

Opportunities for Queensland businesses in Taiwan's agtech market

TIQ international market report

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Executive summary

This report provides an overview of the current market for agtech in Taiwan, and assesses opportunities for Queensland companies to enter that market.

Pressures

The combination of an ageing farming community, extreme weather patterns from climate change, lack of farmland, and public scrutiny of food sourcing will place increasing pressure on agriculture in Taiwan in coming decades.

These pressures have already encouraged considerable investment and have created business opportunities in emerging technologies that can compensate for labour shortages and enhance traceability.

Opportunities

Major opportunities for technologies will relate to labour-saving devices such as drones, sensors, satellite aerial photography and image analysis, which are being rapidly integrated into traditional farming. More modern technologies – such as internet of things (IoT), artificial intelligence and cloud-based systems – will be adopted more slowly due to their knowledge-intensive nature and the need to overhaul existing practices as part of their adoption.

The market for Queensland companies will be limited by the current cost of agtech and the small size of farms in Taiwan. On the other hand, these constraints represent an opportunity for companies that can develop low-cost agtech that delivers benefits for smallholdings or enables production in dense urban areas.

Partnerships

Taiwan's farmers will account for the majority of potential end-users of agtech.

However, due to the fragmented nature of Taiwan's agriculture industry, partnerships with intermediaries such as dominant manufacturers and farmers' associations will be key to gaining market share.

Queensland companies should also consider partnering with Taiwanese manufacturers, as Taiwan is well positioned to become a key player in the global agtech industry. Taiwan produces 25% of the world's semiconductors, is a global leader in solar cells, manufactures a large portion of sensors used in IoT and precision agriculture, and is home to several specialist LED and hydroponic companies critical to the growth of indoor farming.

Taiwan and Queensland – poised for agtech success

Taiwan is poised for agtech success thanks to its strategic geographical position, favourable government initiatives, competitive manufacturing capabilities, and highly educated workforce. It offers Queensland agtech companies significant potential for research and commercial collaboration, investment opportunities and export of technologies.

In particular, Queensland is well placed to leverage its clean, green image and reputation for high-tech, high-quality produce to enter the premium end of the Taiwanese agtech market.



1. Introduction

1.1 The global rise of agtech

As countries around the world face the challenge of feeding their populations and creating a sustainable future, agricultural technology (also known as 'agritech' or 'agtech') is attracting increasing attention.

Agtech involves applying technology to agriculture to improve sustainability, efficiency and productivity throughout the agricultural supply chain. With the advent of what the World Government Summit has called 'Agriculture 4.0', agtech is being hailed by many as the key to the next agricultural revolution.

1.2 This report

This report analyses the market for agtech in Taiwan and identifies agtech export opportunities for Queensland businesses.

While agtech covers a wide variety of technologies and disciplines, this report focuses on the use of software and hardware to mechanise production. It does not discuss agtech fields such as biofutures, crop science or organic cultures.

1.3 Agriculture in Taiwan

Taiwan is a subtropical island characterised by high temperatures and heavy rainfall, offering an extensive range of agricultural biodiversity. Most of Taiwan's land area is mountainous or sloped, leaving 24% of land suitable for agricultural production. Virtually all farmland is intensely cultivated, with some areas used for two to three crops a year.

Taiwan's main crops are rice, sugar cane, tropical fruits and vegetables, accounting for half of all agricultural production. The agricultural sector is composed of small family farms, with an average size of 1.1 hectares, and agriculture is characterised by high yields, irrigation, terracing, multiple cropping and extensive use of fertilisers.

Taiwan's agricultural sector faces several challenges, due to:

- » fragmentation of cultivated land
- » vulnerability to the increasingly serious effects of climate change and extreme weather
- » dramatic shortages in the agrarian workforce due to a rapidly ageing population and urban migration
- » liberalisation of trade.

Modernisation of agriculture has been inhibited by the small size of farms, and regulators have also expressed concern that the scarcity of available land has led to disagreements between agricultural, industrial and housing interests.

Combined, these pressures have driven considerable investment in mechanisation, automation and exploration of ways to produce food in highly dense areas with fewer resources.

1.4 Agtech initiatives in Taiwan

In 2016, under the Tsai Government's 5+2 Industrial Innovation Plan – which aims to transform Taiwan's biotech, green energy, smart machinery and industrial bases – Smart Agriculture 4.0 was designated a key priority, with a pledge of up to USD \$300 million (AUD \$440 million)* by 2020.

Commercially,¹ there has been a push for overseas developers of agricultural devices and system integrators in agriculture to consider partnering with Taiwanese companies in the use of sensors, smart devices, the Internet of Things (IoT) and digitisation of knowledge.

Academically, there are 16 governmental research institutes affiliated to the Council of Agriculture (COA), ensuring strong financial support to underpin continuous R&D innovation.

*Conversion rates for TWD, USD and AUD used in this document are 2019 rates unless stated otherwise.

¹ See Table A-1 in Appendix 1 for a list of major companies active in Taiwan's agtech sector.

Further, agricultural biotechnology precincts, industry cluster policies, and active collaborations with overseas research institutes (in South East Asia, Japan and Australia) are facilitating the development of technologies that meet Taiwan's needs and challenges.

Taiwan can also be seen as a platform for doing business in China in the long term, due to cultural similarities and well-established cross-strait business relationships.

As part of Taiwanese President Tsai's New Southbound Policy to strengthen exchanges between Taiwan and 18 countries in South East Asia, South Asia and Australia, Taiwan has also been actively exporting its agricultural, small-farm technologies and crop/seed cultures to various ASEAN nations.



2. Market analysis

2.1 Industry profile

Over several decades, Taiwan has created a favourable environment as one of Asia's most advanced agricultural technology industries. It possesses:

- » highly regarded research infrastructure
- » high-quality but low-cost R&D and manufacturing environment
- » large talent pool with capabilities in fundamental and applied research
- » vibrant venture capital industry
- » strong intellectual property rights.

