

PROTECTED CROPPING FOR FUTURE FOODS

Innovating plant technologies and infrastructure for efficiency, sustainability, and a future-proof Queensland food industry

EXECUTIVE SUMMARY

This report describes plans to invest in and expand Queensland's protected cropping industry as a joint venture between Queensland Alliance for Agriculture and Food Innovation (QAAFI), the University of Queensland (UQ), the Queensland Department of Agriculture and Fisheries (DAF), Hort Innovation and other national and international stakeholders.

These novel plant technologies will boost Queensland's economy, particularly in regional areas such as Toowoomba and Townsville, where we will build and extend major protected cropping infrastructure and bring new, high-value crops (such as Chinese herbs, saffron, coffee, and berries) to domestic and export markets. The initiative create a large number of new jobs in Queensland regions across the entire supply chain.

Protected cropping provides a sustainable solution for food production in all current and future Queensland climates, and diminishes some of the major environmental issues associated with field-based farming, including fertiliser run-off, excessive use of water, pesticides or herbicides, and waste due to inconsistent product quality.

Between 2020-2025, we will undertake research at UQ Long Pocket to determine the best genetic variants and environmental conditions for our plants; engineer next-level, automated cropping facilities at UQ Gatton and Toowoomba; and ultimately showcase fully integrated and market-ready crops at Toowoomba and Townsville shopfronts.

Challenges

Worldwide, crop yields are declining by 1-2% each year due to rising temperatures, extreme rainfall and drought events, and intensification of land use¹, even as the world requires more food to meet the demands of population growth. Growers must find a way to produce 14% more food each decade to feed and nourish burgeoning populations². Currently, Australia is a major global producer of quality foods, but we must innovate to remain so as our own climate becomes hotter, drier and more volatile.

Protected Cropping

Protected cropping systems are climate-controlled facilities that enable any plant to be produced anywhere regardless of external conditions, thus safeguarding foods from climate change. Protected cropping enables the consistent, year-round production of high-quality crops, resulting in crop production that is up to 800% more efficient³. Temperature, precipitation, light, and other parameters are manipulated to optimise the growth, nutritional quality, or pharmaceutical content of plants. Only 50-80% of field-grown crops meet quality standards for safety, appearance, taste, nutritional value, and texture; in controlled facilities, more than 95% of products are high quality—significantly reducing wastage⁴. In addition, protected cropping has a much lower environmental footprint than field-grown crops. Physical barriers protect the plants from insect pests and weeds, reducing the need for pesticides and herbicides. Many controlled environment systems use hydroponics to grow plants in isolation from soil, and water and nutrients can be recirculated for use on other crops or vegetation. By recycling the majority of water used, these systems increase the conversion rate of water (grams of crop produced per litre of water) by more than 500% and, by eliminating run-off, dramatically reduce the volume of fertiliser needed³.

