

## Final Report

# Emerging leaders in protected cropping

**Project leader:**

Professor Zhonghua Chen and Dr Amy-Marie Gilpin

**Report authors:**

Professor Zhonghua Chen, Dr Amy-Marie Gilpin, Mr David Randall, Ms Shareen Wen Ting Yang, Dr Michelle Mak, Dr Robert Sharwood, Dr Jayakumar Bose, Dr Jing He

**Delivery partner:**

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Emerging leaders in protected cropping (LP18000)

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Level 7  
141 Walker Street  
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Telephone: (02) 8295 2300

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## Contents

<b>Public summary .....</b>	<b>1</b>
<b>Keywords .....</b>	<b>1</b>
<b>Introduction.....</b>	<b>1</b>
<b>Methodology .....</b>	<b>3</b>
<b>Results and discussion .....</b>	<b>5</b>
<b>Outputs.....</b>	<b>5</b>
<b>Outcomes .....</b>	<b>7</b>
<b>Monitoring and evaluation .....</b>	<b>10</b>
<b>Issues and Risks .....</b>	<b>14</b>
<b>Recommendations.....</b>	<b>14</b>
<b>Refereed scientific publications .....</b>	<b>15</b>
<b>References .....</b>	<b>16</b>
<b>Intellectual property .....</b>	<b>16</b>
<b>Appendices .....</b>	<b>17</b>

## Public summary

The objective of this project is to fill an identified gap in the training of future leaders in the Australian protected cropping industry. This was planned to achieve through the development and delivery of a suite of subjects that was offered as a one-year Masterclass in Protected Cropping. The Masterclass included enrolment in, and articulation to, a range of graded qualifications, culminating in six-month Graduate Certificate, one-year Graduate Diploma, two-year Master of Science (MSc) Greenhouse Horticulture major, and micro-credentials (1-3 subjects). Along with the associated course subjects such as Industry Project and MSc Research Project, four major core subjects were designed in collaboration with Hort Innovation, and industry partners they are: Greenhouse Crop Production, Plant-Climate Interactions in Controlled Environment, Advanced Greenhouse Technology, and Greenhouse Control Systems.

The course includes a combination of flexible online learning modules and intensive on-site workshops to align with the likely availability of time pressured industry employees. Students are provided internship opportunities with some core industry partners to facilitate work-integrated learning. Industry was engaged in the development of the course content to ensure it meets market needs. Participants who complete this course could potentially help to meet the high demand for skills and leadership in the Australian protected cropping industry. They will play a vital role for the prosperous future of this industry, thus contributing to the vision of the Hort Innovation Leadership Fund to provide opportunities for horticulture professionals at all stages of their careers to advance along the ladder of leadership. At the end of this project fund, Western Sydney University has established a leading protected cropping education program with three courses and micro-credential. The course program is now self-sustaining through student enrolments and industry support with scholarships and internships, fostering ongoing and/or new relationships with the industry and producing industry-related publications that warrant future R&D. WSU has been successful in obtaining funding from Australian Research Council to establish the Industrial Training Center for Smart and Sustainable Horticulture in 2024 which will be integrated with components of this course.

The course was impacted by COVID-19 pandemic, affecting students' enrollment numbers from 2019-2021. Despite this challenge, a total of 285 students have enrolled in at least one of the four protected cropping core subjects and other related subjects since the commencement of the program in the summer semester 2020, surpassing project targets of 100 participants. The project has so far educated 106 students who completed the core subjects and qualify for a Graduate Diploma in Protected Cropping, and 31 of these have completed the Master of Science (Greenhouse Horticulture major). Two students have successfully completed the graduate certificate and 140 students have successfully completed at least one Greenhouse Horticulture subject to qualify with micro-credentials in protected cropping. The independent mid-term review organised by Hort Innovation highlighted that 'this project developed a targeted, technical course for the Australian context to upskill existing employees and promote careers in horticulture'. The project team has received three teaching, education and outreach awards for the excellent work out of this Hort Innovation, industry, and WSU co-funded project. Given that the enrolments are significantly more than the targets (100), this is one of the most successful horticultural courses in Australian in recent years and represents a significant opportunity for Australian horticulture into the future.

## Keywords

Protected Cropping; Greenhouse Horticulture; Micro Credentials; Graduate Diploma; Master of Science; Education and Training; Industry Partner; Industry Development

## Introduction

### Background of the project

**The Opportunity:** Global food demand will require a substantial increase in world food production by 2050. In China and India, food consumption is projected to more than double between 2009 and 2050. Therefore, there will be much demand for high-value and high-quality produce from Australia. The Australian horticulture industry has set bold export targets that would lift export income by hundreds of millions of dollars a year if they are reached. Growth in the export markets has lifted the profile of Australian horticulture, stimulating more interest as some categories pass the tipping point of distributing more volume through export than domestic markets. Total Australian fresh horticulture exports have increased to \$2.81 billion in 2022/23 (Horticulture Statistics Handbook, Horticulture Innovation Australia Limited, 2024). The Australian protected cropping industry is a rapidly developing horticultural sector and in 2017, it was valued at around \$1.5 billion per annum



at the farm gate, up from \$486 million in 2014. This is equivalent to around 15% of the total value of vegetable and cut flower production in Australia (Growing Australian Agriculture 2019). It is the fastest growing food producing sector with an expansion of 5% per annum. In 2022, the gross value of Australian vegetable production was approximately \$4.5 billion, and vegetable exports were about \$393 million (ABARES Agricultural Commodities and trade data, 2024).

**The Issue:** This growth trajectory has led to a substantial shortage of skilled workers, junior growers, middle-level greenhouse managers, senior growers and associated horticultural experts. Consultation with industry at the project's start confirmed that three major growers expect to employ over 300 more full-time employees over the next three years alone, but qualified personnel are not available. This problem is exacerbated by an ageing workforce in the protected cropping industry. Currently, growers are recruiting many of their leadership positions from overseas as they are unable to source qualified candidates from within Australia. This is not only significantly more expensive but offers limited benefits to the industry as recruits are less likely to be retained in the long term.

Education programs relevant to the Australian protected cropping industry are limited. Although there are 3 current vocational training packages, Certificate II, III and IV in Protected Horticulture, only Certificate III has a single registered training organisation (RTO) approved to deliver this qualification (National register of vocational education and training 2024). Data from the National Centre for Vocational Education Research (NCVER 2024) indicates that there are no current enrolments in these courses and no course completions from 2018 to 2022.

Therefore, there is a need for domestic education facilities and programs that reflect the climatic and environmental factors in Australia. The lack of appropriate and available education courses is a key constraint for the horticultural industry and limits its ability to develop a professional workforce that can innovate and adapt to changes in the future. To address this, an educational framework in protected cropping is needed to accommodate participants from industry and to attract and offer new students' opportunities to advance their professional skills along the leadership ladder.

#### **Previous related Hort Innovation investment and other projects:**

Western Sydney University (WSU) and Hort Innovation have invested significant resources to develop the National Vegetable Protected Cropping Centre (NVPCC, MT13041 and VG17003) at the WSU Hawkesbury campus at Richmond NSW, including building a state-of-the-art greenhouse facility, appointing highly skilled technical staff members and delivering key projects related to light modification (VG16070 and P2-012 via CRC Future Food Systems) and pollination (PH16000 and PH19001). The facility is also used extensively for educating and training students in the current Bachelor of Science program.

NSW Department of Education STEM Project: This project focused on translating innovative research into teaching materials suitable for Science, Technology, Engineering and Mathematics (STEM) teaching programs in NSW schools, combining academic and industry contexts. These resources were in video format and included industry professionals and WSU staff. This project provided valuable profiling for protected cropping as a modern, technology oriented, high skill and high value employer. This contributes to enhancing the sector's image and reputation and supporting the early-stage development of the talent pipeline for the industry.

NSW Department of Education Tertiary Pathway in Protected Cropping Project: Western Sydney University developed and delivered a trial Tertiary Pathway program to model a pathway between VET and University qualifications. Four teaching and learning subjects were developed and delivered swiftly and collaboratively to quickly meet the urgent need for local talent in the protected cropping industry. The four Tertiary Pathway subjects are: protected cropping biosecurity and pollination, internship and community engagement, protected cropping plant nutrition, and protected cropping climate control and technology.

The Pathways Project is WSU's answer to the technical skills deficiency amongst prospective entry level or early career employees in the sector. Establishment of the Masterclass supports later career stage employees looking to move into management roles, or potential employees with current university qualifications and represents an important step towards an integrated suite of training to support staff across their career.

Participants who completed this course could potentially help to address the substantial need for leadership skills in the Australian protected cropping industry and played a crucial part in shaping the industry's prosperous future, thus contributing to the vision of the Hort Innovation Leadership Fund to provide opportunities for

horticulture professionals at all stages of their careers to advance along the ladder of leadership.

## Methodology

The project team, which includes academics from Western Sydney University (WSU) and is supported by the industry representatives, has designed, developed, implemented, delivered and refined the Masterclass in Protected Cropping (Graduate Diploma) with flexibility in modes of course delivery to advance the students' professional roles within the protected cropping industry. Upon funding approval, the proposed course went through the usual steps of approval as determined by WSU. The proposed course was subjected to a rigorous evaluation and approval process at WSU and was assessed by national and international experts to ensure the course met the high educational standards as required by WSU. Following this, two independent reviews were conducted: i) organised by the WSU School of Science, reviewed by a panel of horticulture experts from Wageningen University of Research, University of Adelaide, Western Sydney University, and industry leaders, and ii) organised by Hort Innovation, reviewed by RM Consulting Group Pty Ltd. They have reviewed the course subjects and gave high commendations (Appendix 12). Accordingly, the formal education delivered by these courses had strong linkages to industry and prepared them for more challenging professional roles in Australian horticulture.

The Emerging Leaders in Protected Cropping (LP18000) project was established and received overwhelming industry support and ongoing consultation. The project team from WSU developed three courses to bridge the protected cropping career pathway gap, Graduate certificate, Graduate diploma, and Master of Science (Greenhouse Horticulture) (Table 1). The WSU team has designed and delivered a suite of subjects offered as a one-year Masterclass in Protected Cropping (Graduate Diploma in Protected Cropping) and incorporated in the Master of Science (Greenhouse Horticulture). Students may also choose to undertake a subset of the subjects to graduate with a Graduate Certificate or a micro-credential (e.g. one subject).

The WSU project team also delivered specialized subjects under the themes of Science, Technology, Business and Industry-focused Research (Table 2) to allow students to select those subjects best matched to their employers' requirements and career objectives. The intensive on-campus and on-site workshops, delivered at WSU, have been shown to improve students' academic knowledge and practical skills. This is evident through students' feedback to teaching (SFT) and students' feedback to unit (SFU) at the end of each study semester (Appendix 12). Assurance was provided by the academic staff members at WSU and industry partners (i.e. Priva, Syngenta Australia, Green Camel, Green Plus, AIS Greenworks), who possess a profound understanding of subject matter and extensive years of experience in teaching new concepts to the students. Three teaching, education and outreach awards have been received due to the excellent work out of this Hort Innovation, industry, and WSU co-funded project (Appendix 3).

### Course Design and Development

**Table 1. Description of three courses delivered by WSU**

	Graduate Certificate	Graduate Diploma (Masterclass)	Master of Science (Greenhouse Horticulture)
<b>Masterclass</b>	Pathway for industry participants into the masterclass	Yes	No
<b>Compulsory Requirements</b>	4 subjects (not including industry project subjects)	8 Subjects	16 subjects (Including 4 specialist cropping subjects but not the industry projects)
<b>Completion time frame (full time equivalent)</b>	6 months	1 year	2 years
<b>Admission criteria</b>	As for graduate diploma OR 5 years full time	Undergraduate degree or higher in science or related discipline OR	Undergraduate degree or higher in science or a related discipline

	<b>professional experience in related roles and/or related prior learning</b>	<b>Undergraduate degree in any discipline (or higher) AND 2 years full time professional experience in related roles</b>	
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**Table 2. Core subjects for the Masterclass**

Specialist Protected Cropping Subjects	Existing Business Subjects
<ul style="list-style-type: none"> <li>• Plant climate interactions in controlled environments</li> <li>• Advanced greenhouse technology</li> <li>• Greenhouse control systems</li> <li>• Greenhouse crop production</li> <li>• Industry project</li> <li>• Industry project extended</li> </ul>	<ul style="list-style-type: none"> <li>• Business operations and logistics</li> <li>• Strategic business management</li> </ul>

The highlights of the project are:

- Blended learning of the courses is achieved via innovative and high-quality online modules
- Intensive hands-on onsite workshops held on WSU campus (one week each in Autumn and Spring Semesters) provide flexibility to industry participants of the courses.
- Four core subjects were designed in collaboration with Wageningen University, Hort Innovation and industry leaders includes: Greenhouse Crop Production (Dr Robert Sharwood), Plant-Climatic Interactions in Controlled Environment (Dr Jayakumar (Jay) Bose/Professor Oula Ghannoum), Advanced Greenhouse Technology (Dr Michelle Mak), and Greenhouse Control Systems (Professor Zhonghua Chen/Dr Jing He) have been delivered to students since Summer 2020-2024.
- Students are provided scholarships and internships with industry to facilitate work-integrated learning.

**Delivery of the courses**

Each of the four core subjects is taught using a flipped learning model (a type of learning design which encourages learning that is student-centered and incorporates a range of active learning strategies). In each module of a subject, short lecture pods are available to orientate the student to the learning area. A lecture pod is a short (8 to 15 minute) professionally produced video lecture.

Students are supplied with a carefully selected recommended reading list. These readings give the detail of the subject matter in the module.

Weekly tutorials and guest lectures from industry experts and representatives are used to help students to consolidate the learning they have achieved from the pods and readings.

Each subject has a 2.5-day workshop during which students develop hands-on skills in the greenhouse, lab and computer labs. During the workshops, students are assessed on their communication skills and subject understanding through group seminars. The students are encouraged through an assessed seminar to explore the use of technology and science assisting in greenhouse horticulture production, integrated pest management, and environmental control systems.

Assessment across the four core subjects is consistent and comprises of three short on-line tests, a group seminar presentation, Practical report based on an activity in the workshop and a final major essay on a topic related to the subject matter in the course. Please refer to Appendix 2 for more details.

Students enrolled in the research subjects (Industry Project, Industry Project Extended, MSc Research Project, MSc Research Project Extended) had good opportunities to participate in active research projects at the NVPC.

Students in the program integrated their research projects with the work being done by university researchers, and so contributed to some publications (see details in the Refereed scientific publications section, and students' publications on Soilless Australia, Appendix 13)

## Results and discussion

Appendices 1-2 show the WSU academic and teaching teams from Summer 2020 to Autumn 2024, including course coordinators, lecturers, as well as education and technical staff. All the staff members are well-equipped with extensive experience, skills, and knowledge to support the students of this course. Examples of course structures and materials are also provided in the appendices.

Appendix 3 shows three awards received by the WSU project team due to the excellent work out of this Hort Innovation, industry, and WSU co-funded project.

Appendices 4-5 demonstrate the success of this course through students' participation, with 106 graduates (Graduate Diploma and MSc) and 140 micro-credentials awarded (as of 19<sup>th</sup> July 2024). These numbers not only exceed the project target of 100 but also show continuous students' cohort growth from Summer 2020 to Autumn 2024.

Appendices 6-8 provide examples of students' engagement in workshops and various course activities aimed at enhancing their theoretical knowledge and practical skills relevant to each major subject of this course. These activities include laboratory-based experiments, tours, presentations, greenhouse exercises, and computer-based tasks. During the intensive workshops, students had opportunities to network, fulfil some of their assessment tasks, listen to lectures from industry experts and ask questions freely. Students utilised the National Vegetable Protected Cropping Centre (NVPCC) to gain hands-on experiences and skills in crop sampling and analyses.

Appendix 9 showcases assessment tasks designed to enhance students' skills in scientific communication across different audiences, including industry clients, and to improve their research skills. The students having promising assessment tasks were published in an industry magazine (Soilless Australia) and shown in Appendix 13.

Appendix 10 demonstrates a summary table on the allocation of WSU project team members as the primary contacts for the industry partners.

Appendix 11 describes the industry engagement activities carried out throughout the course of this project.

Appendix 12 reports on the feedback from two groups of independent panels organised by the WSU School of Science and Hort Innovation, respectively. It also includes feedback from industry partners and representatives, graduates, and current students on the course and course materials. Examples of formal student feedback on the four core subjects (SFU) and teaching (SFT) from 2023 are provided.

Appendix 13 demonstrates the course promotion strategies that were employed throughout this project, including promotion in cooperation with WSU's Office of Marketing and Communication, and Office of Advancement, promotion through paid advertising, through industry support and engagement, and through media and social platforms.

Appendix 14 provides a copy of the project monitoring and evaluation (M&E) plan that was established in November 2021. The M&E plan is important and act as a guideline for the execution through to the completion of this project.

Appendix 15 contains a copy of the Hort Innovation Project Intellectual Property Register.

Please refer to the appendices section for more details.