A technological hub, Taiwan also has a flourishing agriculture sector and is a significant producer of produce. Local agricultural production meets 88% of total demand and, in the first half of 2019, Taiwan's Council of Agriculture reported that the island had logged USD \$2.7 billion (AUD \$4 billion) worth of additional agricultural exports. This number is expected to grow as the nation recalibrates its agricultural strategy to integrate high-technology innovations and precision techniques.

Taiwan is world-renowned for its engineering prowess, and educates thousands of electrical engineers, semiconductor specialists and robotics experts each year. This workforce supports a tight-knit supply chain of thousands of SMEs that build intelligent farming components used around the world.² These include:

- » **IoT sensors:** Taiwan has been dubbed the 'the engine room of the Internet of Things,' due to the large number of semiconductors found mainly in the Science Park in Hsinchu. Today, Taiwan produces 25% of the world's semiconductors, which are needed to manufacture sensors, software and data mining algorithms.

- » **LEDs:** Taiwan has the second largest LED industry in the world. The rise in indoor farming is being driven by advances in LED technology for different wavelength requirements.

- » **Robotics:** Taiwan is one of the global front-runners in robotics, with a goal to turn it into a core competency in the next 20 years.

- » **Solar cells:** As a huge producer of solar cells, Taiwanese companies can provide the energy resources of large-scale agriculture projects.

- » **Drones:** 10% of the world's commercial drones are made in Taiwan, and this industry is predicted to grow at a compound annual growth rate of 10% until 2025. Drones will be needed for modelling purposes and efficient application of inputs.

- » **Indoor farming/aquaponics/hydroponics:** Taiwan accounts for 25% of all plant factories in East Asia, with 70% per annum growth. Making use of a wealth of experience and resources in LED lighting, some original equipment manufacturer (OEM) companies have sprung up offering full solutions for indoor farming/aquaponics and hydroponics.

Locally manufactured, innovative farm machinery has captured a growing market share at home and overseas. In 2014, more than 100 technology transfer cases were made, bringing in USD \$2.6–3.3 million in income (AUD \$3.8–4.8 million), of which exports to South East Asia accounted for 60%.³ Taiwan's devices have been viewed as low-cost and easy-to-use compared to Japanese competitors, compatible with the humidity of the tropical climates in South East Asia (and Queensland), and have the added bonus of manufacturers with the connections and cultural know-how to push projects in the China market.

² Ryans M., Taiwan: Home to the Total Supply Chain for Agriculture 4.0

³ Lin Congxian, Chairman of the Agriculture Committee

Taiwan's agritech sector is still very fragmented. There are many companies competing, but few with sufficient market share to have a significant impact on industrial production.⁴ Existing manufacturers are concentrated in the country's central and southern regions, most of them enterprises with 20 or more employees, often family-owned and unlisted. Larger players include companies such as Taiwan Sugar Corporation and Advantech, who have diversified into agtech and possess the capital and know-how to achieve economies of scale.⁵

Finally, low barriers to entry and diversified product lines have made it difficult to effectively integrate the various equipment, systems and technologies in the market, and farmers have reported experiencing difficulty in sourcing components due to having no streamlined supply chain or sourcing channels between individual equipment manufacturers.

2.2 Key drivers and trends

Demand for agtech in Taiwan is being driven by six key elements.

- » **Climate change:** Climate change is leading to unpredictable growing seasons, alterations in pest and disease ranges, and fluctuating and often extreme weather patterns.

- » **Food-quality concerns:** Media coverage of food scandals, excessive pesticide use and counterfeited/adulterated products have led to Taiwanese consumers demanding 'clean food' and greater transparency in the supply chain.

- » **Demand for high-value nutritional products:** Increased consumption of dairy and meat is placing pressure on land, energy and water resources.⁶

- » **Ageing population:** An ageing population is necessitating automation of labour and computerised approaches.

- » **Scarcity of land:** Land scarcity is encouraging production of food in highly dense areas with fewer resources – these trends favour indoor growers whose vegetables are grown without pesticides and in controlled environments.

- » **Increased biosecurity awareness:** African swine fever has increased demand for testing kits, vaccines and technologies to help with disease surveillance, prevention and control.

Together, these pressures will place a strain on agricultural supply and encourage investment in innovations that can increase yield and reduce labour and input costs. The market for agtech among both public and private customers is likely to increase as these pressures become more acute.

⁴ Xu Ruiling, Wu Meiyi (2014), *Taiwan's AgriTech Manufacturing Capabilities*

⁵ Xu Ruiliang and Huang Yuyi (2016), *Taiwan's AgriTech Manufacturing Capabilities*

⁶ Satellite Applications Catapult, *Agricultural Technology – Market Review*



2.3 Issues and challenges

In the past, many Queensland exporters have overlooked Taiwan in favour of rapidly developing economies such as China and South East Asia, exhibiting reluctance to provide low-volume, consolidated shipments of high-value equipment to the Taiwanese market, or change product specifications to comply with Taiwanese regulations and standards.

Due to differing topographies, certain equipment and technologies developed for Australia's vast, flat terrain – such as tractors and harvesters – may not be effective in Taiwan's mountainous and sloped landscape. Taiwan's smaller area also means that it will not achieve the economies of scale through consolidated

mega-farms that dominate in countries such as Australia, Canada or the USA, making it difficult to justify upfront costs.

Taiwan's ageing population and decreasing birthrates in rural communities mean that the average age of Taiwanese farmers is now 62. Explaining the benefits of computer technology, data mining, drone watering and vertical farm stacks to traditional farmers is not likely to be easy, and they will require additional education and training to manage modern high-tech applications. Farmers have also reported security and privacy concerns regarding ready-made foreign technologies such as smart devices, IoT and cloud services.

Tips for successful market entry

To overcome these issues and challenges, Queensland agtech suppliers interested in entering the Taiwanese market should bear the following in mind.

