects. In 2024, expanding on existing collaborations with National Taiwan University, National Chung Hsing University, and National Yang Ming Chiao Tung University, TARI signed a new cooperation agreement with National Chiayi University. This new partnership facilitates annual joint R&D efforts focused on critical and emerging agricultural issues. Research examples include: studying the impact of insect by-products (including feces) on plant growth and defense; exploring 4D hyperspectral imaging and AI recognition for melon cultivation decisions; analyzing the potential of compound applications of natural plant extracts for disease resistance and prevention; and investigating digital twin technology to improve strawberry identification accuracy. This collaboration has already produced significant results.

Resource Introduction of TARI

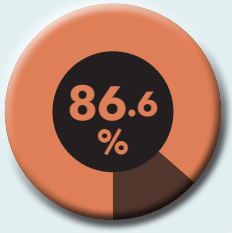
Human Resources

In 2024, our research and development team consisted of 203 persons.



$ Budget

In 2024, the total amount was NT$1.34 billion.



NT$1.16 billion from the government budget

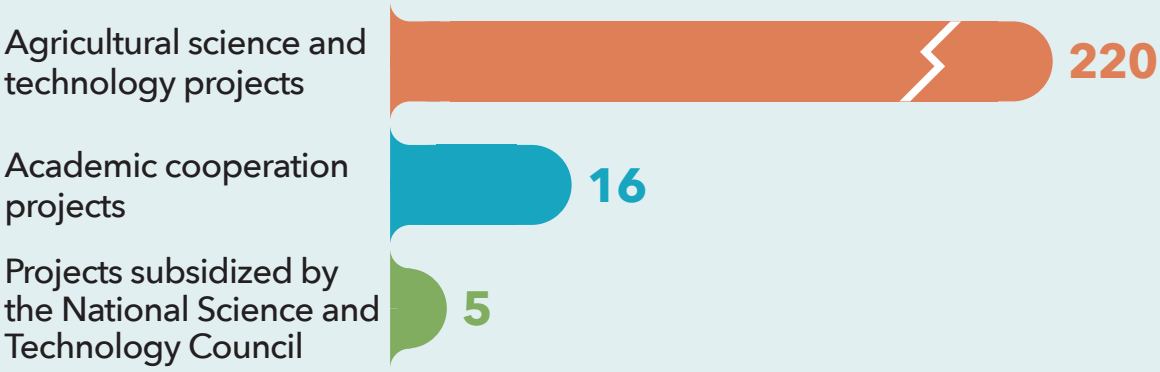


NT$150 million from commissioned experimental research

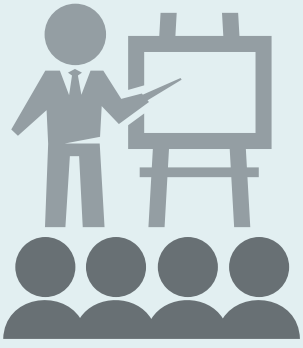


NT$30 million in subsidized projects from the National Science and Technology Council

Number of Research Projects



Performance of the Innovation Incubation Center



- **4** Newly signed enterprises
- Guiding **13** enterprises
- Facilitated **7** companies to invest over NT$3.77 million
- Increased employment to 11 persons at **7** enterprises

Important Academic Publications