## Outputs

### **Table 3. Output summary**

Output (based on the deliverables as per variation agreement)	Description	Detail
1. Eight subjects and four workshops that can be completed either as part of the Masterclass in Protected Cropping (Graduate Diploma) or the Master of Science (Greenhouse Horticulture)	Delivered successfully. Course delivered with elements encompassing Science, Technology, Business, and Industry focused research. The course was designed with flexible modes of delivery to allow concurrent work and study for students in the industry.	The course materials and online lectures are available from Western Sydney University (Permission is required to gain access to the course materials).  (See Appendix 2 on the examples of course structures and materials from Western Sydney University online platform)
2. The qualification will cover off on low and medium as well as high-tech protected cropping	All levels (high, medium and low) of protected cropping are incorporated in the course materials.	Levels of technology are imbedded in modules where appropriate. Reference is made throughout the course to different sectors of the industry, fruiting crops, leafy greens, berries and floriculture
3. A monitoring and evaluation plan with linkage to Hort Innovation and industry objectives	M&E plan was approved in November 2021.	See Appendix 14 on the M&E plan
4. A stakeholder engagement and communication plan	The plan is established. Western Sydney University project members will engage with current and future industry partners.	See Appendix 10 on the allocation of project team members to be the primary contact of the industry partners.
5. Three research publications from the industry-research projects that form part of the teaching program	Exceeded the publication threshold with ten articles.	Please refer to the 'Refereed scientific publications' for the list of publications supported by Hort Innovation (LP18000). Also see Appendix 13 on students' publication in Soilless Australia.
6. Nine milestone reports and a final report	Nine milestone reports completed and accepted by Hort innovation, with achievement to each milestone criteria (Milestones 101-110).	Milestone reports are archived at Hort Innovation.

## Outcomes

Table 4. Outcome summary

End-of-Project Outcomes	Alignment to fund outcome, strategy and KPI	Description	Evidence
<p><b>Number of students participating in course</b></p> <p>285 students were admitted to the course.</p>	<p>The achievements of this outcome align with the theme outcomes of the Hort Frontiers Leadership Fund.</p>	<p>The number of participating students surpassed the project target of 100.</p>	<p>These numbers were extracted from Western Sydney University's student management system.</p>
<p><b>Number of awards of graduate diploma</b></p> <p>106 students have successfully completed sufficient subjects for the Graduate Diploma, 31 of these have continued their studies to qualify for a MSc.</p>	<p>The achievements of this outcome align with the theme outcomes of the Hort Frontiers Leadership Fund by:</p> <p>Achieving an increased pool of professionals with the leaderships skills required to adapt to industry change.</p>	<p>The number of Graduate Diploma awarded surpassed the project total of 40.</p>	<p>These numbers were extracted from Western Sydney University's student management system.</p>
<p><b>Feedback from industry partners</b></p>	<p>Obtained feedback from industry partners on the relevance and applicability of course materials.</p>	<p>By collecting the feedback from industry partners, this ensures a continuous improvement of the course program.</p>	<p>Feedback from industry partners and industry visitors/representatives are included in Appendix 12.</p> <p>A review of the course and course materials by educational and industry professionals at the mid-point of the project gave positive feedback and some suggestions for improvement (Appendix 12).</p>
<p><b>Scholarships and Internships</b></p>	<p>During the project 19 students have been awarded industry funded scholarships, with 11 scholarships to be awarded soon.</p> <p>A total of 13 students have completed internships with industry partners.</p>	<p>The number of scholarships available to students has been increased by the generous involvement of additional industry partners.</p>	<p>Data from WSU Scholarship Office was retrieved and presented in Table 6.</p>
<p><b>Development of Industry</b></p>	<p>Industry partnerships expanded beyond the major growers</p>	<p>In addition to industry funded scholarships, industry partners have</p>	<p><b>PRG</b> Hort Innovation Costa Group</p>

<b>partnerships</b>	and suppliers to include participants from across the protected cropping sector.	contributed to the success of the course by providing advice via the project reference group, providing internships and there has been the generous provision by industry members for lectures and tutorial content.	Perfection Fresh Flavorite Group AIS Greenworks Lynch Group Protected Cropping Australia  <b>Internships</b> Flavorite Group Perfection Fresh Costa group Southern Cross Produce Green Camel  <b>Guest lectures</b> Priva GreenPlus AIS Greenworks Green Camel Syngenta Genesis Horticultural Solutions Queensland DAF
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More details are presented below:

1. Number of students participating in the course. Number of awards of Graduate Diploma (including the total number of students who admitted to the course, total enrollment in each subject and total of micro credentials)

Overall, 285 students were admitted to the course. There are a total of 106 students (Appendix 4) who have completed the Graduate Diploma in Protected Cropping, with 31 of them completed the Master of Science degree (Greenhouse Horticulture major). Two students have graduated at certificate level to date. The number of students who enrolled in each respective subject are summarised in Table 5. To date, 140 students have completed one subject in protected cropping, which will allow them to receive a micro credential in protected cropping (Appendix 4).

**Table 5. Subject enrolments and successful completions**

	Subject Name	Total number of students enrolled from Summer 2020-Autumn 2024
<b>HORT 7001</b>	Advanced Greenhouse Technology	180
<b>HORT 7006</b>	Plant Climate Interactions	186
<b>HORT 7002</b>	Greenhouse Control Systems	200
<b>HORT 7003</b>	Greenhouse Crop Production	221

## 2. Feedback from industry partners

Please refer to Appendix 12.

## 3. Scholarships and internships (Number of students receiving industry scholarships and participating in internships)

### A) Scholarships

Throughout this project, 19 students have been awarded with industry funded scholarships, with 11 scholarships to be awarded soon.

**Table 6. Scholarships provided by industry partners**

Company	Number of scholarships provided
AIS Greenworks/ICI Industries	3
Costa Group	4
Flavorite Group	4
Lynch Group	3
Perfection Fresh	4
Enza Zaden	2
GreenPlus	4
Protected Cropping Australia	4
Yara Australia	2

## B) Internships

There has been strong interest from students enquiring about internships in every semester throughout the duration of the project. However, there have been practical difficulties such as accommodation and transport in the geographic locations that internships are on offer. Despite this, a total of 13 students have completed internships with industry partners. The number of completed internships are summarised in Table 7.

**Table 7. Internship completed at the industry partners' facilities.**

Supporting Company	Number of Internships hosted throughout the course of the project
Flavorite Group	4
Green Camel	5
Southern Cross Produce Brisbane	2
Perfection Fresh	1
Costa Group	1

With the processing of the scholarship and internship applications earlier in 2024, it is hoped that students selected for internships will have more time to prepare transport and accommodation to participate in internships over the summer university break. Negotiations on internship opportunities with industry partners for the 2024/25 summer break are ongoing.

## 4. Development of Industry partnerships

Up until Autumn 2024, new industry partnerships have been developed throughout this project, with internships being offered to students from Southern Cross Produce and Green Camel, as well as scholarships from Lynch Group, Enza Zaden, Yarra Australia, and GreenPlus Australia in addition to continued support from the original industry partners. Protected Cropping Australia have continued their support of the program by offering scholarships.



## Monitoring and evaluation

### Report against the project M&E Plan

#### 1. To what extent has the project achieved its expected outcomes?

**What is the number of students who have been admitted to the course? How many students have enrolled in units?**

Issues associated with COVID19 lockdowns and state, and international border closures impacted the student numbers for this course in 2020 and 2021. However, there has been a substantial increase in the number of enrolments since the Spring intake of 2022, when the Australian borders reopened. The opening of both state and international borders post Covid19 restrictions has substantially increased student numbers in these programs. In Autumn Semester 2024 however, the number of students has decreased due to the strict new visa policy for international students (Table 8).

**Table 8. Subject enrolments and successful completions**

Subject code	Subject name	Summer 2020	Autumn 2021	Spring 2021	Autumn 2022	Spring 2022	Autumn 2023	Spring 2023	Autumn 2024	Spring 2024
HORT 7001	Advanced Greenhouse Technology	4		3		48		104		*69
HORT 7007	Plant Climate Interactions	1		11		43		103		*85
HORT 7002	Greenhouse Control Systems		7		17		84		68	
HORT 7003	Greenhouse Crop Production		10		23		91		67	
		COVID restrictions				Australian borders open				

\*Table 8 shows the number of successful completions of the four core protected cropping subjects except for the current semester (Spring 2024). Note these are updated numbers based on the student records held by Western Sydney University.

**Figure 1. Number of student enrolment in protected cropping subjects (from Summer 2020-Autumn 2024)**

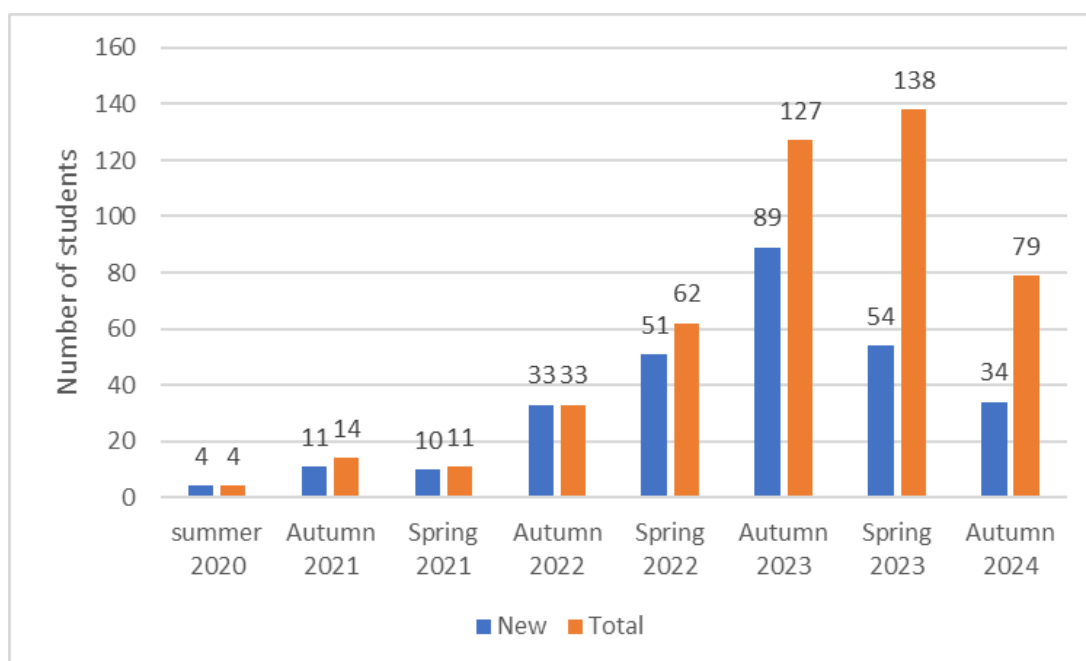


Figure 1 shows both the new and total number of students enrolled in the four core protected cropping subjects (Advanced Greenhouse Technology, Plant Climate Interactions, Greenhouse Control Systems, Greenhouse Crop Production) during each study semester, starting from Summer 2020 to Autumn 2024. The reported number of new students in Blue, refers to those who had their first enrollment in the course in that semester, whereas the total number of students in Orange, refers to the total students enrolled in the two core subjects available in each semester. The enrolments in research and business subjects are excluded from the presented data. It is noted that industry professionals and most students seeking to get into the protected cropping workforce are selecting the four core cropping subjects.

**How many students have completed the various credentials offered within the course?**

Throughout the course of this project, a total of 106 students have completed the Graduate Diploma in Protected Cropping subjects and 140 students have completed one subject in protected cropping, which will allow them to receive a micro credential in protected cropping (Appendix 4).

**Achievement of revised project enrolment and completion targets for semester 1 2024. (Target number of graduates: a further 14 based on a graduation rate of 40% and Completion of micro credentials: a further 15**

Overall, excellent progress has been made in relation to the revised project enrolment and completion targets. The revised project target is achieved for semester 1 2024.

Some of these students have commenced their work in horticulture and many others are looking for graduate jobs or other relevant industry opportunities.

**How many locations have been used for on-site workshops?**

Throughout the duration of the project, the onsite workshops have been held on the Hawkesbury campus of WSU.

**What is the take up by students and industry of internships?**

There has been strong interest from students enquiring about internships in every semester throughout the course of the project. However, there have been practical difficulties such as accommodation and transport. Despite this, a total of 13 students have completed internships with industry partners.

### **To what extent has the recruitment strategy been successful?**

Recruitment of students into the MSc program to this course has been very successful, especially overseas students. An intensive recruitment strategy supported by advertising in industry journals including Vegetables Australia, Berries Journal, Flowers, HFF magazine, Soilless has been started since 2023 and maintained until the end of the project in 2024. Additionally, in 2024, Australian Tree Crop Magazine has been added to expand our recruitment strategy. Furthermore, WSU has had a booth at the PCA conference in 2019, 2022 and 2023 to inform industry participants of course offerings and to build relationships in the industry. The project leader and a representative of project team also attended Hort Connections in Adelaide in June 2023 and in Melbourne in June 2024, respectively. Please refer to appendix 13 on some examples.

### **To what extent has there been development of additional industry partnerships.**

New industry partnerships have been developed throughout the course of this project with internships being offered to students from Southern Cross Produce, Green Camel, and scholarships from Lynch Group, Enza Zaden, Yarra Australia, and GreenPlus Australia in addition to continued support from the original industry partners. Protected Cropping Australia have continued their support of the program by offering scholarships.

## **2. How relevant was the project to the needs of intended beneficiaries? How relevant was the course as perceived by;**

### **(a) Participating students**

Students have found the courses relevant to their needs, and many students applied for scholarships and summer internships to increase their knowledge and skills in the industry.

### **(b) Industry partners**

There has been strong engagement with the industry partners throughout this project in terms of support on the PRG, funding of scholarships and offering internships for the students in the Graduate Diploma and Master of Science courses. In addition to scholarships and internships, there has been significant interaction with industry experts providing lectures and tutorials in subjects within the course. One of the participating students became a director of Southern Cross Produce Brisbane, which is now a new industry partner.

### **(c) Protected cropping industry employers**

Protected cropping industry employers are very interested in getting their staff members trained in the Hort Innovation funded protected cropping courses. One of the good examples is that Green Camel has two current staff members (General Manager and Assistant Grower) from our courses. We have received positive feedback from internship providers on the knowledge and skills of the interns.

Please see Appendix 12 for Formal Student Feedback to Unit (SFU), Student Feedback to Teaching (SFT), feedback from graduated students and industry partners, course review input from industry and university experts.

## **3. How well have intended beneficiaries been engaged in the project?**

### **What engagement has there been with the industry about this project?**

The increase in supporting commercial partners throughout this project shows significant engagement and support from the horticultural industry.

Please refer to Appendix 11 on the industry engagement activities.

### **Did every company engage in the project via the Project Reference Group?**

There has been involvement from the foundation partners as members of the PRG since 2019, except for one partner. A new partner Lynch Group was added to the PRG with approval from the current PRG members on 23 June 2023.

### **Student feedback, through formal and informal course feedback mechanisms.**

Student feedback comes from optional course feedback at the end of semester's courses each year (those formal

university students' feedback can be obtained upon request through WSU Student Service). Some detailed examples of student feedback are shown in Appendix 12.

Student feedback is our most valuable tool to assess the impact of our work. It looks beyond the grades that a cohort may achieve, which tells us that the subject level of difficulty is pitched correctly and that the assessments are well designed. Instead, it gives us a true insight into the value of the learning experience and the impact on the individual. When building a new education offering, it is one thing to collect information and make facilities available. It is wholly another to teach someone beyond the point of exposure to new knowledge, and into a deeper understanding, where they can apply what they know, stand confident in their abilities and become an industry leader.

#### **What opportunities were afforded to students to demonstrate leadership in the industry?**

WSU have encouraged students to participate in industry conferences and have set assessment tasks which can be used as articles in industry publications. Past students have demonstrated strong leadership in the industry, with one student receiving PCA's young grower of the year award, and an award from the organic industry in 2022. Another student, Olumuyiwa Elliott, participated in the student presentations at the PCA conference and International Student Summit (ISS) hosted by Tokyo University of Agriculture in 2022. Elliott won the First Prize for his Research Presentation as a Master of Science (Greenhouse Horticulture) student representing Western Sydney University in 2023. He also received the RodTallis award from The International Plant Propagation Society, Australia region, for his Master of Science research in the same year. Furthermore, Elliott was named the 2023 Young Horticultural Leader by the Nursery and Garden Industry Victoria, and received the 2023 Industry Development award from Protected Cropping Australia.

See Appendix 13 on student publications and Appendices 9 and 12 on student presentations.

## **4. What efforts did the project make to improve efficiency?**

### **How are the funds used efficiently for personnel and teaching?**

#### **Guest lecturers**

Most of the guest lecturers are either industry experts or academic staff members of WSU in this project. We only paid three guest lecturers out of eight industry experts to contribute to the classes.

#### **Course promotions on site and online**

The courses were heavily promoted at Protected Cropping Australia Conference in 2019 and 2022 and Hort Connections 2024. WSU was conference partner and had a booth at each of the conferences to promote our course and research work. See Appendix 11 for more details.

Paid advertising in two industry publications (Soilless Australia and HFF Newsletter) had occurred throughout the duration of the project supplemented with the course promotional articles. Moreover, the continuing advertising strategy encompassing the horticultural sectors that utilise protected cultivation, featuring in a range of industry publications developed for 2023, has been extended until the end of the project in 2024. Refer to Appendix 13 for more details.