- » Queensland companies will need to address concerns relating to cost and understand the value proposition, usability and compatibility with Taiwanese crops in order to penetrate this market.
- » Partnerships with dominant agricultural equipment manufacturers and farmers' associations that link farm owners together will be key to expanding market share for Queensland providers and operators.
- » The complex and fragmented nature of Taiwan's agriculture industry also means that intermediaries in the industry can play a key role in gaining access to end users, articulating needs and distributing products.

By collaborating with Taiwanese firms through original equipment manufacturers (OEMs), original design manufacturers (ODMs) or joint-venture partnerships, Queensland companies can capitalise on existing Taiwanese strengths in manufacturing and overall lower input costs in labour and materials. Taiwan's proximity to East Asia and South East Asia, as well as its well-developed transportation links, means it is ideally poised to export produce or equipment to nearby countries.



Musk melon greenhouse in Taiwan.



2.4 Taiwan's agtech developments

2.4.1 Agtech 'Uber'

In 2013, the Council of Agriculture established the Agricultural Machinery Farming Service System (農業機械耕作服務系統), an online platform where farmers can find suitable agricultural services from an extensive list of providers according to the location of farm, type of crop and desired service.

This initiative was in response to the labour shortage in the agriculture sector, which hastened the need for mechanisation and automation. It provided a solution for smaller farms that were generally unable to afford the initial cost and maintenance costs of agricultural machinery, and overcame the problem of agricultural machines sitting idle during non-planting and non-harvesting seasons.

With 200,000 licensed agricultural machinery operators, and 20,000 pieces of large-scale equipment (including tractors, rice planters and harvesters) available to local townships via the online platform, farmers can now handle their operations on time without the need to purchase or own sophisticated equipment. Local support, marketing and sourcing are provided by representative farmers' associations in each county.

The key takeaway is that Queensland companies specialising in high-value or large-output devices should consider contacting farmers' associations, who have the resources, contacts and access to platforms for small-scale farmers. A list can be found in Table A-4 in Appendix 1.



Auto watering system for orchid in Taiwan.

2.4.2 Young farmers

Farming's poor prospects once pushed young people from the countryside into the cities to seek better-paying jobs. However, stagnating wages from weak economic growth and a desire to return to their roots have resulted in a trend for second- or third-generation farmers to return to rural areas to take up family businesses. They are differentiated from the older generation by their high degree of education, specialist knowledge from other industries, quick adoption of new technologies, and pursuit of self-education, and are driving the advancement of scientific techniques and capitalising on business opportunities.

There are an estimated 3,000 new farmers entering farming every year, their ages ranging from early 30s to 50s, the average being 35 years old compared to the typical farmer's average of 62 years old. The national and local governments have fully supported this, committing an annual NDT \$30 million (AUD \$1.45 million) in young farmer training programs, along with interest-free loans, assistance on business expansion projects, mentoring and subsidised tuition fees and grants.

Young farmers have been touted as the key to revitalising the agrarian workforce, and a target market for more sophisticated and novel technologies.

2.4.3 Agriculture precincts

Taiwan has a range of agricultural biotechnology parks and industrial parks to foster a technology-intensive, high-value environment to propel Taiwan's transformation into smart agriculture.

The largest, Pingtung Agricultural Biotechnology Park (PABP), is a high-tech agricultural industrial cluster comprising 180 agri-enterprises, 6,000 employees and NT\$18 billion (AUD \$870 million) in annual output value in Southern Taiwan. It was established to attract foreign investment and partnership, offering:

- » **administrative services:** Science Park Administration is a one-stop shop for all government-related topics, such as environmental, safety, labour and tax issues for all regulatory processes

- » **strong industry clusters:** industry-academia R&D cooperation incentives create a concentration of a critical mass of companies that helps exchange resources

- » **financial incentives:** these include tax exemptions, low-interest loans and rapid customs clearances

- » **sound infrastructure:** PABP has ready-to-use lots, and all necessary pipelines for water, gas, power supply, logistics, housing and security for local and foreign businesses to swiftly set up.



Smart integrated monitoring system.

It has integrated agricultural resources with three established satellite parks:

- » **Central Taiwan Agricultural High-Technology Park** (Smart Agriculture)

- » **Taoyuan Agricultural Logistics Centre** (logistics to link to global markets)

- » **Taiwan Orchid Plantation.**



2.5 Local procurement channels and market entry

Queensland businesses can make use of a range of local entities to aid their market entry.

Government authorities and agencies, industry associations, farmers' associations, large-scale farms, agricultural corporations, and agricultural commodity traders are likely to represent the core addressable market for Queensland agtech firms.

2.5.1 Industry associations

Taiwan has thousands of small manufacturers of agtech, whose products are distributed by dedicated industry associations. Organisations such as the Importers and Exporters Association of Taipei and Taiwan Plant Factory Industry Development Association are good places to start to seek potential partners.

2.5.2 Farmers' associations

Government-assisted farmer organisations around Taiwan, of which there are 302, carry out joint marketing, agricultural production materials supply, distribution and financial services. Many processed and exported agricultural products are contracted through these associations. This means that agricultural associations and cooperatives are a key point of contact to reach smaller stakeholders.

2.5.3 Distributors and agents

Except for large exporting companies that maintain representative offices in Taiwan, the appointment of an import agent is a critical decision for most exporters. Imported goods must conform to local standards and labelling regulations, which a local agent or distributor should be able to advise on. They should also be able to help Queensland businesses obtain the necessary certifications and permits needed for importation. For more information on import requirements, please see <https://eweb.customs.gov.tw/>

Choosing a distribution partner for an agtech device requires systematic selection and vetting to find the most suitable partner for your product. Ask yourself the following questions during the selection process.