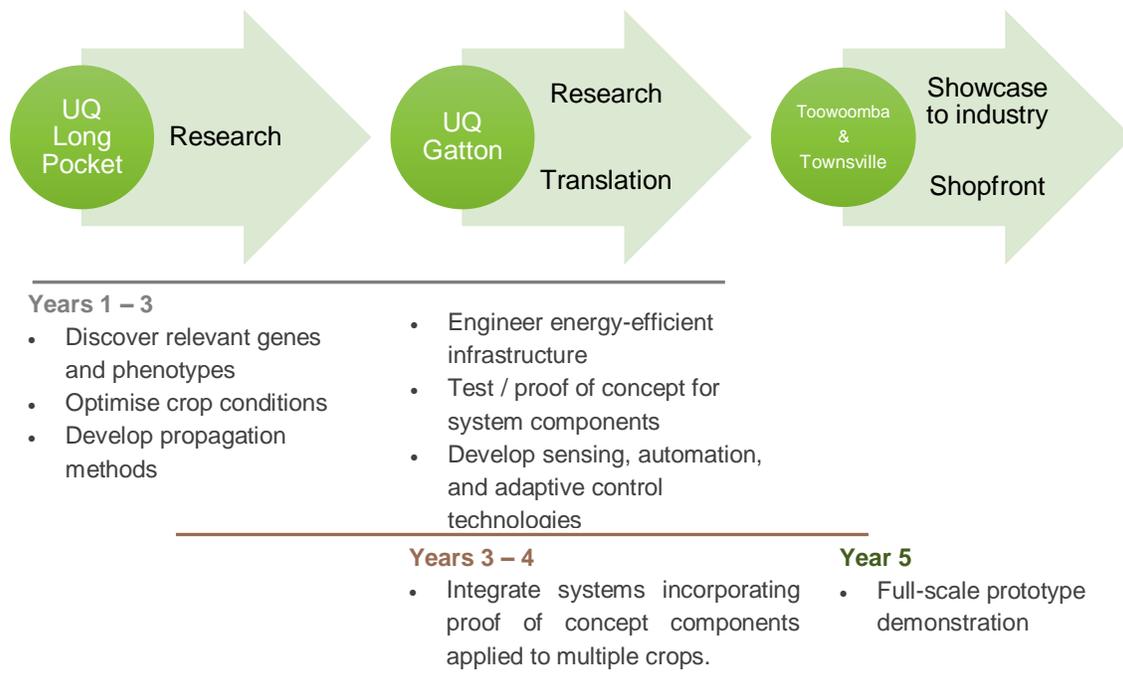
Currently, Australian growers use protected cropping primarily for cut flowers, tomatoes, and vegetables (particularly leafy greens); however, fewer than a third of Australian vegetable growers use these facilities, and 92% of those users are based in New South Wales, Victoria, or South Australia⁴. A greater diversity of crops can be grown in controlled environment systems, so investment in the protected cropping will not only safeguard Australia's food supply, but bring new and desirable varieties of fruits and vegetables to consumers and fill the demands of niche markets⁵. The industry is expanding at 4-6% annually⁴, and the potential return on investment for high-tech, greenhouse vegetable enterprises is around 20-25% each year⁴.

Our initiative:

Beginning in 2020, we will invest in and expand Queensland's protected cropping industry through new research, development, and infrastructure in partnership with DAF Queensland, Hort Innovation and major industry stakeholders such as FKG, Philips, Siemens, Telstra and others. Our work will boost food and agricultural production for all Australians and bring economic growth to regional areas of Queensland where traditional farming is unsustainable or where new jobs are urgently needed. Furthermore, these facilities can be built on non-arable land, such as disused mine sites; can be made energy-neutral with water and nutrient recycling and solar energy; and can make high-value foods such as coffee, spices, or blueberries accessible to Queensland agribusinesses.

Our Model

With our major partners, we will build cutting-edge protected cropping facilities at UQ Long Pocket, UQ Gatton, and as part of FKG's Agritech Innovation Centre in Toowoomba and DAF's protected cropping infrastructure in Townsville. We aim to attain translational capacity within five years for at least four high-value crops including vegetables, rock melons, coffee, spices and berries. From there, we will expand our work with other crops, build infrastructure in other regional areas, and engage with Indigenous communities to develop new food markets. We also aim to translate this model to provide alternate industry options at mining sites (both active and closed mines)



Our proposed work will take innovation in indoor farming to the next level. The project is highly interdisciplinary and industry-facing, and will require myriad skills in engineering and design, energy, automation and technology, supply chain dynamics and, of course, biology. This will attract top EMCRs and students to the project at UQ, where we will create and support exciting opportunities to collaborate, innovate, and build outstanding and diverse careers.

- We will **develop the future leaders** of Australian crop science, technology, and business.
- We will **engineer custom protected cropping solutions** for regions experiencing severe flooding, storms, cyclones, heat, or drought in current or future climates.
- We will **build next-generation growing facilities** that make Australian food production more efficient and sustainable
- We will **bring new, high-value horticultural crops to Queensland** to meet local, domestic, and export demands
- We will **innovate machine learning, smart monitoring technologies, and automated solutions** for crop planting, monitoring and harvesting, and to optimise growth

Capacity and Capability

UQ is ranked #1 in agriculture research in Australia and #5 in the world. Based at UQ, QAAFI leverages research excellence, regional networks, and extension expertise of the university and DAF to deliver significant outcomes for agriculture. QAAFI is projected to have generated over half a billion dollars in research funding by 2022.