#### **In-kind contributions**

Throughout the workshops held so far, we were pleased to welcome contributions from Syngenta, Priva, ICI industries (Greenworks), Protected Cropping Australia, Green Camel, Graeme Smith Consulting, GreenPlus, Genesis Horticultural Solutions and Department of Agriculture and Fisheries Queensland who provided lectures and tutorials to the students.

#### **University funded lecturers**

The cost of the lecturers (Dr Michelle Mak, Dr Jayakumar Bose, Dr Robert Sharwood, Prof. Zhonghua Chen, Dr Jing He from School of Science, and two lecturers from School of Business) for these subjects is met by the university as part of the LP18000. Support for these lecturers in terms of subject development, tutorials and marking are funded by this project.

### Delivery of a flexible course

All the subjects for this course have been developed and have been refined following each delivery. The high enrolment of students in the course has significantly increased the workload of the teaching and administration staff, however the high quality of course delivery has been maintained. The quality of the course has been recognised by The Australian Society of Plant Scientists with the award of their Education and Outreach award in December 2023 (Appendix 3). The teaching team was also awarded the Western Sydney University Team Teaching excellence award and teaching award from Australian Institute of Horticulture (See Appendix 3). The teaching was delivered online and onsite for domestic and international students studying those core protected cropping subjects. This is reflected in the excellent student feedback of the course (Appendix 12).

### Suggested continuous improvement opportunities for improvement and future development of the course in response to the Key Evaluation Questions

Refinement of the course materials to respond to changes and technology within the protected cropping industry, development of on-farm intensive workshop towards micro-credentials for employees of protected cropping companies, and potential offering of modified version of the courses through the WSU Indian and Indonesia Campuses in 2025-2026 to sustain the courses and attract international talent to the Australian horticultural industry.

## Issues and Risks

Although the project was affected by COVID lockdowns and international border closure, causing low student numbers in 2020 and 2021. From 2022 to 2024, students' numbers progressively increased and exceeded all targets.

## Recommendations

Some of the approaches from this course are relevant for any future courses in protected cropping:

- Part time/flexible delivery and online to fit in with busy work schedules.
- Small units or modules can build to a formal qualification or stand alone.
- Support of Industry through scholarships and internships.
- A combination of theoretical knowledge and practical skills.

Some constraints which this university-based model has encountered are:

- University entrance requirements into undergraduate or postgraduate programs mean that many people in the industry are unable to enrol.
- The high cost of university education. For most of the duration of this program Fee-help was unavailable for domestic students until 2024, making this masterclass program very expensive.
- More support from industry to develop graduates with suitable job-ready skills.

This course did not attract large number of domestic students, and less participants from the industry. This is consistent with the poor take-up of Vocational Education and Training (VET) courses in protected cropping. Although there are 3 current vocational training packages, Certificate II, III and IV in Protected Horticulture, only Certificate III has a single registered training organization (RTO) approved to deliver this qualification (National register of vocational education and training 2024). Data from the National Centre for Vocational Education Research (NCVER 2024) indicates that there are no current enrolments in these courses and no course completion from 2018 to 2022. Students in the Diploma of Production Horticulture (the only relevant AQF 5 qualification for this sector) are scarce with only one VET RTO registered to deliver this qualification, and NCVER 2024 indicating no course completions nationally over the most recent years reported (2021 and 2022).

Another education model which bears consideration are extension courses offered by government and industry bodies. These are usually a few hours or a single day and are focused on very specific issues. These types of education courses can be on site or delivered remotely. The take-up of PCA webinars recently is good example of this model in action. Growers can also take the opportunities offered overseas such as Indoor Science Ag Café and from Hort Americas.

Given the constraints of time and money which seem to be inhibiting the take up of specialist horticultural education it is time to consider short, focused courses delivered across 1 or 2 days on specific topics. This might

be a viable model to investigate and then formalise the qualifications into an educational portfolio which could be recognized by VET and/or universities towards more formal qualifications via advanced standing into university courses, or recognition of prior learning (RPL) for VET courses.

#### Future directions for the protected cropping courses

1. This course has proven to be a flagship and highly successful course that will be continued to be delivered by Western Sydney University. Based on student enrolments, this course is now self-sustaining.
2. The course materials will be continually updated for relevance and to cater to the current trends in the horticultural industry.
3. The strong partnerships with industry will be maintained to support student learning, scholarships and internships.
4. A continued and targeted approach will be employed to match interested students to internship opportunities with excellent partnerships between Australia horticultural sector, Hort Innovation and WSU.
5. Scholarships will be awarded to high achieving students based on academic success within their candidature.
6. To entice more domestic students to undertake the protected cropping courses, FEE-HELP needs to be continued beyond 2024.

#### Refereed scientific publications

Many students in the LP18000 project have been involved in the research work as part of their Industry Project and MSc Research Project. The research results were included in their assignments and were also disseminated in the following publications. Hort Innovation and industry supported LP18000 project is acknowledged in these publications.

Samaranayake, P., Liang, W., Chen, Z.H., Tissue, D., Lan, Y.C., 2020. Sustainable protected cropping: A case study of seasonal impacts on greenhouse energy consumption during capsicum production. *Energies* 13(17), p.4468.

He, X., Chavan, S.G., Hamoui, Z., Maier, C., Ghannoum, O., Chen, Z.H., Tissue, D.T., Cazzonelli, C.I., 2022. Smart glass film reduced ascorbic acid in red and orange capsicum fruit cultivars without impacting shelf life. *Plants* 11(7), p.985.

Lin, T., Goldsworthy, M., Chavan, S., Liang, W., Maier, C., Ghannoum, O., Cazzonelli, C.I., Tissue, D.T., Lan, Y.C., Sethuvenkatraman, S., Lin, H., 2022. A novel cover material improves cooling energy and fertigation efficiency for glasshouse eggplant production. *Energy* 251, p.123871.

Rasouli, F., Babla, M., Li, L., Liang, W., Yong, M.T., Ahmed, T., Tissue, D., Huda, S., Chen, Z.H., 2022. Physiological and Yield Performance Is Partially Linked to Water Use Efficiency of Eggplant Genotypes in a High-Tech Glasshouse. *Horticulturae* 9(1), p.19.

He, X., Solis, C.A., Chavan, S.G., Maier, C., Wang, Y., Liang, W., Klause, N., Ghannoum, O., Cazzonelli, C.I., Tissue, D.T., Chen, Z.H., 2023. Novel transcriptome networks are associated with adaptation of capsicum fruit development to a light-blocking glasshouse film. *Frontiers in Plant Science* 14, p.1280314.

Maier, C.R., Chavan, S.G., Klause, N., Liang, W., Cazzonelli, C.I., Ghannoum, O., Chen, Z.H., Tissue, D.T., 2023. Light blocking film in a glasshouse impacts *Capsicum annuum* L. yield differentially across planting season. *Frontiers in Plant Science* 14, p.1277037.

Sharma, S., Fang, G., Chen, Z.H., Obst, O., Tissue, D., Zou, J.J., Liang, W., 2023. Capsicum Flower Identification for Robotic Pollination in Greenhouses. In: 2023 International Conference on Machine Learning and Cybernetics (ICMLC). IEEE, pp. 520-527.

Sonali, Huda, S., Jayasena, V., Ahmed, T., Chen, Z.H., 2023. Potassium transport and use efficiency for sustainable fertigation in protected cropping. *Journal of Sustainable Agriculture and Environment* 2(3), pp.346-356.

Islam, M.M., He, J., Yong, M., Babla, M., Liang, W., Li, L., Bose, J., Donovan-Mak, M., Huda, S., Tissue, D., Ahmed, T., 2024. Reduced fertigation input sustains yield and physiological performance for improved economic returns and cleaner production of greenhouse eggplant. *Scientia Horticulturae*, 331, p.113097.

Lin, T., Maier, C.R., Liang, W., Klause, N., He, J., Tissue, D.T., Lan, Y.C., Sethuvenkatraman, S., Goldsworthy, M. and Chen, Z.H., 2024. A light-blocking greenhouse film differentially impacts climate control energy use and capsicum production. *Frontiers in Energy Research* 12, p.1360536.

## References

ABARES. Agricultural commodities and trade data, 2022.

<[https://www.agriculture.gov.au/abares/research-topics/agricultural-outlook/data#\\_2022](https://www.agriculture.gov.au/abares/research-topics/agricultural-outlook/data#_2022)>

Hort Innovation Australia Limited. Australian Horticulture Statistics Handbook 2022/23, 2024.

<<https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/australian-horticulture-statistics-handbook/>>

Protected Cropping Australia. Growing Australian Agriculture Submission, 2019.

<<https://www.aph.gov.au/DocumentStore.ashx?id=c38d2f99-5bd8-4d6a-9e28-8e65642df4a4&subId=671583>>

National Centre for Vocational Education Research (NCVER), 2024.

<<https://www.ncver.edu.au/research-and-statistics/data/databuilder>>

Australian Government. National register of vocational education and training 2024

<<https://training.gov.au/>>

## Intellectual property

This program developed new IP through the development of a course that meets Australian industry needs. The content was developed in partnership with Hort Innovation, with ownership based on Commercialisation under Clause 16.1 (b) of the Research Agreement Frontiers terms. Project IP developed in this project is assigned to Western Sydney University after a five-year co-investment period. This discussion will occur after 30 June 2024 between Hort Innovation and Western Sydney University. An IP Register has been maintained during the life of the investment and updated annually. [See Appendix 15 for more details.](#)

## **Appendices**

***Appendix 1. Teaching team for Protected Cropping Course***

***Appendix 2. Examples of course structures and materials***

***Appendix 3. Three awards received by the LP18000 project team in promoting Australian horticulture***

***Appendix 4. Students identifying numbers of the various graduates***

***Appendix 5. Student Cohort Growth from 2020-2024***

***Appendix 6. Students' workshops from 2020-2024 (guest speakers invited)***

***Appendix 7. Face-to-face on campus workshop schedule examples***

***Appendix 8. Course activities***

***Appendix 9. Students' assessments examples***

***Appendix 10. Allocation of project team members to be the primary contact of the industry partner.***

***Appendix 11. Industry engagement activities***

***Appendix 12. Feedback from industry partners, students, graduates, and independent panels***

***Appendix 13. Course promotion strategies***

***Appendix 14. Project Monitoring and Evaluation (M&E) Plan***

***Appendix 15. Hort Innovation Project Intellectual Property Register***



## Appendices

### Appendix 1. Academic and Professional team members for Protected Cropping Courses

#### Lecturers of the Protected Cropping Courses



*Prof. Zhonghua Chen*



*Assoc. Prof. Oula*



*Dr. Jayne Bye*



*Dr. Robert Sharwood*



*Dr. Michelle Mak*



*Dr. Henry Lau*



*Dr. Premaratne Samaranyake*



*Dr. Ryan McQuinn*



*Prof. Yi-Chen Lan*



*Assoc. Prof. Robert Spooner*



*Dr. Jayakumar Bose*



*Assoc. Prof. Yi Guo*



*Dr. Jing He*

#### Education and technical staff



*Dr. Wei Liang*



*Mr. David Randall*



*Dr. Sachin Chavan*



*Ms. Chelsea Maier*

## Appendix 2. Examples of course structures and materials

### i) Layout of student learning platform (vUWS)

The screenshot shows the vUWS interface for the course '301357 (Spring 2020) Plant-Climate Interactions In Controlled Environments'. The left sidebar contains navigation menus for Home, Learning Zone (Learning Modules, Recordings), Communication Zone (Announcements, Discussion, Online Meetings), Assessment Zone (Assessment 1-4), and Support Zone. The main content area features a vertical list of course components: Welcome, Getting Started, Unit Learning Outcomes, Workshop Schedule, Learning Guide & Unit Outline, Teaching Staff, Assessment Summary, and Technical Skills and Recommended Software. Each item has a plus icon to expand it. The course title and Western Sydney University logo are at the top right.

### (ii) Example of the subject topics and contents

The screenshot displays the 'Subject Topics and Contents' page with four modules:

- Module 1 - Introduction:** Focuses on crop production, studying factors like light, CO2, and temperature. Includes a photo of a greenhouse.
- Module 2 - Plant Physiology Basics:** Covers plant physiology components like photosynthesis, respiration, and transpiration. Includes a diagram of a plant.
- Module 3 - Photosynthetic Variables:** Examines climatic factors like light, CO2, and temperature, and their effects on photosynthesis. Includes a diagram of a tree.
- Module 4 - Light & Plant Function:** Discusses the electromagnetic spectrum and its effects on plants. Includes a spectrum diagram.
- Module 09 - Advanced Light Technology:** Details lighting types (LED, fluorescent) and their application in greenhouses. Includes a photo of a modern greenhouse.
- Bonus: Module 10 - Sustainable Development Goals:** Links course content to the UN Sustainable Development Goals.

### (iii) Student assessment tasks

Subject	Ass. 1	Ass. 2	Ass. 3
Greenhouse Crop Production	Quizzes x3 30% (Individual)	Report & Presentation 30% (Group)	Essay 40% (Individual)
Plant-Climate Interactions in controlled environments	Quizzes x3 30% (Individual)	Report & Presentation 30% (Group)	Essay 40% (Individual)
Advanced Greenhouse Technology	Quizzes x3 30% (Individual)	Report & Presentation 30% (Group)	Essay 40% (Individual)
Greenhouse Control Systems	Quizzes x3 30% (Individual)	Report & Presentation 30% (Group)	Essay 40% (Individual)

**Appendix 3. Three awards received by the LP18000 project team in promoting Australian horticulture**

i) Award of Merit for the LP18000 project team in promoting Australian horticulture



12<sup>th</sup> October 2020

Prof. Zhonghua Chen

Dear Prof. Zhonghua Chen and his team,

The Australian Institute of Horticulture has immense pleasure in announcing that you are the recipient of the **Award of Merit**.

On behalf of the Australian Institute of Horticulture, we congratulate you on the wonderful work that you do in supporting and raising awareness of the importance of horticulture in today's world.

2020 has seen many events cancelled and our annual dinner and awards night was one of them. This came with great disappointment as this was also our 60th anniversary. We will make arrangements to present the award to you in the near future and also invite you next year's celebrations in Sydney.

The AIH wishes you well for your current and future endeavours.

Yours sincerely

Michael Casey  
President AIH

**Australian Institute of Horticulture Inc.**  
PO Box 2238 Toowong, Qld, 4066 Australia  
P: (02) 8001 6198 info@aih.org.au www.aih.org.au



ii) Education and outreach award for Professor Zhonghua Chen



AUSTRALIAN SOCIETY  
OF PLANT SCIENTISTS

The Australian Society of Plant  
Scientists proudly presents the  
2023

Education and Outreach Award  
to

Professor Zhonghua Chen

in recognition of his role in  
excellence and innovation in  
teaching plant science at  
University level.

ASPS President

Date

*Alex The Ludwig*

11 December 2023

iii) WSU Staff Excellence Award for the teaching team of Protected Cropping Masterclass (Professor Zhonghua Chen, Professor Oula Ghannoum, Dr Robert Sharwood, Dr Jayakumar Bose, Dr Michelle Mak, Mr David Randall, Dr Jing He)



School of Science  
Staff Excellence Award 2023

**WINNER**

**EMERGING LEADERS IN PROTECTED  
CROPPING MASTER CLASS  
TEACHING TEAM  
for  
TEACHING EXCELLENCE - TEAM**



A handwritten signature in black ink, appearing to read "Graciela Metternicht".

Professor Graciela Metternicht  
Dean, School of Science

**Appendix 4. Students identifying numbers of the various graduates**

i) 106 Graduates (Graduate Diploma and Master of Science degree)

List of students identifying numbers of the 75 students who completed the Graduate Diploma

Student ID					
22031706	22057809	22076753	22055601	22031860	22085204
22027144	22060843	22076996	22057612	20684206	22088826
22048378	22060853	22081107	22057618	22056605	22092112
22047825	22061022	22085874	22060218	22056150	22092336
22047823	22061035	22039860	22060334	22056772	22092909
22040208	22068768	22050326	22060733	22070165	22094326
22054546	22068995	22060439	22080685	22076029	22101278
22023779	22070144	22074372	22080959	22058019	22106322
22049717	22070242	22074787	22082876	22068226	22108125
22050319	22074616	22032991	22085868	22069852	22109853
22050930	22075226	22083846	22057402	22075777	22094090
22052016	22075562	22055999	22060875	22078328	22107652
22055084		22032443	22075522		

List of students identifying numbers of another 31 students who continued and completed the Master of Science in Greenhouse Horticulture major

Student ID			
19827588	22023468	22028073	22041175
20214614	22032128	22032022	22046242
20256151	22032470	22048221	22040072
20486118	22032988	22050290	22048782
20498085	22040195	22050673	20077538
20550471	22041239	22051052	22034291
20562478	18080995	22051214	22040982
20788520	22027817	22034264	

ii) Graduate certificate recipients

Student ID
20665294
20312842

iii) Completion of micro credentials: 140 students. All these students have completed at least one of the protected cropping subjects and associated workshop.