Questions to ask a potential distributor or agent

1. Does the potential distributor sell products that are synergistic or similar to your own? This can be an advantage if it shows that the company has expertise in this area, or a disadvantage if it means your product will be competing with existing products in the distributor's portfolio.
2. Does the distributor have strong sales and marketing personnel? Set some vetting qualifications: for example, that the distributor is large enough that at least one salesperson can be dedicated to the promotion and sale of your products.
3. Relationships are important in Taiwan, as in the rest of Asia. How well do you know your potential distributor? How will you develop the relationship going forward?
4. Do you speak the distributor's language or is their English good enough to communicate?
5. Does the distributor understand conflict of interest, contracts and international business practices? Are you both on the same page with regards to ethical business practices and conduct?
6. Do you have a plan in place if the relationship with your distributor takes a turn for the worse, or if sales expectations are not met?

See Table A-2 in Appendix 1 for a selection of the largest agtech device distributors and integrators in Taiwan.

2.6 Regulatory and business requirements

Finding distributors, agents and local representation is an important part of an export strategy for Taiwan. Queensland businesses should consider in-market representation to enable them to understand nuances in the market, marketing and distribution channels, buyer identification strategies, product support, and relationships with key government agencies in the market.

In general, agents or distributors usually function as a first contact for exporters looking to engage in Taiwan. Taiwanese companies importing products need to have an import licence. However, if local agents or distributors do not have import licences, Australian companies can import through an import-export company. It is vital to spend time in Taiwan with your representative to clearly explain the product, effectively negotiate terms of business and develop networks in the market.

Import procedures

Under the terms of the Foreign Trade Act, most commodities can be imported freely. In general terms, no import permit or licensing is required and importers can apply for customs clearance

directly. The only exemptions are commodities under the Negative List, which are subject to import restrictions if concerning national defence, societal security, cultural protection, hygiene, and moral and environmental and ecological concerns.

Importing samples

Commercial samples, professional instruments and equipment, as well as exhibition goods that are brought into Taiwan for sales promotion and exhibition purposes, are exempted from customs duty.

For further information

[Taipei Customs Office](#)

[Department of Customs Administration](#)

[Ministry of Economic Affairs](#)

[Intellectual Property Office](#)

[Small and Medium Enterprises Administration, MOEA](#)

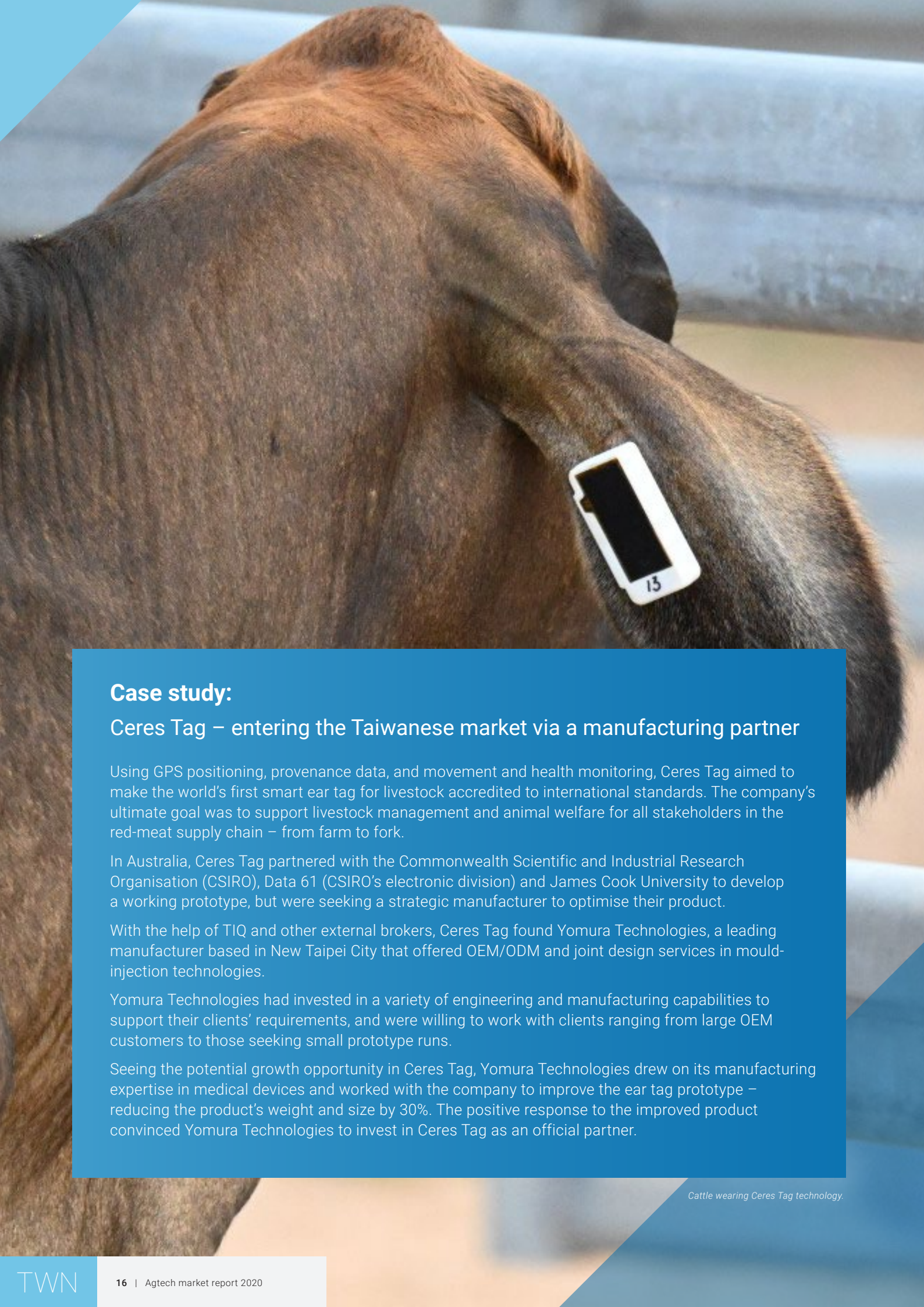
[Taiwan External Trade Development Council](#)

[Food and Drug Administration](#)



Drone over rice farm in Taiwan.