UQ and the Australian government are actively investing in plant science, crop solutions, and agribusiness. For example, the ARC recently awarded UQ a \$17.5M ARC Research Hub for Sustainable Crop Protection, to be led by the Director of QAAFI's Centre of Horticulture Science, Professor Neena Mitter. The Research Hub aims to develop and commercialise an innovative biopesticide called BioClay as an alternative to existing chemical products—thus addressing issues of resistance, chemical residues in food, off-target effects, and environmental harm in field and especially in controlled environmental cropping.

UQ has also invested \$16M to develop a new Plant Tissue Culture Facility and Food Analysis and Sensory Centre at Long Pocket, which will enable us to optimise light, nutrient, temperature, and other growth conditions for each crop. The Food Analysis and Sensory Centre will provide essential information about the nutrition, taste, and market quality of crops grown in protected cropping. We can then scale up plant propagation to provide plants at industry-relevant scales in our Gatton, Toowoomba, and Townsville facilities.

We are focusing on crops that have the highest potential return on investment and will produce reliable, high-quality yields. Over the long term, we aim to generate \$1M gross margin per hectare per annum, indicating revenues of around \$100M for an operation covering up to 100Ha. so by partnering with Hort Innovation, and our major partner DAF, UQ can create Australia's largest protected cropping venture and revolutionise sustainable agribusiness.

We will begin research and development of high-value, aspirational crops (e.g. coffee, ginger, berries) simultaneously with crops already optimised for greenhouse production (e.g. rockmelon) or grown hydroponically (e.g. saffron). This way, we can begin to build and test infrastructure and automation with existing crops even as we determine the best genetic variants and environmental conditions for new ones.

Impact in Queensland

Over the next five years, we will invest in new infrastructure and industry in Toowoomba and Townsville, boosting **economic growth in key regional centres for Queensland** and laying the groundwork for **expansion across the state**. Our initiative **will create new jobs through the entire supply chain** from biologists and engineers to transporters and marketplaces and will attract local, domestic, and international investment in Queensland food production. We can begin to develop new, high-value crops for export, including Chinese herbs, coffee, and berries.

Importantly, protected cropping has the potential **to revitalise areas stricken by drought or the closure of major industries and mines**, and will reduce future losses due to dramatic weather events or climate change. In controlled environment facilities, nutritious foods can be grown in any external conditions, **making healthy foods more abundant and accessible** and improving health and reducing obesity, which is a particular problem in regional areas. Protected cropping produces higher-quality products with improved shelf life, **extending export potential**. Toowoomba and Townsville are already connected to international markets by major airports or ports, and we can use our partner FKG's warehouse facilities to store crops such as saffron and coffee, which have inherently longer shelf lives, before export.

Finally, controlled environment cropping is better for the environment, **and will reduce the impacts of farming on natural systems such as the Great Barrier Reef**. Less water, fertiliser, herbicides and pesticides are used in cropping practices and less produce is wasted due to poor quality or shelf life. We aim to develop protected cropping infrastructure on active or disused mine sites or in areas of poor climate that could not otherwise be used to grow food. With investment in protected cropping, we can better meet growing global demands for quality, healthy foods.

Investment Required

Our plan, as described here, will require an investment of \$30M.

- 1 Porter, J. R., L. et al. in Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 485-533 (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014).
- 2 Alexandratos, N. & Bruinsma, J. (ed Agricultural Development Economics Division (ESA)) 147 (Food and Agriculture Organization of the United Nations (FAO), Rome, Italy, 2012).
- 3 Smith, G. in Industry Overview 2011 – Case for National Training Centre for Controlled Environment Horticulture (2011).
- 4 Boserup, E. The conditions of agricultural growth: The economics of agrarian change under population pressure. 10 (Routledge, 2017).
- 5 Carruthers, S. Protected cropping in the tropics. Practical Hydroponics and Greenhouses, 36 (2015).