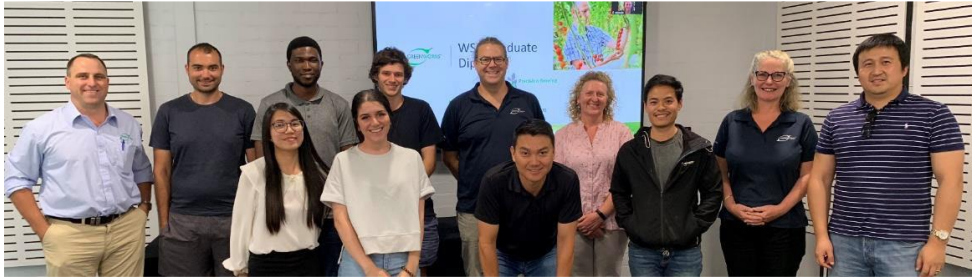
Student ID					
19235673	22078623	22055384	22119168	22101440	22049998
22078641	22023981	22047947	22121076	22094716	22053005
22093778	22031891	22050900	22122027	18975198	22051018
22057739	22046585	22069695	22134283	20019307	20789060
22075182	22076689	22043984	22134439	20027735	22077388
22098150	22093800	22077632	22134832	20027849	22081082
20659918	22076039	22055271	22135770	20028868	22060616
20644231	22108787	20473176	22136380	20029294	20437679
20662745	22107358	20641418	22136731	20195801	20485102
20582991	18006331	22027551	22145485	20434625	20241285
22031517	20258418	22047634	19584124	20436533	20446563
22044587	20317850	22050233	19994778	20449982	22078054
20789813	20655105	22060080	22081126	20473248	22083326
22048401	20679343	22103987	22107533	20636412	22032347
22032131	22023204	22081116	22109719	20599847	22073863
20792826	22024748	22076611	22119307	20278944	22077888
22050926	20655831	22105123	22122019	20092968	22028081
22027174	22032969	22107087	22132706	20750666	22050890
22052439	22024017	22107102	22134267	22048041	22022346
22051124	20310774	22113607	22134637	22048678	22040435
22077827	20289137	22113621	22136891	22050502	22108927
22073946	22047938	22114097	20256500	22054181	22080585
22074811	22051234	22115509	22023857	22047916	22053689
22024675	22041078				



**Appendix 5. Student Cohort Growth from 2020-2024**



Student Cohort: 2019 and some of the original teaching team



Student Cohort: Spring 2021



Student Cohort: Spring 2022



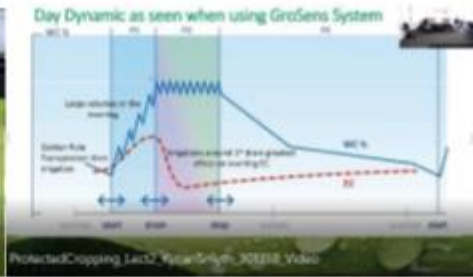
Student Cohort: Autumn 2023



Student Cohort: Autumn 2024



**Appendix 6. Students' workshops from 2020-2024 (guest speakers invited)**



Guest speakers 2020: Nicky Mann (then PCA Chair) from Family Fresh Farms, and Kynan Smyth from AIS Greenworks



Guest speakers 2021: Industry expert Tony Bundock (online from Melbourne)



Guest speakers 2023: Prof. Yi-Chen Lan: Business and sustainability expert, and Andrew McIlwain from Green Camel



This is an ex-student presenting at the Autumn 2023 Greenhouse Crop Production Workshop.



Guest speakers 2024: A/Prof Yi Guo: Data Science and AI expert, and Industry expert Graeme Smith

## Appendix 7. Face-to-face on campus workshop schedule examples

Workshops for [Crop & Production Management](#) (linked to [Plant-Climate Interactions](#)) and [Fertigation Systems](#) (linked to [Advanced Greenhouse Technology](#))

Date	Monday 7 Dec 2020	Tuesday 8 Dec 2020	Wednesday 9 Dec 2020	Thursday 10 Dec 2020	Friday 11 Dec 2020
8:30am – 10:30am	8:30 - 9:30am Lecture 1 - Opening Presentation Nikky Mann (PCA Chair) (Industry Expert) <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	8:30-9:30am Lecture 4 – SmartGlass David Tissue <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Group presentations for Plant-Climate Interactions (Marking Session) Oula Ghannoum & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	8:30 - 9:30am Lecture 3 – Biofortification Zhonghua Chen <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Group presentations for Advanced Greenhouse Technology (Marking Session) Michelle Mak & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>
	9:30 - 10:30am Lecture 2A - Photosynthesis in crop production Ghannoum <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	9:30-10:30am Lecture 5 Industry Expert – Marcus Van Heijst <a href="#">Zoom "GalleryRoom" – L2.G.13</a>		9:30 - 10:30am Lecture 4 – Fertigation, water, and practical nutrient recycling Tony Bundock (Industry Expert) <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	
10:30am – 11:00am	Morning Tea Break	Morning Tea Break	Morning Tea Break	Morning Tea Break	Morning Tea Break
11:00am – 12:00pm	Lecture 2B – Photosynthesis in crop production Oula Ghannoum <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 6 – plant phenotyping Zhonghua Chen <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Research Tour Plant-Climate Interactions on a Macro-Environmental Scale <a href="#">EucFACE &amp; Whole Tree Chambers</a>	Lecture 5 - Medicinal Cannabis Emily Rigby (Industry Expert) <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 8 – Protected Cropping in the tropics Elio Jovicich (Industry Expert) <a href="#">Zoom "GalleryRoom" – L2.G.13</a>
12:00pm – 1:00pm	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
1:00pm – 3:00pm	1:00pm – 1:30pm Greenhouse Safety Induction – Chelsea Maier <a href="#">S40 Greenhouse Education Bay</a> 1:30 – 3:00pm Tutorial 1 - Low, med & high-tech systems Tony Bundock (Industry Expert) <a href="#">S40 Greenhouse Education Bay</a>	Tutorial 2 - Group presentation planning session Michelle Mak & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	1:00 - 2:00pm Lecture 1 - Introduction to Fertigation System & unit discussion Michelle Mak <a href="#">Zoom "GalleryRoom" – L2.G.13</a> 2:00 - 3:00pm Lecture 2 - Growing substrates and Rockwool Henry Bosman <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Tutorial 1 – Group Presentation planning session Michelle Mak & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Practical 3 – Lab: sap test K <sup>+</sup> , Ca <sup>2+</sup> discussion, measure for chlorophyll a & b Michelle Mak & David Randall <a href="#">S12.01.01 Entomology lab</a> <a href="#">S8.G.Prep-Room</a>
3:00pm – 3:30pm	Afternoon Tea Break	Afternoon Tea Break	Afternoon Tea Break	Afternoon Tea Break	Afternoon Tea Break
3:30pm – 5:30pm	Practical 1 – Oula Ghannoum fluorescence, PAM, & Licor on Eggplant <a href="#">S40 Greenhouse Research Bay</a>	Practical 2 – Chelsea & David Randall (reflectance, radiospectrometer, other sensors) <a href="#">S40 Greenhouse Multiple Bays</a>	Practical 1 – Fertigation experimental design, yield, fruit size, sample for chlorophyll) Wei Liang & David Randall <a href="#">S40 Greenhouse Education Bay</a>	Practical 2 – MM & DR (sampling from gutters EC, SPAD – new and old leaves) <a href="#">S40 Greenhouse Education Bay</a>	3:30pm – 5:30pm Wrap up session – student feedback opportunity <a href="#">Zoom "GalleryRoom" – L2.G.13</a>
5:30pm – 7:00pm	Networking Session				Networking Session

Workshops for [Software and Hardware Systems](#) (linked to [Greenhouse Control Systems](#)) and [Crop and Produce Management](#) (Greenhouse Crop Production)

Date	Monday 26 April 2021	Tuesday 27 April 2021	Wednesday 28 April 2021	Thursday 29 April 2021	Friday 30 April 2021
8:30am – 10:30am	Lecture 1 – Australian Protected Cropping Systems Graeme Smith (Industry expert, Graeme Smith Consulting) <a href="#">Zoom "GalleryRoom" – L2.G.13</a> Lecture 2 - Introduction to Software and Hardware System & unit discussion Prof. Zhonghua Chen <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 4 - Priva System: software and hardware Macus van Heijst (industry expert, Priva) <a href="#">Zoom "GalleryRoom" – L2.G.13</a> Lecture 5 – Systems approaches of sustainable greenhouse design Dr Premaratne Samaranyake <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Group presentations for Greenhouse Control Systems (Marking Session) Prof. Zhonghua Chen & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 9 - Greenhouse Crop Molecular Genetics Dr Robert Sharwood <a href="#">Zoom "GalleryRoom" – L2.G.13</a> Lecture 10 - Greenhouse Crop Protection - pests A/Prof. Robert Spooner-Hart <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Group presentations for Greenhouse Crop Production (Marking Session) Dr Robert Sharwood & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>
10:30am – 11:00am	Morning Tea Break	Morning Tea Break	Morning Tea Break	Morning Tea Break	Morning Tea Break
11:00am – 12:00pm	Lecture 3 – Energy Management in Protected Cropping Prof. Yi-Chen Lan <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 6 – Data science and horticulture A/Prof. Yi Guo <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Wrap up session and student feedback to Greenhouse Control Systems Prof. Zhonghua Chen <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 11 - Greenhouse Crop Production at Sun City Produce W/A Bao Duy Nguyen (Industry Expert, Sun City Produce) <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Lecture 12 - Cover materials and greenhouse crop production Dr Sachin Chavan <a href="#">Zoom "GalleryRoom" – L2.G.13</a>
12:00pm – 1:00pm	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
1:00pm – 3:00pm	Tutorial 1 – Group Presentation planning session Prof. Zhonghua Chen & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Practical 2 – Operating hardware in greenhouses Prof. Zhonghua Chen & Dr Wei Liang <a href="#">S40 Greenhouse</a>	Lecture 7 - Greenhouse Crop Genetics Dion Potter (Industry expert, Syngenta) <a href="#">Zoom "GalleryRoom" – L2.G.13</a> Lecture 8 - Introduction to Greenhouse Crop Production & unit discussion Dr Robert Sharwood <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Tutorial 2 – Group Presentation planning session Dr Robert Sharwood & David Randall <a href="#">Zoom "GalleryRoom" – L2.G.13</a>	Practical 6 – Greenhouse Crop Production Simulation model Dr Robert Sharwood & David Randall <a href="#">S40 Greenhouse</a>
3:00pm – 3:30pm	Afternoon Tea Break	Afternoon Tea Break	Afternoon Tea Break	Afternoon Tea Break	Afternoon Tea Break
3:30pm – 5:30pm	Practical 1 – The practical use of Priva Software Industry expert from the Netherlands <a href="#">S40 Greenhouse</a>	Practical 3 – Integrating software with hardware in greenhouses Industry expert from the Netherlands <a href="#">S40 Greenhouse</a>	Practical 4 – Greenhouse Crop Genetics Dr Robert Sharwood & Dr Wei Liang <a href="#">S40 Greenhouse</a>	Practical 5 – Greenhouse Crop Biochemistry Dr Robert Sharwood <a href="#">S40 Greenhouse</a>	Wrap up session and student feedback Dr Robert Sharwood <a href="#">Zoom "GalleryRoom" – L2.G.13</a>
5:30pm – 7:00pm					Networking Session

## Workshop for HORT7002 Greenhouse Control Systems 2024

Monday 22 April 2024		Tuesday 23 April 2024	
9:00 am – 9:30 am	<b>Introduction to workshop and grouping information</b> <i>Dr. Jing He</i> <b>Lecture Theatre: G1.G.51</b>	9:00 am – 12:30 pm	<b>Parallel group presentation</b> (2 large parallel groups) 4 students per group <i>Dr. Jing He</i> <i>Terry Lin</i> <i>Shareen Yang</i> <i>Mazdul Islam</i> <b>Collaborative learning space:</b> <b>G.6.1.15, G6.1.18</b>
9:30 am – 11:30 am	<b>Lecture 1 - Australian Protected Cropping Systems</b> <i>Graeme Smith</i>		
	<b>Lecture 2 - Introduction to the Software and Hardware System in the National Vegetable Protected Cropping Centre</b> <i>Prof. Zhonghua Chen</i>		
11:30 am – 12:30 pm	<b>Lecture 3 - Data Science and Artificial Intelligence - A Short Introduction</b> <i>A/Prof. Yi Guo</i>		
12:30 pm – 1:30 pm	Lunch break (students to bring your own lunch)	12:30 pm – 1:30 pm	Lunch break (lunch provided)
1:30 pm – 3:30 pm	<b>Parallel Group Practical 1</b> Greenhouse induction and tour to the operating hardware and software systems in greenhouses (2 large parallel groups) <i>Prof. Zhonghua Chen</i> <i>Dr. Jing He</i> <i>Dr. Wei Liang</i> <i>Shareen Yang</i> <b>S40 Greenhouse</b>	1:30 pm – 5:00 pm	<b>Parallel Group Practical 2, 3</b> (2 large parallel groups) <b>Practical 2:</b> Virtual Grower greenhouse design and modelling <i>Shareen Yang</i> <b>Computer Lab: G6.G.02</b> <b>Practical 3:</b> Greenhouse data management and decision making. <i>Terry Lin</i> <b>Computer Lab: G6. 1.11</b>
	<b>Group discussion on presentation and preparation of slides</b> (Students to bring your own laptops/tablets) <i>Dr. Jing He</i> <b>Computer Lab: G6.1.11, G6.1.12</b> <b>Collaborative learning space: G6.1.18</b>		
3:30 pm – 5:00 pm			

Notes: (1) 3-4 students per small group for group presentation. (2) 34 students per big group for the parallel group practices. (3) lunch is provided on the second day of workshop. (4) Please wear closed shoes (e.g., boots, water-proof shoes); open-toe shoes are prohibited during the workshop. (5) Each group practices takes around 1.5 hour, giving enough time for the students to move between places.



**Appendix 8. Course activities**

(i) Farm tours



Students see first-hand A) experiments run in real time to understand the influences of climate change on soil-plant interactions, and B) experience their first on-farm interview with a growers of protected cropping speciality plants.



(ii) Student hands-on learning in greenhouse, laboratory, and computer lab settings



Students engage in hand-on activities during the purpose built, on-campus workshops: A) Laboratory analysis of leaf sap  $K^+$  and  $Na^+$  with Dr. Michelle Mak and David Randall, B) Irrigation calibration training with head grower Dr. Wei Liang, C) Light sensor over greenhouse gradient and leaf canopies with Dr. Jay Bose, D) Light alternative greenhouse cover using spectral analysis with greenhouse technician Chelsea Maier, David Randall and Michelle Mak, E) Student group presentations with Prof. Zhonghua Chen and Dr. Jing He.

## Appendix 9. Students' assessments examples

(i) Example of student assessment: Developing science communication through a mock methods paper



### Fertigation Efficacy for Improved Eggplant Nutrition and Productivity

1 Name Removed<sup>1\*</sup>, David Randall<sup>1</sup>, Zhonghua Chen<sup>2</sup>, Michelle Mak<sup>1</sup>

2 <sup>1</sup>Institute of Advanced Greenhouse Technology, School of Science, Western Sydney University, Penrith,  
3 NSW, Australia

4 <sup>2</sup>Hawkesbury Institute for the Environment, Western Sydney University, Penrith, NSW, Australia

5 \* Correspondence:

6 Student Name Removed

7 19827588@student.westernsydney.edu.au

8 **Keywords:** chlorophyll<sub>1</sub>, electrical conductivity<sub>2</sub>, spectrometer<sub>3</sub>, translocation<sub>4</sub>, Flame photometers<sub>5</sub>.

#### 9 Abstract

10 This study investigated two major methods of determining the efficiency of nutrition provided to plants.  
11 The chlorophyll contents or greenness of plant leaves is an indication of plant health and photosynthetic  
12 capability to drive productivity. The chlorophyll contents were measured using both a destructive and  
13 non-destructive method. Also, sap analysis was conducted to determine the uptake and translocation of  
14 nutrients within the plant canopy. This was useful to determine the efficiency of the various levels of  
15 nutrition provided.

16 The first method is non – destructive which growers can easily measure in the greenhouse or field while  
17 the second method is destructive which would require samples to be taken to the laboratory for subsequent  
18 analysis by an absorbance spectrophotometer. The efficiency of nutrition was also analyzed using the  
19 flame photometer to ascertain the potassium (K<sup>+</sup>) and Calcium (Ca<sup>2+</sup>) contents within the plant canopy.  
20 It was interesting to see the translocation of these nutrients between the older and younger leaves.

#### 21 1 Introduction

22 Soilless greenhouse crop production systems are designed to achieve higher crop productivity with the  
23 least amount of inputs (especially water and fertilizer) and impact on the environment (Hagin, Lowengart  
24 & Sneh 2002). The practice of supplying plants with fertilizers or nutrients through the irrigation water is  
25 referred to as fertigation. This process allows growers to control the timing, volume and concentration of  
26 nutrients supplied to the plants thereby improving the return on water and fertilizer supplied.