Case study:

Ceres Tag – entering the Taiwanese market via a manufacturing partner

Using GPS positioning, provenance data, and movement and health monitoring, Ceres Tag aimed to make the world's first smart ear tag for livestock accredited to international standards. The company's ultimate goal was to support livestock management and animal welfare for all stakeholders in the red-meat supply chain – from farm to fork.

In Australia, Ceres Tag partnered with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Data 61 (CSIRO's electronic division) and James Cook University to develop a working prototype, but were seeking a strategic manufacturer to optimise their product.

With the help of TIQ and other external brokers, Ceres Tag found Yomura Technologies, a leading manufacturer based in New Taipei City that offered OEM/ODM and joint design services in mould-injection technologies.

Yomura Technologies had invested in a variety of engineering and manufacturing capabilities to support their clients' requirements, and were willing to work with clients ranging from large OEM customers to those seeking small prototype runs.

Seeing the potential growth opportunity in Ceres Tag, Yomura Technologies drew on its manufacturing expertise in medical devices and worked with the company to improve the ear tag prototype – reducing the product's weight and size by 30%. The positive response to the improved product convinced Yomura Technologies to invest in Ceres Tag as an official partner.

Cattle wearing Ceres Tag technology.

3. Opportunities for Queensland businesses

3.1 Precision technology

Background

Most of the farmland cultivated by farmers in Taiwan is less than 1 hectare and may be divided into several blocks for various crop species. Soil texture, structure and fertility are not uniform, even within a single piece of farmland. Thus, cultivation management requires more elaborate planning for fragmented land plots, which makes large-scale agribusiness difficult. In addition, smaller farmers cultivate crops based on intuition and experience, leading to over-application of pesticides and fertilisers, while stock farming using enterprise-management strategies can lead to antibiotic or chemical residues due to improper additives. As Taiwan shifts from increasing productivity to global competitiveness, it is keen to learn from Australian expertise on reducing chemical use and applying precision farming techniques to support waste reduction.

Current status

In May 2019, Taiwan promulgated the Organic Agriculture Promotion Act to expand the organic foods sector, bringing about opportunities for Queensland companies who possess infrastructure to handle labelling and quality inspections for the 5,500+ organic⁷ products on the market and set out standard operating procedures for organic agricultural products for county and city government departments to handle inspection and verification.

Precision technologies are currently used for high-value crops such as dragonfruit, jujubes and lychees, and are increasingly adopted by produce cooperatives in eastern and southern Taiwan that specialise in a wide variety of crops at different stages of growth.

Opportunities

Capitalising on the growth of smart agriculture, opportunities exist for Queensland businesses to support farmers in installing environmental-control equipment, including:

- » intelligent hardware such as temperature, humidity, soil pH and luminosity sensors that wirelessly transmit to desktops, tablets and mobile phones

- » IoT monitoring systems to automatically control field operations via software control and remote programming

- » remote sensing to provide much-needed monitoring and prediction of crop disease and/or pest outbreaks, such as tools to track pests in real-time

- » UAVs such as autonomous drones or satellite technology

- » all-in-one integrated systems

- » VRTs (variable rate technologies) that can realise the application of input variables and allow farmers to control the amount of input applied in specific locations. Basic VRT methods are map-based, sensor-based and manual.

These examples may also apply to smallholders in other countries in the Asia-Pacific region.

⁷ Organic Agriculture and Friendly Farming, Council of Agriculture



3.2 Tracing technology

Background

Food scandals, false labelling and adulterated products have damaged consumer confidence in domestic agricultural products and are driving consumer demand for provenance assurance. There have been many high-profile food safety incidents in recent decades and a growing demand for cheap food has led to an overreliance on fertilisers, pesticides and antibiotics. In addition, the increasing circulation of products that are high-quality, high-value and easily imitated by, or confused with, inferior versions of the same product (eg tea, honey) has damaged the reputation of some original products. Thus, there has been a social push to establish a traceability system to authenticate the origin of agricultural products to prevent false labelling and adulterated products.

Current status

Taiwan introduced a traceability system for agricultural products known as the TAP (Traceability/Good Agricultural Product) System in 2007.⁸ This mandates suppliers to record all stages of production, processing, distribution, sales and any third-party certifications that can be accessed by consumers through QR codes affixed to the products' packaging.

It seeks to develop a more comprehensive system to ensure the agricultural supply chain is fully transparent – as, currently, different methods of mapping the supply chain and data collection still rely on legacy systems and paper-based processes that can contribute to inaccuracies during data transcription and make real-time auditing difficult. New data-capture solutions to increase insight into the supply chain will help to ease the regulatory compliance burden for Taiwanese authorities.

Opportunities

As mobile traceability technology sales are expected to reach USD \$14.1 billion (AUD \$20.5 billion) by 2020 with an annual growth of nearly 9%,⁹ an automated track-and-trace process will

not only address existing business challenges in Taiwan but also open up future opportunities internationally. Specific opportunities include:

- » automated data collection via rugged devices using barcode, RFID technology or IoT
- » data aggregation in real time to provide intelligence across the supply chain from farm to retailer
- » integration into existing processes or redefining processes to incorporate track-and-trace.

These challenges require a robust data-management system consisting of rugged data-capture hardware plus track-and-trace software. Some organisations may need to invest in a technology overhaul, while others may simply need to upgrade pieces of their existing infrastructure.

3.3 Vertical agriculture

Background

Increased pollution, media coverage of food scandals and excessive pesticide use have led Taiwan's consumers to demand 'clean food', typically defined as being pesticide-free and from reputable sources. The scarcity of land has also led to exploration of ways to produce food in highly dense areas with fewer resources. These trends favour indoor growers whose vegetables are grown without pesticides and in controlled environments, such as indoor farms, hydroponic greenhouses and plant factories, container farms and in-home systems.