27 An experiment was setup at the NVPCC greenhouse S40 – chamber 9 of the Western Sydney University  
28 Hawkesbury Campus for two varieties of Eggplant (*Solanum melongena L.*) namely Tracey and Lydia.  
29 Each variety was placed under three different nutrient concentrations treatments of 1.8mS/cm, 2.8mS/cm  
30 and 3.8mS/cm. These nutrient levels represented below industry standard, at industry standard and above  
31 industry standard nutrition provided to greenhouse grown eggplants, respectively. The irrigation channels  
32 or gutter in the experimental setup were fixed from 1 – 6 while the variety location was randomized (fig.  
33 1)

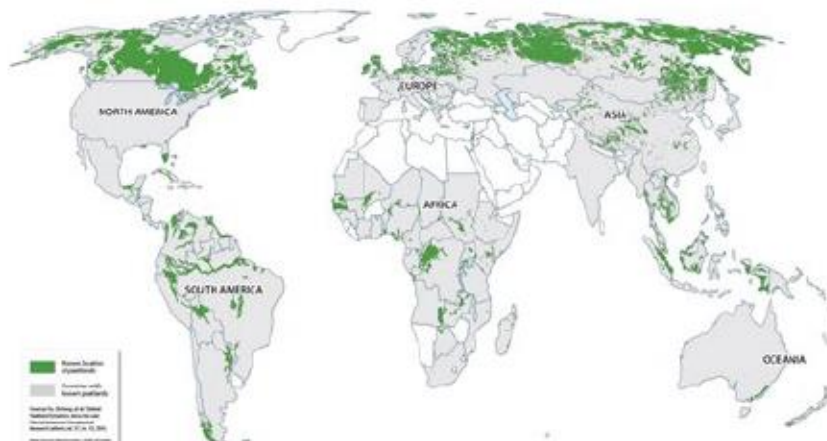


(ii) Example of student slide presentation directly to industry client: Genesis Horticultural Solutions.

This presentation was later accepted and presented as a full speaker presentation at the peak industry bodies' conference, PCA2021, Coffs Harbour, NSW.



### Global distribution of peatlands



### EMBRACING SUSTAINABLE DEVELOPMENT

- SDG's
  - PC is directly related to at least 9 goals.
- How they can be implemented to PC
  - Energy use and Water Use conservation
  - Habitat and Biodiversity
  - Pollution and Renewable stewardship



### (iii) Example Student Assessment Task: PC Technology Investigative Report

#### Writing an investigative report:

Investigative reports should be written with the end reader in mind. The reader should be able to read your report at a reasonable speed, whilst maintaining a high level of comprehension which can result in accurate communication of ideas and ease of analysis, to enable quality decision making. Your audience for this report are high-tech or medium-tech protected cropping growers, therefore your topic must relate directly to this industry.

Write an investigative report examining the future prospective of ONE new or emerging technology of your choice. You should employ a managerial communication style that investigates:

1. Design strategies, technical design, or specifications
2. Risks and opportunities (including costs where known)
3. Purpose and application
4. Logistics of implementation
5. And allows the reader to assimilate new information through easy-to-read sentence and paragraph structures.

As you write keep in mind that the reading style of your audience is focused on "making a decision", therefore they are not reading to gather all the necessary details, they are more likely to read in context of giving your investigation a "yes or no" decision. Therefore, your paragraph structure may take some thought and would benefit from persuasive texts (if you have formulated an opinion during your research, if you haven't formed an opinion, then a balanced argument would be expected). Consult the PCA Soilless magazines provided by your unit coordinator for an example of audience level.

To start the reporting process, it is beneficial to use a mind map to better understand the mapping process your reader will use to come to their decision. What factors are greenhouse grower looking for to make their decision?

#### 'Tips':

Things to keep in mind to make your report readable:

- Avoid long paragraphs
- Use the opening sentence of each paragraph to introduce the information that will follow
- Use one controlling idea (focus point) per paragraph
- Use final sentences to link paragraphs and highlight relationships between ideas
- Use major heading and subheading to help the reader navigate through topics
- Use bullet points, tables or bold font where appropriate.
- Use direct quotes (correctly UWS Harvard referenced) to snap-shot pertinent information
- Avoid long sentences that cause the reader to forget the purpose of the idea
- Use correct industry jargon with explanation or glossary as necessary, use 'normal' language in all other circumstances
- Give examples or case studies where direct applications exists
- How can the reader get more information/buy the product/connect with the researcher
- Consider the level of "schemata" the reader may have in relation to your schemata

Schemata are the frameworks you use to relate one concept that is new to a concept you are already familiar with. This new concept is then processed and makes sense to you based on what you already know and you can "place" the new information into your understanding by taking a shortcut. For example, you have experience using a hand hoe in your field work, and then a new robot is designed to weed a plot as it drives over it. The robot operator mentions the weeding arm is hoe-like in design. In your mind you link the hand-hoe action to your imagination of how the robot will work, even if you can't see the mechanism.



(iv) Example Student Assessment Task: Agricultural Biotechnology 2022

**Background:** Throughout this subject we have investigated numerous technologies that span tissue culture, synthetic biology, biofortification and edible vaccines. Utilising this knowledge, assessment task 4 will provide an opportunity for students to experience research through the lens of designing a project and preparing the appropriate forms that are required by research institutions in Australia.

**The task:** Design a laboratory-based research project that utilises synthetic biology which aims to provide an improvement to sustainable agriculture and / or productivity. For a specific experiment, you will be required to prepare a standard operating procedure (SOP).

**Document Outline:**

**Title:**

**Background:** Provide context for your project and outline the knowledge gaps.

**Research Aims/Objectives:** Detail the aims of your project.

**Methods:**

Outline the experimental methods you would use. For one experiment provide an SOP utilizing the template provided. The template for WSU will be provided.

**Anticipated Outcomes:**

Provide an overview of your anticipated outcomes.

**Word limit – up to 2,500 words including SOP.**

**Weighting – 30% - (Pre-submission 5%, SOP 10%, 15% main document)**

**Appendix 10. Allocation of project team members to be the primary contact of the industry partner.**

Industry partners	Industry partners	WSU contact
Flavorite (Foundation partner)	Protected Cropping Australia (Foundation partner)	Dr Michelle Mak
Perfection Fresh (Foundation partner)	Hydroponic Farmers Federation (Supporting partner)	Dr Robert Sharwood
Costa Group (Foundation partner)	Priva Oceania (Supporting partner)	Dr Jay Bose
Green Plus (new partner)	Enza Zaden (new partner) Yarra Australia (new partner)	Prof. Zhonghua Chen
AIS Greenworks (Foundation partner)	Syngenta Australia (Supporting partner)	Prof David Tissue
Lynch Group Australia (new partner)	Green Camel (new partner)	Prof. Yi-Chen Lan
Southern Cross Produce Brisbane (new partner)	OptiFarm (new partner)	A/Prof. Oula Ghannoum

## **Appendix 11. Industry engagement activities**

(i) Some examples from Conferences

### Hort Connections 2021 conference 25-28<sup>th</sup> October 2021

A representative Dr Michele Mak of the project team attended Hort Connections 2021 conference in Brisbane in June 2021 to promote the course offerings.



### Protected Cropping Australia Conference 28-31 March 2022

Western Sydney University (WSU) had a strong presence at the Protected Cropping Australia (PCA) conference held at Coffs Harbour. WSU had an important presence in the trade section of the conference as well as in the presentations. There are a total 4 short student talks and 6 conference session presentations from WSU students and staff members. The trade stand was used for promotion of the protected cropping courses and received significant interest from the industry. Project member Professor Yi-Chen Lan (Pro Vice Chancellor, Global Development) was discussing with conference attendees at the WSU booth about the protected cropping courses and student research projects (left). Project member Dr Michelle Mak gave an insightful talk on the opportunities and challenges around education and training for the protected cropping industry (right).



One of our current students and scholarship recipients Andrew McIlwain (Graduate Diploma in Protected Cropping) was awarded Young Grower of the Year 2022 (left). One of the Scholarship recipients Olumuyiwa Elliott was presenting his research work at the PCA 2022 conference. He has graduated from Graduate Diploma in Protected Cropping and is currently studying the Master of Science – Greenhouse Horticulture major (right).



#### Hort Connections 2024

The course is promoted in the Hort Connections 2024 Conference in Melbourne in June.





(ii) Industry representatives and growers' visit to Western Sydney University (WSU)

Hosting industry visitors from Coffs Harbour and surrounding to WSU

On the 30<sup>th</sup> of May 2024, WSU hosted a group of growers and agronomists from Coffs Harbour and surrounding, by introducing them on the National Vegetable Protected Cropping Centre (NVPC), the research going on in there, as well as promoting the protected cropping course to encourage them to send their employees to study the course.



(iii) Engagement with Project Group Reference members (PRG)

The PRG is comprised of WSU project team members, Horticulture industry representatives and a Hort Innovation representative. WSU will work with Hort Innovation in the identification and engagement of PRG members to ensure appropriate cross-industry representation and expertise. Members of the team heavily involved in the practical aspects of the delivery of the program will not be responsible for reviewing their own work. The roles of the PRG were to:

- review and comment on courses, progress and outputs;
- approve communication strategy and make announcements;
- review recommendations from teaching, training and technical team;
- review and approve scholarship and internships recipients and
- review, approve and submit progress reports to the HIA

Throughout the course of the project, the project team has regularly reported to Hort Innovation and the key industry partners. These are achieved through PRG meetings (twice a year), email communications, zoom meetings for interviewing scholarship and internship application from the students who are enrolled in the courses. By far, the six-monthly PRG meetings have been held for 10 times:

- 1<sup>st</sup> PRG meeting held on 12 December 2019
- June 2020
- May 2021
- August 2021
- December 2021
- September 2022
- December 2022
- June 2023
- December 2023
- May 2024

## **Appendix 12. Feedback from industry partners, students, graduates, and independent panels**

(i) Feedback by Independent Panels, industry partners/representatives, and horticulture experts on the course and course materials

In 2022, four course subjects; Advanced Greenhouse Technology (HORT7001), Greenhouse Control Systems (HORT7002), Greenhouse Crop Production (HORT7003) and Plant-Climate Interactions in Controlled Environment (HORT7006) and their respective workshops were reviewed and highly commended by two independent reviews. Firstly, by a panel of Horticulture experts from Wageningen University of Research, University of Adelaide, Western Sydney University, and industry leaders, organised by WSU School of Science and secondly by RM Consulting Group Pty Ltd, organised by Hort Innovation Australia. The response or evaluation proforma has covered 3 main scopes: learning outcomes (considering the scope, specificity and applicability), learning modules (range of concepts presented and their relevance to the industry), and course materials (in terms of the way that learning in these subjects is approached) of the four course subjects.

*“There has been significant investment to date to design and deliver specific protected cropping units for the Masterclass (Graduate Diploma), and related Graduate Certificate and Master of Science. It was generally agreed by those interviewed that the Masterclass is a technically strong course that is delivered well. The original drivers for development of this course remain. A targeted, technical course developed for the Australian context is still required now, more than ever, to upskill existing employees and promote careers in horticulture.”* - RMCG Final report: Mid-term evaluation of LP18000 – Educating emerging leaders for Australian protected cropping 2022

*“I think the strong points are the modular character of the program, different levels of education (i.e. simple messages, lectures, practical seminars, industry involvement, scientific reading), different forms of education (i.e. pods/short films, classical lectures, practical exercises, learn to make scientific studies), and most aspects of greenhouse production are covered”*- Dr Silke Hemming, Wageningen University of Research

*“.....the plant-climate unit gives a good baseline of science knowledge (though need to add root environment) which provides the context behind controlled environments.....The suite of tech and the concept of managed environments would be appropriate as the course starting point, then enabling the base scientific principles to be identified. Then, the real world of crop production and the associated control and decision support systems are addressed.”* -Jeremy Badgery-Parker, University of Adelaide

*“Greenhouse control systems: it is good that students get an introduction to advanced control systems as there is probably not a course that provides this in the country. At the same time, students should understand that technologies are a set of tools. They are suitable and cost-effective in specific scenarios. Hopefully, not far in the future some of these tools will be cost-effective for smaller-scale business too.”*

*“The industry projects are a great opportunity for students to integrate concepts, search for additional information and present possible solutions as in a real case scenario. It is a critical component of the program.”* -Dr. Elio Jovicich, Department of Agriculture and Fisheries (DAF), Queensland

*“In short, I'm really pleased to see how forward looking the program is. Where I see the industry heading in the future is more towards climate smart design of structures and a greater consideration of the chosen location. I also see the emerging potential of light spectrum manipulation as a key component. We will soon have a colour conversion climate screen which we expect to greatly increase the utilisation of spectrum shifting smart materials.*

*Modules 4, 6 and 9 of Hort7001, module 10 of 7002, and perhaps most relevantly module 3 and 9 of 7006 have the potential to cover the above themes. I assume at least module 9 of 7006 involves the Future Food CRC project in the NVPCC? As the supplier of one of the films, I am of course eager for our future industry researchers to be well versed in this”* -Chris Wilkins, member of The Protected Cropping Association's Committee for Education and Training

In addition, feedback from industry representatives during their visits to WSU and meeting with the project team members are included:

*“The growers love it when they can talk ‘farmer’ talk and you certainly did that well when they asked their questions. Also big thanks to Michelle. You’re a great advocate for the industry and the growers spoke very highly of you on the bus trip home. It’s also great to see some work being done in the low-tech setting which remains*

*the predominant structure type on the North Coast (and Aus in general I imagine)."- North Coast Local Land Services*

*"...thank you for always being so accommodating of our students, industry and growers.*

*We are so lucky to have such dedicated and passionate people in our industry." - Local Land Services Greater Sydney*

(ii) Feedback from graduates

#### About the relevance and applicability of the course materials

Overall, 100% positive feedback is obtained indicating that the content of the course materials is relevant and applicable to ensure a future career in the protected cropping industry among our graduates of this course.

*".....the knowledge and strength gained from this course has a lot of benefits especially for myself....." -name withheld*

*".....The course is job-oriented, ideal for students who wants to do a career in Horticulture, a lot of hands-on experiences throughout the course and useful skills related to greenhouse. The course is also research focused and very informative for students to conduct their research....." -name withheld*

*"Yes, the course materials are relevant. Concerning the population growth that causing famine or hunger, there is a need to maximise production in small area. The good thing about this course is that the course allows me to learn about the techniques from Australia and gain something from there and the knowledge I gained can be applied to help my home country" -name withheld*

*".....The course teaches me about the actual science behind the application such as studying the climate, maintaining temperatures in greenhouse etc., and they are all beneficial for me" -name withheld*

#### Three good examples of graduated student success and their feedback are being utilised in the 2023-2024 advertising strategy

*"Studying at WSU allowed me to understand, interpret and apply the theoretical knowledge of crop cultivation into everyday practical applications in my glasshouse" -Andrew McIlwain | General Manager – Operations Green Camel*

*"My journey started in 2019 as a non-award student in protected cropping and the invaluable lessons gained influenced my decision to proceed into the Graduate Diploma program in 2020. Besides the opportunity of working hands-on in a state-of-the art facility and the privilege of having both industry experts & distinguished academics impart knowledge, I was excited by the real time competence it afforded me to apply my learnings and excel in my everyday work. These new skills I gained, the added qualification, & expertise were a perfect springboard in propelling my promotion at work and helping me deliver next level solutions to key clients in the industry. I knew where I started and appreciate how much my scope of knowledge has broadened hence, the reason why I continued to pursue a Master of Science specializing in Greenhouse Horticulture in 2021. Indeed, studying at WSU remains one of the best decisions of my academic and professional career. WSU would no doubt challenge you but equally open your mind beyond what's obtainable. I would in less than a heartbeat recommend students, industry professionals and employers to enroll in an industry focused programs such the protected cropping at WSU" -Elliott Akintola | Agronomist and Category Manager – Plant Health and Protection Garden City Plastics*

*"From this course I gained deep understanding of how crops are produced in controlled environments which I now apply in my job"-Mamta Khadka | Assistant Grower - Green Camel*



(iii) Examples of current student feedbacks (collected during the end of each subject delivery)

(A) Feedbacks from our Summer 2020-21 subject deliveries

#### Protected Cropping Plant-Climate Interactions

*"Hi Oula, I would like to express my gratitude for your support in the just concluded Unit. Your patience, accessibility, and effort you put into ensuring that I understood the concepts and all that was required of me during the unit study was incredible. I am grateful for the opportunity to have been taught by you. Indeed, I got more than I expected from the study and the knowledge I have gained has further equipped me to help my clients and industry achieve better desired outcomes. I look forward to our paths crossing again in the future. In the meantime, stay safe. Best regards,"* -Student name withheld – Industry allied trade employee

#### Industry Project

*"Hi Michelle, Thank you as always for your support. This is no doubt going to be a challenging time for me, especially with an "out of comfort zone" project. I am ready to learn and will definitely rely on your expertise more than ever. I'm already committed to my course and these units, so there's no going back for me. I am not afraid to fail but I'm terrified of regretting that I never tried or gave it my all to succeed. I will follow up with "my client" today and give you an update ASAP. Thanks again. Regards,"* -Student name withheld – Industry allied trade employee

#### Advanced Greenhouse Technology

*"Hi Michelle, I have really enjoyed the unit, as this is my first real exposure to protected cropping, I have learnt a lot, you have been supportive, and I felt like I could always approach you with any questions or concerns that I may have about the topics or the unit. During the 2&1/2-day work shop you and David did a really good job considering the issues that came up with COVID-19, limited time and resources etc. although I felt a bit rush and stressed with the presentation but overall the unit is good and I have taken a lot of positive things from it. Thank you for this semester,"* -Student name withheld – Full-time Masters of Science student

*"Hi Michelle, Thanks for all your help this semester, I definitely got a lot out of the course and through my interactions with you and the other students. I've decided to defer this semester, as I'm looking down the jaws of a brutal few months with the project and know that second half of the year will be better for me in terms of timing. Thanks,"* -Student name withheld – Protected cropping entrepreneur and future grower

(B) Feedbacks from our Autumn 2021 deliveries

#### Student Feedback on Course Delivery

*"Right now, I am actively applying for jobs in the industry. The knowledge achieved from this course will have a big impact when working in the industry, because whatever we learn is practically applied in all greenhouse industries."* - Student name withheld

*"This course has increased my interest and given me good insight about what one could expect working in a protected cropping sector."* - Student name withheld

*"My current job in allied trade is benefiting greatly from my studies and they are very happy to support my personal efforts to better know and service this industry."* - Student name withheld

#### Student Feedback on Individual Subjects

*"The units are very well-structured and class sizes are small, making teacher to student ratio interaction very good. If you are coming from a non-agricultural background, the learning content is easy to grasp as the units are structured to ease you into the information and not overwhelm you from the start."* - Student name withheld

*"The online structure has made it much easier to balance work and life commitments around the studies. Not*

*requiring regular attendance on campus has reduced time required for commuting. The weekly online tutorials are often scheduled to allow most students to be able to attend after work hours” - Student name withheld*

#### Industry Project Extended

*Hi Michelle, Thank you for your confirmation and support to get this task done. I am sincerely grateful for your feedback and encouragement. Best regards,” -Student name withheld – Industry allied trade employee*

*“The industry project composite delivery method was perfect to fit into a fulltime and family work-life schedule. Having dedicated tutorial times that was flexible and set-in agreement with the supervisor, helped to make study easier. The one-on-one online sessions with the supervisor provided an opportunity to share ideas and get clarity on scheduled tasks. Another great positive was the structure of the unit which encouraged critical thinking, resourcefulness, and research skills of the student to be developed and professional skills especially communication and presentation skills sharpened. The unit also gave the opportunity to investigate an issue that is relevant within the industry hence, the need to reach out and consult industry stakeholders. It gave a sense of purpose and relevance that the outcome of the project is beneficial to at least start a conversation on a key issue within the industry. The aspect of evaluating sustainability with the eye of the United Nations Sustainable Development Goals within the project was the first time in the whole Graduate Diploma program that it was explored. The unit provided a great opportunity to examine the sustainability of the protected cropping industry. One minor drawback of the unit is the absence of colleagues doing the same unit that we could relate and share our challenges together. Overall, it was a great learning that are relevant to life and career both now and in the future.” -Student name withheld*

#### Work Integrated Learning (WIL)

*“It was a wide-ranging course that was rich in content, and there were many highlights. First was the research component – aside from the ability to utilise the latest technological tools and equipment for research, the course afforded the opportunity to investigate issues that are relevant and applicable in the industry.” - Student name withheld*

#### Teaching and Engagement

*“The teaching staff are very supportive in terms of making students aware of scholarships and internships, and helping the students apply for them,” - Student name withheld*

*“Having all your lecturers accessible via emails, phone calls and zoom session along with the online materials and online communication with my fellow students has been excellent.” - Student name withheld*

(C) Examples of WSU formal feedback platforms (2023 deliveries)

Student feedback to unit (SFU)

HORT7001 Advanced greenhouse technology (Overall 100% satisfaction)

**WESTERN SYDNEY UNIVERSITY**

**Teacher Performance**

Clicking a teacher name, subject, year or teaching calendar will display further details. Clicking again will remove the details.  
Pre-2021.2: Agreement %s and comments only shown if at least 5 responses...

**Student Feedback on Teaching (SFT) Performance**

Broad Agreement Explicit Agreement % of Neutral (3), Agree (4) & Strongly Agree (5) responses.  
% of Agree (4) & Strongly Agree (5) responses.

School	Teacher	Year	Half Year	Teaching Calendar	Subject	Agreement Type
All	All	2023	All	All	Advanced Greenhouse Technology (HORT7001)	Explicit Agreement

Teacher	Unit	Year	Teaching Calendar	Resp #	Resp %	Encouraging	Effective	Respected	Approachable	Respect	Perspectives	Feedback	Overall
MICHELLE MAK (30039224)	Advanced Greenhouse Technology (HORT7001)	2023	Spring	11	0%	Q1 01%	Q2 01%	Q3 01%	Q4 64%	Q5 100%	Q6 100%	Q7 01%	Q8 100%

Benchmarking	Science	Year	Half Year	Teaching Calendar	Resp #	Resp %	Encouraging	Effective	Respected	Approachable	Respect	Perspectives	Feedback	Overall
	Western Sydney	2023	Spring	10.2	10%	80%	80%	01%	80%	90%	90%	88%	90%	

**Best Aspects**

She gives more information about studies and careers.  
As per me, all aspects were valuable which are taught by teacher in the class.  
Always encourage us to think about problem solving rather than just doing such activities.  
She brought many guest speakers that allows us to know the real industries. She always tried to give us the knowledge in every w...  
Her teaching style is encouraging. She always motivates students towards teaching and gave good feedbacks to improvement on ...

**Needs Improvement**

Everything is perfect.  
Can be more approachable.  
In my opinion, she is perfect.  
I don't think she needs to improve anything.

Produced by The Office of Competitive Intelligence and Analytics

SFU/SFT Policy Feedback/Questions

HORT7002 Greenhouse control system (Overall 100% satisfaction)

**WESTERN SYDNEY UNIVERSITY**

**Subject Performance**

In the below table, clicking a Teaching Calendar will update the bottom part of the page to display the associated Best Aspects and Needs Improvement comments along with benchmarking agreement figures for the School and Western Sydney. Clicking the selection again will clear this part of the page.

**Student Feedback on Subjects (SFS) Performance**

Broad Agreement Explicit Agreement % of Neutral (3), Agree (4) & Strongly Agree (5) responses.  
% of Agree (4) & Strongly Agree (5) responses.

School	Year	Half Year	Teaching Calendar	Course	Subject	Agreement Type
All	2023	All	All	All	All	Broad Agreement

Subject	Code	Year	Teaching Calendar	Resp.	Rate	Activities	Materials	Assessments	Groupwork	Technology	Support	Workload	Critical Skills	Work Related	Overall
SCI - Greenhouse Control Systems	HORT7002	2023	Autumn	17	100%	Q1 100%	Q2 100%	Q3 100%	Q4 100%	Q5 100%	Q6 100%	Q7 94%	Q8 100%	Q9 100%	Q10 100%

Benchmarking	Science	Year	Half Year	Teaching Calendar	Resp #	Resp %	Activities	Materials	Assessments	Groupwork	Technology	Support	Workload	Critical Skills	Work Related	Overall
	Western Sydney	2023	Autumn	11,868	12%	92%	93%	01%	80%	93%	87%	87%	92%	92%	91%	

**Best Aspects**

Practical exposure.  
Very supportive and understanding [teacher] he ma'am.  
Reasonable work load work related knowledge and skills.  
From classes, quiz to workshop and practical everything is related and easy. I loved this.  
Green house control efficiently improve my knowledge skills through practicals and different assessment as well as learning mod...

**Needs Improvement**

Nothing.  
More tutorials for further study.  
It would be better if we gets feedback for our presentation as we receiving just grade can't helps us to find our weakness and with...  
Nothing really, however I wish in future the assignment are more evenly distributed. For example last week I had practical report...

Produced by Office of Competitive Intelligence & Analytics

SFU/SFT Policy Feedback/Questions

Last Updated: 04 March 2024

## HORT7003 Greenhouse crop production (Overall 95% satisfaction)

**WESTERN SYDNEY UNIVERSITY**

In the below table, clicking a Teaching Calendar will update the bottom part of the page to display the associated Best Aspects and Needs Improvement comments along with benchmarking agreement figures for the School and Western Sydney. Clicking the selection again will clear this part of the page.

**Student Feedback on Subjects (SFS) Performance**

Broad Agreement % of Neutral (3), Agree (4) & Strongly Agree (5) responses.  
Explicit Agreement % of Agree (4) & Strongly Agree (5) responses.

**Subject Performance** (For pre-2021.2 teaching calendars, results only shown if there is at least 5 responses)

School All Year 2023 Half Year All Teaching Calendar All Course (All) Subject All Agreement Type Broad Agreement

Subject	Code	Year	Teaching Calendar	Resp.	Rate	Activities	Materials	Assessments	Groupwork	Technology	Support	Workload	Critical Skills	Work Related	Overall
						Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
SCI - Greenhouse Crop Production	HORT7003	2023	Autumn	22	19%	95%	91%	91%	95%	95%	95%	95%	95%	95%	95%

**Benchmarking**

Best Aspects Needs Improvement

Produced by Office of Competitive Intelligence & Analytics

SFU/SFT Policy Feedback/Questions

Last Updated: 04 March 2024

## HORT7006 Plant-Climate Interactions in Controlled Environments (Overall 100% satisfaction)

**WESTERN SYDNEY UNIVERSITY**

In the below table, clicking a Teaching Calendar will update the bottom part of the page to display the associated Best Aspects and Needs Improvement comments along with benchmarking agreement figures for the School and Western Sydney. Clicking the selection again will clear this part of the page.

**Student Feedback on Subjects (SFS) Performance**

Broad Agreement % of Neutral (3), Agree (4) & Strongly Agree (5) responses.  
Explicit Agreement % of Agree (4) & Strongly Agree (5) responses.

**Subject Performance** (For pre-2021.2 teaching calendars, results only shown if there is at least 5 responses)

School All Year All Half Year All Teaching Calendar All Course (All) Subject All Agreement Type Broad Agreement

Subject	Code	Year	Teaching Calendar	Resp.	Rate	Activities	Materials	Assessments	Groupwork	Technology	Support	Workload	Critical Skills	Work Related	Overall
						Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
SCI - Plant Production	HORT2003	2022	Spring	6	38%	100%	100%	100%	100%	100%	100%	83%	100%	100%	100%
		2023	Spring	2	17%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
SCI - Plant-Climate Inter	HORT7006	2021	Spring	8	73%	88%	100%	100%	100%	100%	100%	100%	100%	100%	100%
			Summer A	0	0%										
		2022	Spring	9	19%	99%	100%	100%	100%	100%	100%	89%	100%	89%	89%
	2023	Spring	9	8%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

**Benchmarking**

Science	2023	Spring	743	11%	95%	94%	93%	92%	94%	92%	95%	94%	95%	93%
Western Sydney	2023	Spring	11,224	14%	95%	95%	94%	93%	95%	94%	95%	95%	95%	94%

Best Aspects Needs Improvement

No comments. Everything was perfect.  
The best aspect for me is to learn about the how light intensity, wavelength effect the growth of the plant, using new technologies ... Over all good, no need to improvement.

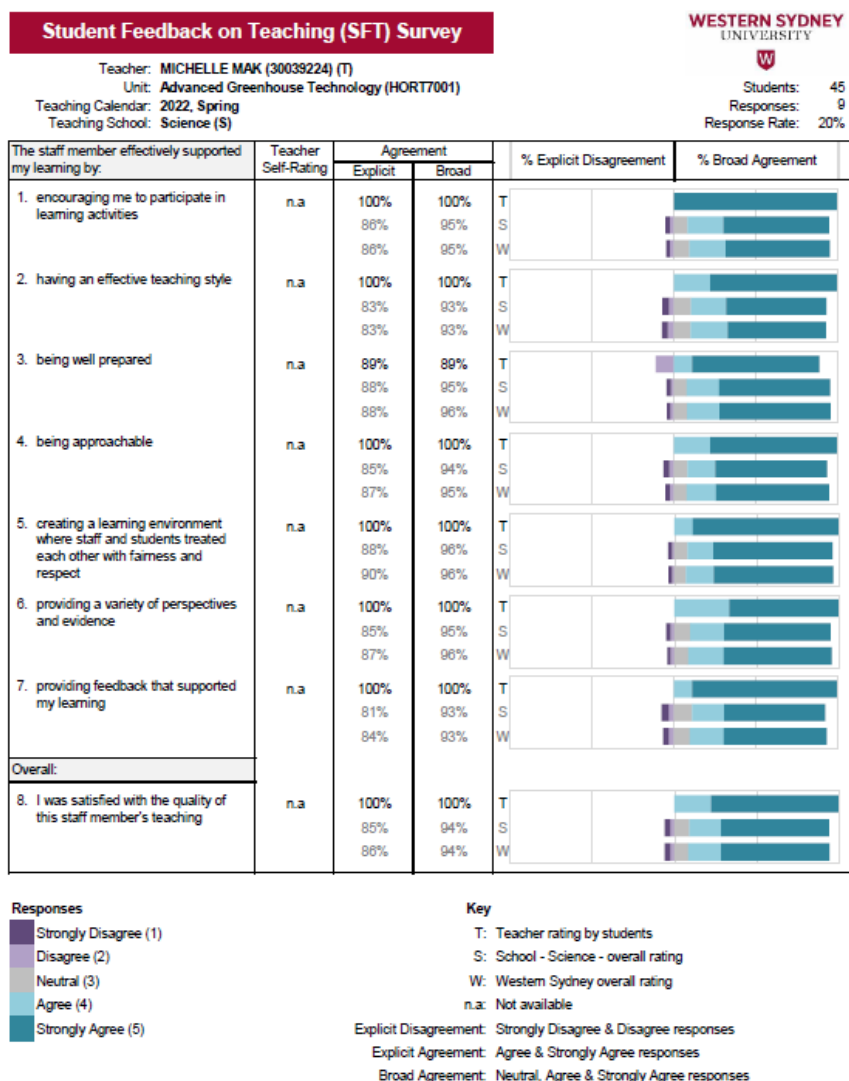
Produced by Office of Competitive Intelligence & Analytics

SFU/SFT Policy Feedback/Questions

Last Updated: 01 May 2024

## An Example of Student Feedback to Teaching (SFT)

### HORT7001 Advanced greenhouse technology



**Notes:**

- Care should be taken when analysing ratings where the number of responses is less than 10 as this does not allow for a meaningful analysis.
- Science (S) and WSU (W) ratings are for the 2022.2 half-year period.
- If a comment contains teacher names, swear words, student IDs, phone numbers, etc, these have been removed (where possible) and square brackets [] shown with a description of what was removed within them, e.g. [teacher]. Swear words have also been classified as mild, moderate, or severe, e.g. [swear word - mild]. If any teacher names, swear words, etc, have slipped through, please advise surveys@westernsydney.edu.au.

Comments	
Best Aspects	Needs Improvement
She was very understanding and helpful. She looks after the students when we are lagging behind. The professor has the quality to deliver information more practically that could be easily understood. She always tried her best to teach us. Even in online class she gave us a tour of greenhouse and the farm tour was good too. I didn't talk much and always hesitated but whenever I talked with her she responded really nicely.	She should have explored more practical learning. Her determination to help students understand better.