Current status

Taiwan has exhibited 70% per annum growth in the number of Taiwanese plant factories since 2009, with 120 nation-wide as of 2016.¹⁰ Taiwan is home to 25% of all East Asia's plant factories, behind Japan (41%) and tying with China (25%).

⁸ Council of Agriculture, Executive Yuan ROC, *Traceable Agricultural Product Status Quo and Prospects*

⁹ Panasonic Corporation of North America, 2016 *Manufacturing Report: Track & Trace*

¹⁰ Kozai, Niu & Takagaki, *Plant Factory, An Indoor Vertical Farming System for Efficient Quality Food Production*

Opportunities

TIQ has identified four main technologies that present significant opportunities for Queensland companies.

- » **Growing systems:** are a series of vertical layers of grow racks that contain the nutrient-rich water in which plant roots grow, housed in controlled environments and insulated from the outside world via air locks or clean-room conditions. 90% of Taiwan's plant factories are housed in office buildings.¹¹

Opportunities: Players varying from Panasonic and Fujitsu to one-person start-ups are involved. Opportunities lie in improving efficiencies in the systems or in creating add-on solutions (eg white-labelled organic nutrient solutions). Adding automation and robotics to systems is also a promising research avenue, as this offers the potential to reduce the labour costs that make up around one-quarter of plant factory operating costs.

- » **Environmental control units:** monitor and adjust a range of indoor farm factors, such as pH, nutrient and humidity levels. Companies such as Argus Controls, Autogrow and Priva have a large presence, and several have cloud-based options that allow users to remote access and control their farms.

Opportunities: Big-data control systems (based on vast data sets that can be analysed for patterns and trends) are an attractive area for further development to achieve better crop yields by applying analytics results. Cheap sensors and analytic platforms have opened up the possibility of creating a better understanding of plant behaviour, one which is likely to be captured by both existing players and start-ups.

- » **Nutrient supply and control** – in hydroponic systems, plants' nutrient needs are supplied

through a solution in which roots rest, and which differ according to plant life and stage. Commercially available nutrient mixes are often used, and most use dosing-control systems that monitor and administer nutrients to the farm's recirculating water system. A combination of longstanding greenhouse suppliers, such as Dosatron International, and newer market entrants, offer these systems.

- » *Opportunities:* Small growers are always looking for cheaper, simpler systems to use in their farms. Many growers would like to better verify the plant growth and flavour claims made by commercial nutrient suppliers.

However, there is also intense competition in the IoT sensor space, given Taiwan's manufacturing prowess and its access to cheap components from factories in mainland China. Therefore, Queensland companies are advised to invest in high-value services and software that add value to existing equipment.

- » **Lighting** – is a vital component for plant factories, as it provides the only source of illumination for plant growth in a closed system. It is an important financial decision for the grower, as some growers run LEDs for as long as 18 hours per day, accounting for 70–80% of all electricity spend.

Opportunities: Bringing down the cost and energy consumption associated with lighting is a priority for growers, so lighting, automation and control systems are likely to be key areas for technical upgrades as growers seek to contain operating costs.

This industry is in its infancy in understanding how light and plant biology interact, so there are numerous opportunities for commercialisation of new approaches and discoveries.

¹¹ Dr Wei Fang, National Taipei University, Department of Bio-Industrial Mechatronics Engineering



3.4 Robotics and automation

Background

Driven by the growing use of robots to cope with an increasing labour shortage, there is a good opportunity for start-ups and SMEs to engage with the Taiwanese sector for manufacturing and software development of intelligent automation for protected and outdoor cropping, as well as pig and chicken livestock.

Current status

In 2015, Taiwan's intelligent-automation industry generated an estimated USD \$36.6 billion (AUD \$53 billion at 2015 values) in revenue, with the robotics sector alone generating an estimated USD \$1.8 billion (AUD \$2.6 billion at 2015 values).¹² Although local manufacturers are capable of producing unitary axial robots and vertical coordinate robots, Taiwan relies on foreign countries for high-scale robots and imports critical components (eg server motors, controllers, decelerators). Hence, most manufacturers act as importing agents for foreign-brand robots.

Automation is not as widely adopted as it is in Australia, and older farm practices such as manual planting are still practised in more rural areas. There is a growing use of tablets and meters to automate pumps etc, but the lack of a cohesive sourcing channel for key components remains a barrier for farmers wanting to upscale.

Opportunities

Robotics and automation opportunities include:

- » robotics and automation for bulk sorting in the fresh produce industry

- » automated grading systems and data collection

- » software innovations, including smartphone apps that enable the monitoring and managing of sensors, robots and more sophisticated IoT applications

- » other automated systems to replace human labour.

Table 1: Top 10 research topics identified in Taiwan Agricultural Technology Foresight 2025

1. Development of accurate, rapid and simple diagnostics for pesticide residues
2. Research on the ecological restoration of polluted farmland, derelict rearing ponds, overdrawn groundwater areas, riverbed and banks, and degraded forestland
3. Elucidation of global climate change affecting Taiwan's agricultural ecosystem and the development of counter measures
4. Improvement of integrated safety tests, a tracking system and certification for agri-food products
5. Development of crop production systems with low energy consumption, low emission of greenhouse gases and efficient use of water resources
6. Improvement of forecasting and monitoring techniques for slope-land debris slides
7. Development of groundwater-saving aquaculture
8. Development of agricultural environmental resources monitoring and early disaster warning technology
9. Development of energy-saving and carbon-reducing preservation and shipping technologies for agricultural products
10. Clarification of transmission modes and pathogenic mechanisms of animal and human infectious diseases

¹² http://topic.cw.com.tw/cw2000_2017/

3.5 Research collaboration

Background

Taiwan Agricultural Technology Foresight 2025 was commissioned by the government to identify R&D priorities to meet long-term research objectives for agriculture in Taiwan. It compiled a 'national priority' index that reflects the priorities for shaping Taiwan's agricultural future in ways to improve farmers' livelihoods (priorities 2, 6, 8), develop resource-efficient and environmentally friendly methods of farming (priorities 3, 5, 7, 9), and ensure food safety by instituting a traceability system (priorities 1, 4, 10).

Current status

As outlined in Table 1, key areas for developments in research and capability include crop-breeding programs, plant biotechnology, animal nutrition and livestock technology, sustainable farming systems, tropical crops and bio-commodities, robotics, drone and sensor technology and aquaculture.

Falling under the Council of Agriculture are 16 research institutes,¹³ which publish their findings

in the *Journal of Taiwan Agricultural Research* and collaborate with a wide range of academic organisations, government organisations and international organisations to commercialise their research.

Opportunities

Opportunities for research collaboration exist in many areas and can be explored through both informal and formal channels in the first instance.

For example, researchers can be approached at Taiwan's many large-scale exhibitions, conferences, symposiums and tradeshows – the largest being the annual International Taipei Food Show and the Asia Agri-Tech Expo & Forum. Taiwan's researchers¹⁴ also have a long record of international collaboration with universities and institutions in the Asia-Pacific, and opportunities could be pursued in conjunction with Queensland universities and research institutions.



Drone over Red Dragon fruit farm, Taiwan.

¹³ See Table A-3 in Appendix 1 for more details.

¹⁴ See Table A-3 in Appendix 1 for more details.



4. Government support

4.1 Queensland Government support

Innovation is a priority for the Queensland Government, and is critical to the future competitiveness of all Queensland industries. The government's Advance Queensland program has a wide variety of programs to foster innovation, which are tailored to the needs of industry, entrepreneurs, researchers and small businesses.

The Queensland Government also offers a range of other programs to build business capability and facilitate access to global supply chain opportunities. As the Queensland Government's global business agency, Trade and Investment Queensland can support your business throughout its export journey. Our network of specialist advisors across Queensland can provide advice, information and introductions, whether you are looking to export for the first time or are wanting to expand your export operations.

Grants and other financial support for agtech or export projects may be available through Advance Queensland, Trade and Investment Queensland, the Department of Agriculture and Fisheries, or other Queensland Government agencies.

For more information:

- » visit <https://advance.qld.gov.au/>

- » contact Trade and Investment Queensland on +61 7 3514 3147

- » visit <https://www.grants.services.qld.gov.au/>

- » visit <https://www.business.qld.gov.au>.

4.2 Taiwanese Government support

The Taiwanese Government also has a variety of programs that aim to join the manufacturing capabilities of Taiwan's system integrators, ODM, OEM, start-up accelerators and research organisations with domestic and international start-ups to develop prototypes and commercialise agtech ideas.

For more information, visit the websites of:

- » Taiwan Innovation & Technology Arena (TITAN) at <https://www.titan.org.tw/>

- » Taiwan Rapid Innovation Prototyping League for Entrepreneurs (TRIPLE) at <https://www.triplelinkage.com/index.aspx>.

5. Conclusion

Agriculture is facing challenges and change worldwide, including in Taiwan.

Taiwanese governments and farmers are looking to agtech to help them achieve the transformation required by Agriculture 4.0, creating opportunities for Queensland businesses to provide agtech products and services to support that transformation.

Key agtech opportunities for Queensland companies lie in:

» precision technology

» tracing technology

» vertical agriculture

» robotics and automation

» research collaboration.

Given the fragmented nature of Taiwan's agriculture industry, partnerships with intermediaries such as dominant manufacturers and farmers' associations will be key to gaining market share.

In addition, Queensland companies should consider partnering with Taiwanese manufacturers, as Taiwan is well positioned to become a key player in the global agtech industry and offers unique access to nearby Asian markets.





Research on Agrivoltaic Farming – TARI.

Appendix 1 – Company and other industry data

Table A-1: Major Taiwanese companies in the agtech sector

Name	Notes and website
GCL Garden Design Co., Ltd	Greenhouse environmental control systems that monitor microclimate conditions, cooling and heating systems, ventilation systems, ventilation systems and plant bed facilities. https://www.sheigen.com/
Huang Lin Machinery	Established in 2013, manufactures intelligent environmental control systems for greenhouses, cooling systems, lighting and irrigation systems, sprayer and related accessories, weather sensors. http://www.huanglin.com.tw/
Hua-Wang Agricultural Equipment LTD. (KAO) 花王農業器具有限公司	Has been researching and developing integrated greenhouse and environmental control systems with 30 years of experience. http://www.huawang.com.tw/
GEOSAT Aerospace & Technology Inc	Developer of UAVs, aerial image capturing operations, satellite technologies and unmanned flight systems. https://www.geosat.com.tw
Chainwin Agrotech	Integrates smart farm management, interferon (IFN), nutrient formula, vaccine and diagnostic kits for animals to set up animal health management modules. http://www.chainwin-agrotech.com/
AAC Life	Smart, environmentally controlled indoor plant factory manufacturer, produces short-cycle herbage crops. http://en.aaclife.com/
AdvanTech Co. Ltd	Leader in IoT and intelligent systems, AdvanTech has branched into providing complete, smart-farming solutions for agriculture. https://www.advantech.tw/
Knownyou Seed Co.	Leader in IoT and intelligent systems, AdvanTech has branched into providing complete, smart-farming solutions for agriculture. https://www.advantech.tw/
SmartAgri	Provider of management platforms, integration systems and news. http://www.smartagri.com.tw/