### Appendix 13. Course promotion strategies

(i) WSU promotion of the Masterclass in Protected Cropping in cooperation with WSU's office of Marketing and Communication

- By optimised the WSU course page
- Inbound/outbound campaign
- Organic social strategy for promoting the course
- Electronic Direct Marketing (eDM) campaign for those current students in a relevant pathway that may be interested in the course, and in additional to all our alumni
- Print media ads and course brochures
- Postgraduate information webinar for prospective students
- Student support with the application and enrolment process
- PCA conference 2019 to 2023 and Hort Connections 2022 to 2024 promotion on the PCA stand
- Postgraduate information webinars for international students and their parents

(ii) Promotion of the course through paid advertising

Soilless Australia	HFF Newsletter	Vegetables Australia	Berry Journal	Flowers Magazine	Tree Crop Magazine
Soilless Australia Vol 2 2020	HFF Newsletter June 2020	AusVeg Weekly update 27 <sup>th</sup> April 2021	Australian Berries Journal Autumn 2023 Edition 14	Flowers Magazine Issue 94 Jun-July 2023	Tree Crop Magazine May-June 2024
Soilless Australia Vol 3 2020	HFF Newsletter October 2020	AusVeg Autumn 2023	Australian Berries Journal Winter 2023 Edition 15	Flowers Magazine Issue 95 Aug-Sep 2023	
Soilless Australia Vol 4 2020	HFF Newsletter December 2020	AusVeg Winter 2023	Australian Berries Journal Summer 2023 Edition 17	Flowers Magazine Issue 97 Dec-Jan 2024	
Soilless Australia Vol 5 2020	HFF Newsletter April 2021	AusVeg Spring 2023	Australian Berries Journal Autumn 2024 Edition 18	Flowers Magazine Issue 98 Feb-March 2024	
Soilless Australia Vol 6 2021	HFF Newsletter June 2021	AusVeg Summer 2023	Australian Berries Journal Winter 2024 Edition 19	Flowers Magazine Issue 99 Apr-May 2024	
Soilless Australia Vol 7 2021	HFF Newsletter September 2021	AusVeg Autumn 2024		Flowers Magazine Issue 200 Jun-July 2024	
Soilless Australia Vol 8 2021	HFF Newsletter March 2023	AusVeg Winter 2024			

Soilless Australia Vol 9 2021	HFF Newsletter October 2023				
Soilless Australia Vol 10 2022	HFF Newsletter March 2024				
	HFF Newsletter June 2024				

(iii) Contact by email to protected cropping growers and allied industry organisations

- 6th May 11, growers and the 4 Industry partner growers
- 6th May 15, related allied industry companies
- 20th May 50, follow up emails to people and companies who have expressed some interest in the course.
- Graeme Smith (Graeme Smith Consulting) has agreed to email promotional material to his Australian database of 735 people involved in the protected cropping sector
- Contact has been made with the Deans of the 16 other Australian Universities which have an agriculture school/faculty, with information to distribute to any interested students
- TAFE NSW are planning to promote our course to its alumni who have a Diploma or advanced Diploma in Agriculture or Horticulture through its alumni network when it is fully operational

(iv) Promotion of the course through the extensive network and social media of Hort Innovation

The project courses have attracted extensive interest in multiple forums, helping to raise the profile of the courses and of Hort Innovation. A selection of instances include;

- Soilless Australia
  - Volume 3- Spring 2019, p. 16
  - Volume 7- Winter 2021, p. 22
- Vegetables Australia
  - Autumn 2020, p. 14
- Undercover Newsletter
  - May 2021
- Hortidaily
  - Wed 16<sup>th</sup> June 2021
- LinkedIn
  - Wed 3<sup>rd</sup> March 2021 (1,152 Views)
- Facebook
  - Thu 24<sup>th</sup> June 2021





(v) Strategic Exposure Articles

WSU students' publications in Soilless Australia and other articles in industry publications raising awareness of Western Sydney University's protected cropping credentials across the horticultural industry

- Soilless Australia: Student Research
  - Volume 2 – Autumn 2020, pp. 26-28
  - Volume 3 – Winter 2020, pp. 28-30
  - Volume 4 – Spring 2020, pp. 23-25
- Soilless Australia: Project team member Michelle Mak joins the PCA Board of Directors
  - Volume 6 – Autumn 2021, p. 35
- Soilless Australia: The project team wins the NSW Merit Award from the Australian Institute of Horticulture
  - Volume 7 – Winter 2021, p. 36
- Undercover Newsletter: Prof. Chen and WSU recognized for crops from the advanced protected cropping system (NVPCC)
  - December 2020



WESTERN SYDNEY  
UNIVERSITY

**BE A  
SECTOR  
LEADER  
IN PROTECTED CROPPING**

# GRADUATE DIPLOMA IN PROTECTED CROPPING GRADUATE CERTIFICATE IN PROTECTED CROPPING

The Graduate Diploma/Graduate Certificate in Protected Cropping will educate future leaders for the Australian horticultural sector via an innovative and flexible industry-supported training model.

Be part of the fastest growing food producing sector in Australia and join the only protected cropping course delivered at a postgraduate level in Australia. Western Sydney University offers a unique Graduate Diploma/Graduate Certificate course in Protected Cropping providing exciting learning opportunities. Extend your knowledge and further develop your expertise in the areas of science, technology and business with a strong focus on high-tech and intensive horticulture.

This course is designed to comprehensively cover both Australian and international challenges in sustainable greenhouse production in a changing global climate. Students will learn how protected cropping utilises cutting-edge technologies in the core areas of crop production, plant physiology, biotechnology, pest management, postharvest, climate control systems, integrated data intelligence, and business management and logistics. Additionally, students will learn best-practices from the protected cropping industry experts to equip graduates for employability and mobility.

The Graduate Diploma/Graduate Certificate courses in Protected Cropping are funded by the Hort Frontiers Leadership Fund, part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from Western Sydney University, key industry partners (Flavorite, Costa Group, Perfection Fresh, Australian Fresh Leaf Herbs, and Greenworks) and contributions from the Australian government.

The industry partners will host students for their industry research projects. Therefore, engaged students will be job-ready to start in the protected cropping industry following completion of the course.

## ACCREDITATION

Both the Graduate Certificate and the Graduate Diploma in Protected Cropping are recognised by the two industry organisations – Protected Cropping Australia and the Hydroponic Farmers Federation.

## WHAT YOU'LL STUDY

The course includes a combination of flexible online learning modules and practical on-site workshops to allow you the flexibility to work while studying.

The highlight for your learning journey is the Masterclass experience, where you will meet with industry experts and work on real life industry challenges in a world-class, high-tech greenhouse facility. Themes within the workshops for the Masterclass include software and hardware systems, crop and produce management, integrated pest management and fertigation systems.

## PRACTICAL EXPERIENCE

The Graduate Diploma/Graduate Certificate in Protected Cropping courses are a key education and training component of National Vegetable Protected Cropping Centre, jointly funded by Horticulture Innovation Australia and Western Sydney University. The Centre encompasses 1800sq. m. over 9 independently controlled growing spaces designed with the world's very best glasshouse infrastructure and sensor controlled systems, to offer research, education and training opportunities in modern protected cropping horticulture.

The practical experience gained during this course will allow you to be part of the sustainable solution that focuses on resource management, reducing agricultural pollutants and environmental footprint, and using technology to advance production.

Graduates of this degree can look forward to career opportunities, such as; Horticultural Business Managers, Crop and Nursery Managers, Business Consultants or High-tech Growers.

## HOW TO APPLY

Postgraduate course applications are processed online and can be made directly to Western Sydney University at [westernsydney.uac.edu.au/ws](http://westernsydney.uac.edu.au/ws) or alternatively through the Universities Admissions Centre (UAC) at [uac.edu.au/postgraduate](http://uac.edu.au/postgraduate).

Students are eligible to apply for one of the 65 **scholarships** (up to \$5,000 each) and **internships** (up to \$17,500 each) generously provided by the five industry partners. The applicants need to submit an Expression of Interest form and the Project Reference Group will make the selection.

For more information about studying this course, please contact

**Professor Zhonghua Chen**  
**0466 544 696**  
[z.chen@westernsydney.edu.au](mailto:z.chen@westernsydney.edu.au)

Visit our Protected Cropping course pages for more information.

[westernsydney.edu.au/graduate-certificate-in-protected-cropping](http://westernsydney.edu.au/graduate-certificate-in-protected-cropping)

[westernsydney.edu.au/graduate-diploma-in-protected-cropping](http://westernsydney.edu.au/graduate-diploma-in-protected-cropping)



LEADERSHIP  
FUND



[westernsydney.edu.au](http://westernsydney.edu.au)





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27 APR 2021

## Be a sector leader in protected cropping



Be part of the fastest growing food producing sector in Australia and join the only protected cropping course delivered at a postgraduate level in Australia.

Western Sydney University offers a unique Graduate Diploma/Graduate Certificate course in Protected Cropping

(<https://www.westernsydney.edu.au/future/study/courses/postgraduate/graduate-diploma-protected-cropping.html>), which is providing exciting learning opportunities.

[Privacy - Terms](#)



# Western Sydney University



WESTERN SYDNEY  
UNIVERSITY



POSTGRADUATE

## Protected Cropping

## Western Sydney University

# PROTECTED CROPPING

## BE A SECTOR LEADER.

Protected cropping is one of the fastest growing food producing sectors in Australia.

These unique Graduate Diploma/Graduate Certificate courses in Protected Cropping offer you exciting learning opportunities to extend your knowledge and further develop your expertise in the areas of science, technology and business with a strong focus on intensive horticulture.

Both the Graduate Certificate and the Graduate Diploma in Protected Cropping are recognised by Protected Cropping Australia and the Hydroponic Farmers Federation.

### WHAT YOU'LL STUDY

The highlight for your learning journey is the Masterclass experience, where you will be meeting with industry experts and working on real life industry challenges in a world-class greenhouse facility. Themes for the Masterclass include software and hardware systems, crop and produce management, integrated pest management and fertigation systems.

In addition, you will have the opportunity to set up and complete your own protected cropping industry project by integrating and applying what you have learned. It will also help you to harness and showcase leadership, communication and business skills.

### CAREER OPPORTUNITIES

These versatile courses will open up more doors for your future, including articulation into Masters Degrees (AQF 9), bringing back the latest research findings and practices to your workplace, or exploring new career options in the field of horticulture with an elevated perspective and a new skillset.

	GRADUATE CERTIFICATE IN PROTECTED CROPPING	GRADUATE DIPLOMA IN PROTECTED CROPPING
UAC Code	950719	950718
Apply Direct Code	3773	3772
CRICOS Code	To be advised	To be advised
Duration	0.5 F/1P	1F/2P
Location	Hawkesbury	Hawkesbury
Intake	March/July	March/July
Admission	<p>Applicants must have successfully completed: an undergraduate degree, or higher, in agriculture, horticulture, environment, science, technology or business</p> <p><b>OR</b></p> <p>An undergraduate degree, or higher, in any discipline</p> <p><b>AND</b></p> <p>Two years of full-time equivalent professional experience in technical or management roles.</p> <p><b>OR</b></p> <p>Five years of full-time equivalent professional experience and/or training in technical or management roles</p> <p>Applicants seeking admission on the basis of work experience must support their application with a Statement of Service for all work experience listed on the application.</p>	<p>Applicants must have successfully completed an undergraduate degree, or higher, in agriculture, horticulture, environment, science, technology or business</p> <p><b>OR</b></p> <p>An undergraduate degree, or higher, in any discipline and two years of full-time equivalent professional experience in technical or management roles in the agriculture, horticulture, environment, science, technology or business industry areas.</p>
Accreditation	The Graduate Certificate in Protected Cropping and the Graduate Diploma in Protected Cropping are recognised by Protected Cropping Australia and the Hydroponic Farmers Federation.	

**Key:** F = Full-time; P = Part-time.

**Note:** Part-time mode is not available to international student visa holders.



**LEADERSHIP FUND**

These courses are funded by the Hort Frontiers Leadership Fund, part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from Western Sydney University, key industry partners (Flavorite, Costa Group, Perfection Fresh, Australian Fresh Leaf Herbs, and ICI Industries) and contributions from the Australian government.



# Western Sydney University

## You've come a long way. Go further.

Located in the heart of one of Australia's fastest growing economic regions, Western Sydney University offers unlimited potential to postgraduate students with the drive, ambition and will to succeed.

Ranked amongst the top two per cent of universities in the world, Western Sydney is a world-class university with a growing international reach and reputation for academic excellence and impact-driven research.

To take your career to the next level, you need more than classrooms, more than theory.

That's why we offer a combination of on-campus, online and clinical learning environments, with real-life, on-the-ground, hands-on opportunities for skill development in professional and community settings. We value academic excellence, integrity and the pursuit of knowledge.

And we continue to challenge traditional notions of what a university 'should' be by pushing the boundaries of how knowledge is exchanged.

We equip our postgrads with the means to do more than just advance their careers. We are unlocking the potential of the next generation of global citizens, leaders and change-makers.

**PROGRESS. UNLIMITED.**

## Application Information

### ENGLISH PROFICIENCY REQUIREMENTS

If you have undertaken studies overseas you may need to provide proof of proficiency in English. Minimum English proficiency requirements and acceptable proof are found on the Universities Admissions Centre (UAC) website at [uac.edu.au](http://uac.edu.au)

Overseas qualifications must be deemed equivalent by the Australian Education International - National Office of Overseas Skills Recognition (AEI-NOOSR) - in order to be considered by UAC and Western Sydney University.

### RECOGNITION OF PRIOR LEARNING

You may be granted special equivalence or advanced standing for academic, professional and/or any other qualifications you hold on the basis of evidence submitted at the time of application.

### HOW TO APPLY

Postgraduate course applications are processed online through the Universities Admissions Centre (UAC) at [uac.edu.au/postgraduate](http://uac.edu.au/postgraduate) or direct to Western Sydney at [westernsydney.uac.edu.au/ws](http://westernsydney.uac.edu.au/ws)

### INTERNATIONAL STUDENTS

International students apply direct to Western Sydney University at [westernsydney.edu.au/international/apply](http://westernsydney.edu.au/international/apply)

For information about studying at Western Sydney University, including courses, tuition fees, English requirements, intakes, assessment methods, accommodation options and living in Australia, visit [westernsydney.edu.au/international](http://westernsydney.edu.au/international)

### POSTGRADUATE INFORMATION SESSIONS

Postgraduate Information Sessions are held throughout the year, and give you the opportunity to meet academic and professional staff, and to ask questions about courses, admission, fees and more. At these sessions, you will gain a better understanding of course content, what you can expect from the program and possible career paths. To register for a Postgraduate Information Session, visit [westernsydney.edu.au/postgraduatesessions](http://westernsydney.edu.au/postgraduatesessions)

To view the full range of postgraduate courses available visit [westernsydney.edu.au/postgraduate](http://westernsydney.edu.au/postgraduate)

### CONTACT US

To discuss your study goals and career options contact one the following:

#### Domestic students:

Call **1300 897 669** or email [postgraduatestudy@westernsydney.edu.au](mailto:postgraduatestudy@westernsydney.edu.au)

#### International students:

Call **+61 2 9852 5499** or email [internationalstudy@westernsydney.edu.au](mailto:internationalstudy@westernsydney.edu.au)

### DISCLAIMER

Western Sydney University reserves the right to withdraw or vary courses listed within this publication. In the event that the course or courses are to be changed, or in the event of cancellation, applicants will be advised by the email address specified on their application.

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Printed February 2020.

### Contact Information

1300 897 669  
[postgraduatestudy@westernsydney.edu.au](mailto:postgraduatestudy@westernsydney.edu.au)

Western Sydney University  
Locked Bag 1797  
Penrith NSW 2751 Australia

**WESTERN SYDNEY  
UNIVERSITY**



Contact Michelle for more information.  
[m.mak@westernsydney.edu.au](mailto:m.mak@westernsydney.edu.au) 02 45701376

## **Providing education and training for the protected cropping industry**

Our education programs are;

- Work compatible (Online with workshops and work based projects)
- Scientifically and technologically based
- Commercially applicable
- Focused on Australian conditions

**We offer 2 courses;**

**Tertiary pathway in protected cropping**

**Graduate Diploma in protected cropping**

A woman with long brown hair, wearing a white lab coat, is smiling and looking down at something in a greenhouse. The background is filled with green plants and white structural elements of the greenhouse.

# BE A SECTOR LEADER

Join Australia's only protected cropping course delivered at a postgraduate level, and be part of the sustainable solution. Western Sydney University offers unique Graduate Diploma and Graduate Certificate courses in Protected Cropping, which will provide you with exciting learning opportunities to extend your knowledge and further develop your expertise in the areas of science, technology and business with a strong focus on intensive horticulture.

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research

# Better energy efficiency in protected cropping



*Elliott Olumuyiwa Akintola has investigated the benefits of CHP systems for protected cropping as part of his studies.*

Elliott Olumuyiwa Akintola from Western Sydney University reports on increasing energy efficiency with combined heat and power systems. This is the first in a series of student investigative papers to be published in this magazine.

Protected cropping is a precise science that requires growers to have the right technology and equipment to effectively manage and control the protected cropping microclimate in accordance to crop needs to achieve optimum productivity. The systems for controlling growing conditions ultimately affect the crop performance, cost and yield. For instance, it is an established science that carbon dioxide (CO<sub>2</sub>) supplementation in protected cropping systems is positively correlated to plant photosynthesis and yield.

This report compares the conventional greenhouse energy-generation systems against a combined heat and power (CHP) system for efficient energy utilization, return on investment and reduction of CO<sub>2</sub> emissions.

Protected cropping systems are commonly

designed to have multiple equipment installations for their climate needs. These include separate units for heating, cooling, ventilation, screening, CO<sub>2</sub> supplementation and humidity control. These units are then connected to a central control unit or computer program using algorithms to achieve internal climate control. The efficiency and wastes from distribution of individual units, more often than not, increase the overall costs and CO<sub>2</sub> emissions in order to achieve optimum plant growth conditions.

The most conventional way of heating a greenhouse is by installing steel pipes and bars to transport heat from large boilers powered by natural gas. The output from this system are CO<sub>2</sub> and heat that is usually generated in surplus and have to be kept separately in insulated tanks for later use. Furthermore, the average fossil fuel electricity

generator typically performs efficiencies of up to 40 per cent with the rest of the energy lost. by comparison, a single Combined Heat and Power (CHP) system is capable of generating CO<sub>2</sub> gas, heat and electrical power at higher efficiency, distribution and conversion rates.

## Energy savings and CO<sub>2</sub> emission reduction

Carbon dioxide and other so-called 'greenhouse gases' are major contributors to climate change and global warming with research revealing that a low-carbon economy is needed for a sustainable earth. The protected cropping industry can contribute to mitigation strategies by investing in equipment that increases energy efficiency and reduces CO<sub>2</sub> emissions. An excellent example is a Combined Heat and Power (CHP) system.

## Spotlight on Western Sydney University student work

Over the coming year, three investigative reports will be showcased in *Soilless Australia* magazine to highlight new or emerging technologies that may be of interest to protected cropping specialists. These reports are the individual work of three students who have recently undertaken the Tertiary Pathway in Protected Cropping units at Western Sydney University (WSU). The pathway bridges the gap between TAFE and university to give continuing education options and support for the PCA industry and its dedicated workforce in the form of specialised, online units. The student reports formed an assessable task for those enrolled in 'Protected Cropping Climate Control and Technology' at WSU, which they took on with enthusiasm to bring PCA readers a balanced and informative insight into adoptable technologies.