Table A-2: Selected Taiwanese distributors

Name	Contact details and website
<p>Yuling Agricultural Machinery Co. Ltd</p>	<p>Telephone: 05-6322585 Email: yulinoji@gmail.com http://www.yulinoji.com/m/</p> <p>Note: Yuling Agricultural Machinery Co. Ltd has successfully obtained exclusive agency/distribution rights to larger partners such as Mitsubishi Agricultural Machinery and Sasaki Agricultural Machinery.</p>
<p>Taiwan Irrigation 日胜貿易股份有限公司</p>	<p>Telephone: 04-24718899 Email: magnatet@ms16.hinet.net http://www.taiwanirrigation.com/</p>
<p>Chushia Agricultural Machine Works Ltd</p>	<p>Telephone: +8862 23313320 Email: joanko0221@yahoo.com.tw www.chushia.ko.com.tw</p>
<p>Taipei Trading Co., Ltd</p>	<p>Telephone: +8862 25035688 Email: ttc@tpetrade.com www.tpetrade.com</p>
<p>FECO Corporation</p>	<p>Telephone: +8862 27912828 Email: feco@fecocorp.com.tw WWW.FECO-CORP.COM.TW</p>
<p>Foreport Enterprises Co., Ltd</p>	<p>Telephone: +8862 27625771 Email: info@foreport.com.tw www.foreport.com.tw</p>
<p>Ikeuchi Taiwan Co., Ltd</p>	<p>Telephone: +8862 25116289 Email: ikeuchi@ms57.hinet.net www.ikeuchi.com.tw</p>
<p>Plastico Corporation</p>	<p>Telephone: +886-2-2346-1666 Email: wchien@plastico.com.tw http://www.plastico.com.tw</p>

Table A-3: Taiwanese research institutes and universities

Name	Notes and website
<p>Taiwan Agricultural Research Institute (農業試驗所)</p>	<p>Located in Wufong, Chiayi and Fengshan, the institute conducts both basic and applied research on agronomic and horticultural crops in the fields of breeding and genetics, physiology, soils, plant nutrition, diseases, pests, and farm machinery. https://www.tari.gov.tw/english/</p>
<p>Livestock Research Institute (畜產試驗所)</p>	<p>Located in Tainan, the institute conducts research on breeding and genetics, physiology, nutrition, livestock management, animal product processing, and forage crops. http://english.tlri.gov.tw/</p>
<p>Fisheries Research Institute (水產試驗所)</p>	<p>Located in Keelung, the institute conducts research on fishery resources, fishing technology, aquaculture development, and the preservation and processing of fishery products in Taiwan. https://en.tfrin.gov.tw/</p>
<p>Forestry Research Institute (林業試驗所)</p>	<p>Located in Taipei, the institute conducts research related to forestry and forest products, such as forest technology, silviculture, forest protection, forest management. https://www.tfri.gov.tw/</p>
<p>Animal Health Institute (家畜衛生試驗所)</p>	<p>Located in Danshuei, Taipei County, the institute conducts research on animal disease diagnosis and surveillance schemes to develop national animal disease control measures. https://eng.nvri.gov.tw/</p>
<p>Smart Machinery Promotion Office</p>	<p>Located in Taichung, this office provides resources on smart machinery developments, industry information and upcoming association events and tradeshow. http://www.smartmachinery.tw/</p>
<p>Agricultural Technology Research Institute</p>	<p>Located in Hsinchu, this institute strengthens the commercialisation and industrialisation of agricultural research results, with a database of exportable agricultural technologies. https://www.atri.org.tw/</p>
<p>Agricultural Research and Extension Stations</p>	<p>Located in Hualien, Kaohsiung, Miaoli, Taichung, Tainan, Taitung, and Taoyuan, these stations focus on the R&D of commercial crops in the local agricultural industry, which differ due to climate and soil diversity.</p>
<p>Food Industry Research and Development Institute</p>	<p>Located in Hsinchu, this institute is responsible for food industry development policies, and development and marketing of new food processing technologies. https://www.firdi.org.tw/</p>



Table A-4: Relevant Taiwanese associations

Name	Notes and website
Importers and Exporters Association of Taipei (IEAT)	Has 6,000 member companies in its directory of importers and exporters and actively helps businesses to explore global opportunities. http://www.ieatpe.org.tw/
Taiwan Agricultural Machinery Manufacturers Association	Regularly organises agricultural-machinery related tradeshow. http://www.tamma.org.tw/
Taiwan Plant Factory Industry Development Association	Promotes technological exchanges, investment cooperation and strategic alliances, and monitors industrial trends for plant factory technologies. Also organises forums, lectures, seminars and visit activities. https://www.tpfida.org.tw/about/
Taiwan Automation Intelligence and Robotics Association (TAIROA)	Promotes the development of the intelligent automation industry by integrating professionals from engineering, automation, precision and communication technologies. http://www.tairoa.org.tw/
Farmers' Association	Comprises joint import-export trade associations of 14 counties and cities in Taiwan based on import-export needs of each region. http://www.tiec.org.tw/

Table A-5: Taiwanese exhibitions and conferences with an agtech focus

Name	Notes and website
Taipei International Food Expo	Exhibit categories: fresh fruits and vegetables, poultry, seafood, meat products, dairy products, processed foods, coffee and tea, condiments and confectionery . https://www.foodtaipei.com.tw/
Asia Agri-Tech Expo & Forum	Exhibit categories: agri biotech, agriculture machinery, irrigation systems, plant factory, seeds and flowers, smart agriculture and greenhouse. https://www.agritechtaiwan.com/en-us/
Taiwan Smart Agri-Week	Exhibit categories: fruit and vegetable show, agriculture technology expo, flower expo, cold chain expo. http://www.taiwanagriweek.com/
FUTEX Future Tec	Exhibit categories: artificial intelligence and IoT applications, biotech, electronics and optoelectronics, medical devices, smart agriculture, smart machinery, smart disaster prevention, space technology. https://www.futuretech.org.tw/
TAIROS Taiwan Automation Intelligence and Robot Show	Exhibit categories: artificial intelligence, industrial supply, service robots, smart manufacturing, smart services (business application). https://www.tairos.tw/en/





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