### More information

For more information contact David Randall, Senior Horticultural Education Officer, at WSU by email [David.Randall@westernsydney.edu.au](mailto:David.Randall@westernsydney.edu.au) or phone (02) 4570 1143.



*Protected cropping students at WSU (left to right) Joshua Muthiah, Elliott Akintola, Angella Hill, Miguel Manas Torres and Tom Gleeson-Stanley, with David Randall (WSU Senior Education Officer).*



When considering the global CO<sub>2</sub> emission reduction by installing a CHP system, a primary energy saving exceeding 20 per cent and an average CO<sub>2</sub> emission reduction of 35 per cent can be achieved when compared to the conventional energy generation systems for heat and electricity<sup>[1]</sup>.

The cogeneration of heat and power ensures that energy output can be utilised for multiple purposes. The electricity generated can be used to meet power needs such as lighting or may be diverted to contribute to the electricity grid, providing an additional source of income. Furthermore, while the thermal energy is diverted for the heating needs of the protected cropping system, the by-product, CO<sub>2</sub>, can be supplemented to the plants to stimulate increased production. The advantage of CHP systems over conventional gas or coal energy-generation systems is that CHPs ensure the thermal energy produced is efficiently utilised at the point of generation or transmission rather than lost by inefficient use patterns.

### Economic viability

Several case studies where CHP systems have been successfully used were reviewed to ascertain the economic viability and the overall reduction in CO<sub>2</sub> emission and losses in protected cropping systems. A trial supported by the Belgium government<sup>[2]</sup> found



CPH unit. From [intergrowgreenhouses.com](http://intergrowgreenhouses.com)

an overwhelmingly positive Net Present Value (NPV) of using a CHP system. In a protected growing area of 10,000m<sup>2</sup> with a CHP system of 1.4 MWe, the NPV remained positive for both tomato and lettuce production. The Internal Rate of Return (IRR) of the CHP system was 33 per cent and 16 per cent, for growing tomatoes and lettuce respectively. Analysing the IRR and the NPV gave an indication of

proportionate savings in cost gained by an increased level of production. This was also confirmed by a research conducted in the Netherlands<sup>[2]</sup> where growers realised an average return on investment of three to four years. Furthermore, the CHP systems not only reduced energy costs but also allowed growers an opportunity to sell self-generated electricity whilst utilising the co-generated



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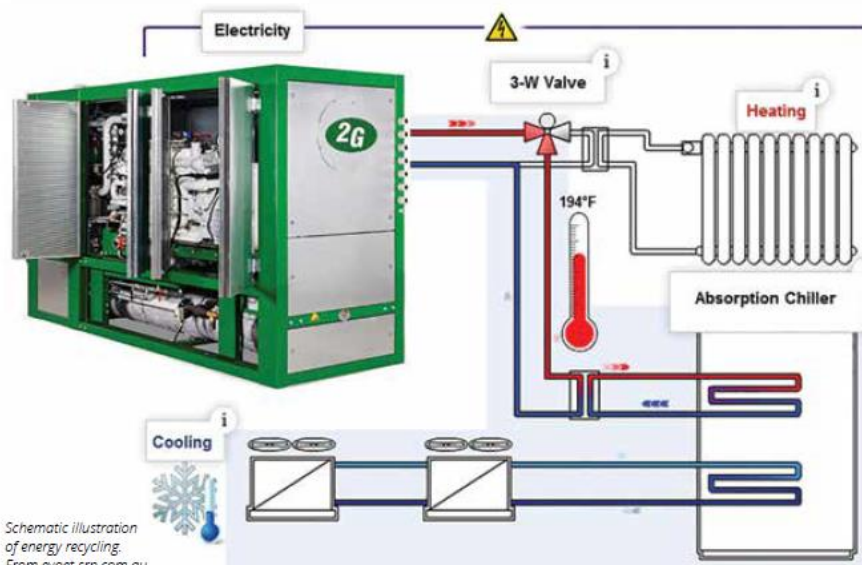
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heat for increased crop production. Moreover, growers could decide to over-dimension the CHP system in order to exceed their own needs and engage in short-term energy transactions. There is a great possibility that the advantages of CHP systems will be a key determinant in enhancing grower competitiveness and profitability.

### Summary

CHP units can be sized and dimensioned specifically to meet the greenhouse production requirements. An accurately designed system has a conversion efficiency of primary fuel to useable power and heat of around 75 per cent<sup>[3]</sup>. For 100 units of fuel, a CHP would typically produce around 30 units

of electricity and 45 units of heat. To produce an equivalent level of heat and electricity, a conventional power station boiler would need around 139 units of fuel, meaning CHP systems yield primary energy savings of 28 per cent<sup>[4]</sup>.

Additionally, CHP systems provide opportunities to avoid distribution losses. The electricity requirements of the greenhouse are matched with the right CHP capacity to reduce the demand in power. The by-product of power generation in a co-generation plant is heat, which is then passed through an absorption chiller and can additionally be used to cool the greenhouse.

In Australia, the CHP system is regarded as

an emerging technology. Its full potential is yet to be accessed by the vast majority of growers. In a time of uncertain resource longevity, CHP systems provide a great opportunity for the protected cropping industry to play an active role in energy production. At the same time, the industry can reduce CO<sub>2</sub> emissions and increase profitability by adopting a low-risk, sustainable solution. SA

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# Biomass in greenhouses



Miguel Mañas Torres has investigated the benefits of biomass systems for protected cropping as part of his university studies.

In the second of our investigative reports by Western Sydney University students, Miguel Mañas Torres examines the effective use of biomass in the greenhouse.

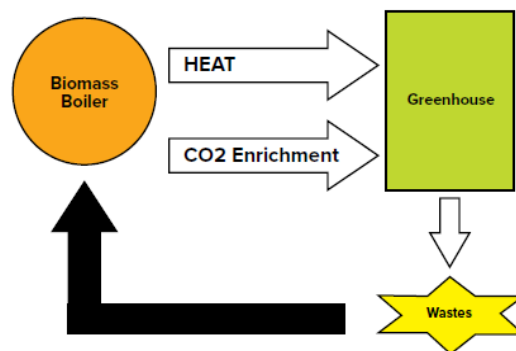
New technologies and improvements in renewable energy are providing new options, as profitable as their fossil energy competitors. The challenge is to implement clean energy technologies to industry without a significant loss in profitability and productivity.

In protected cropping, many changes can be implemented to create a more eco-friendly industry, which emits fewer residues. The idea of a 'cost-free' greenhouse is closer to being reality thanks to renewable energy. Solar energy and geothermal energy are examples of technologies that can be implemented in greenhouses, but offering even more is biomass. Due to its lower investment cost, its high energy efficiency and the potential

for improvement, biomass and biogas boilers may have huge benefits for the protected cropping industry.

## Why biomass?

Heating costs can account for up to 90 per cent of the total energy required in a greenhouse depending on climate, location, aspect and structural materials and design<sup>1)</sup>. However, a study carried out in Greece found that few renewable energy sources are capable of supplying the total heating requirements of a



How biomass works in a greenhouse.

greenhouse. Geothermal and biomass are two options that can.

Compared with geothermal, biomass is a more attainable energy source for the protected cropping industry due to its much lower capital investment cost. Biomass or biogas boilers are also much cheaper than traditional fuels such as propane or diesel oil. Choosing biogas or pellets will lead to a decrease in heating costs<sup>2)</sup>. As well, many recent studies have shown that exhaust gases from biomass boilers can be a source of CO<sub>2</sub> for enrichment in greenhouses.

Another significant advantage of implementing biomass technologies is that all types of agricultural, livestock raising, and landfill residues can have a second life heating greenhouses instead of polluting our environment. These advantages might give a new perspective to a 'cost-free' scenario for the cropping industry where cities and rural residues will provide heat and CO<sub>2</sub> to greenhouses.

This report covers the advantages of boilers that burn biomass (wood pellets) as well as boilers that run on biogas, since both have very similar features and costs.

Biogas is produced through the biological decomposition of organic matter under

Figure 1

Outdoor wood EPA (Environmental Protection Agency, USA) boiler represents the most cost efficient option<sup>4)</sup>

Fuel type	Energy Content Btu per unit	Boiler Thermal Efficiency <sup>3)</sup>	Unit Cost <sup>1)</sup>	Cost per 1,000,000 Btu
Corn	380,000 / bu	70-85% (80%)	\$5.00 / Bu	\$16.45
Wood Pellets	15,400,000 / ton	70-85% (80%)	\$220 / ton	\$17.82
Outdoor Wood Boiler - typical	19,200,000 / full cord <sup>2)</sup>	40%	\$200 / full cord <sup>5)</sup>	\$24.04
Outdoor Wood Boiler - EPA P2	19,200,000 / full cord	69%	\$200 / full cord <sup>5)</sup>	\$13.94
Electricity	3413 / kWh	100%	\$0.11/kWh	\$32.23
Propane	91,500 / gallon	70-85% (78%)	\$1.70/gallon	\$23.82
Natural Gas	100,000 / Therm <sup>3)</sup>	70-85% (78%)	\$1.15 / Therm	\$14.74
Heating Oil	138,000 / gallon	70-85% (75%)	\$2.50 / gallon	\$24.15

1) Costs available in Madison, WI - October 2008.

2) Full Cord has a volume of 4 feet x 4 feet x 8 feet or 128 cubic feet.

3) 1 Therm (100,000 Btu) equals approximately 1 CCF - hundred cubic feet equals

4) 100% Efficiency value used to calculate "Cost per 1,000,000 Btu"

5) Based on purchasing cut and split wood from a vendor

Figure 2

Scott Sanford, Rural Energy Program, University of Wisconsin. Biomass heating of greenhouses.<sup>[4]</sup>

Heating System	System Cost	Biomass Quantity	Biomass Energy Cost	Propane (gallons)	Propane Cost	Total Savings	Simple Payback (years)
A) Residential pellet stove	\$4350	282 40# bags	\$1184	639	\$1278	\$722	6.0
B) Pellet furnace	\$6030	355 40# bags	\$1491	318	\$636	\$1057	5.7
C) Outdoor wood boiler-EPA Certified	\$13050	6 cords	\$900	318	\$636	\$1648	7.9
D) Outdoor wood boiler	\$11634	10 cords	\$1500	318	\$636	\$1048	11.1

anaerobic conditions by a specific group of bacteria. This gas has a high combustion efficiency due to its high content of methane (50- 70 per cent) and CO<sub>2</sub> (25-45 per cent).

The exact concentration of the components in the gas depends mostly on the origin and characteristic of the organic waste (for example moisture content) and in the treatment that it has in the specific landfill (coverage time, average temperature, annual precipitation in the area). Both technologies are based on the extraction of the energy contained in the organic matter which would otherwise be released into the atmosphere mostly as CO<sub>2</sub> by decomposing microorganisms<sup>[5]</sup>.

### Costs of implementing biomass technologies

Biomass boilers can use a huge range of

vegetable waste as fuel, some directly (such as grain, wood, cord wood, green-wood chips) and sometimes indirectly after a densification process that turns any type of vegetable waste into pellets.

Biomass boilers and stoves are used in greenhouses around the world, especially in Europe and North America, to reduce heating costs. The price of its fuel, as shown in Figure 1<sup>[4]</sup>, is cheaper than more commonly used propane or electricity.

When buying a boiler or biomass stove the options are varied. Factors to consider are the number of greenhouses to heat, their size, the nature of the residue to be used as fuel or the required investment. Figure 2 shows different options of biomass heating systems with their corresponding prices and the time necessary to amortise the investment.

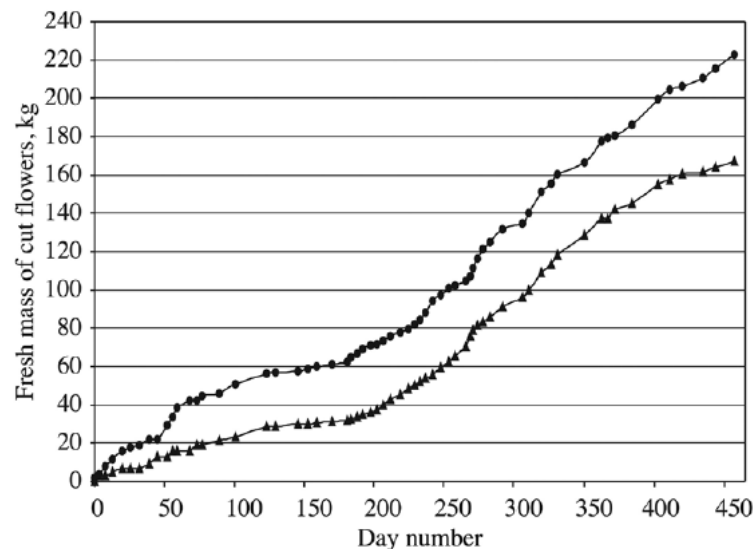


Figure 3 Comparison between the cumulative crop yields in the CO<sub>2</sub> enriched tunnel (circles) and in the control tunnel (triangles), for the complete experimental period. Jaffrin et al. 2003. [3]

### How does biomass boiler technology work?

In the process of burning plant matter, smoke rich in carbon dioxide (CO<sub>2</sub>) is produced along with water vapour and other impurities, such as nitrogen oxides (NOx), sulphur oxides (SOx), carbon monoxide (CO) and volatile organic compounds (VOCs). Numerous studies are looking at ways to take advantage of that smoke to enrich crops with CO<sub>2</sub> in greenhouses. Exhaust gases taken from heating systems provide a 'free' source of CO<sub>2</sub> for greenhouse enrichment. It can be considered 'free' since it is a waste product but the method requires adjustments and investments for installation and maintenance<sup>[6]</sup>.

In ideal combustion of hydrocarbons, only CO<sub>2</sub> and water vapour would be produced, however, in reality, other toxic gases such as carbon monoxide, nitrogen oxides, sulphur oxide, ethylene, and VOCs are produced. As these compounds can be very dangerous for staff and crop, control measures must be applied. In order to purify the CO<sub>2</sub> for injection into a greenhouse, several modifications in the boiler have been successfully tested such as scrubbing systems or membrane separation of CO<sub>2</sub>, which allows high permeability of CO<sub>2</sub> but prevented diffusion of NOx. Studies show that NOx and SOx product captured by the scrub filter can be transformed into nutrients for greenhouse plant fertilisation<sup>[6]</sup>.

The easy access and price of fuels and the fact that it is a renewable energy as well as supplying the free source of CO<sub>2</sub> and nutrients are the biggest advantages of using biomass powered boilers in the intensive greenhouse industry.

### Biogas adoption

There are upward of 50 biogas plants in Australia, most of them in New South Wales and usually associated with municipal waste treatment facilities. These plants manage to magnify anaerobic decomposition reactions that occur naturally in landfills to industrially extract a methane-rich gas. This gas has many uses, for example, to produce electricity, as fuel for vehicles, or to produce heat.

This technology reduces the emissions of methane into the atmosphere (methane is 21 times more harmful than CO<sub>2</sub> as a greenhouse gas) and provides a cleaning treatment for landfill waste reducing the contamination of soils and aquifers. A study in France showed that placing protected cropping facilities near biogas plants lead to yield and efficiency benefits for the greenhouse<sup>[7]</sup>.

Another experiment used biogas produced in a controlled landfill for heating and for CO<sub>2</sub> enrichment of two greenhouses growing roses (variety 'Parfum de Rose') demonstrated how effective the enrichment with CO<sub>2</sub> is using gases expelled by a biogas boiler. The study occurred in two identical greenhouses, one with CO<sub>2</sub> injection and one without. →



Both were heated from a biogas boiler that was fuelled from the landfill-sourced biogas. During the experimental period of 24 months, high productivity was obtained and the productivity gains were higher than the heating cost reduction due to biogas use<sup>15</sup>.

Figure 3 shows the productivity of the first 70 days in both greenhouses. The improvement of the technique would lead to greater benefits from the free CO<sub>2</sub> enrichment than those achieved due to the reduction in heating costs.

In this study it was also observed that any malfunction of the purifying scrubbers is very detrimental to production. The initial situation showed the CO<sub>2</sub>-enriched greenhouse had a yield increase of 130 per cent. Two months into the trial, carbon monoxide and ethylene were detected in the greenhouse, although

this situation was rectified, the greenhouse injected with contaminated CO<sub>2</sub> decreased its yield by 25 per cent below the control.

### Conclusion

According to the WA Department of Primary Industries and Regional Development, Western Australian farmers produce up to 10 million of biomass waste every year<sup>16</sup>. This waste has untapped opportunities, for example, in the industrial production of ethanol. Despite the possibility of making money from waste while helping the environment, very few businesses in Australia are implementing these technologies.

Here, the biogas industry, like the protected cropping industry, is an emerging industry with room for both growth and improved efficiencies. Many European studies show the advantages a good relationship between both Industries can provide in terms of cost reduction and better treatment of our increasingly abundant waste.

On a small scale in Western Australia, the implementation of biogas boilers in peri-urban and rural west-coast greenhouses would have sufficient access to the large quantities of urban, horticultural and agricultural (including animal) waste sources to help small producers reduce heating costs. This is shown in Figure 4.

On a large scale, a drastic improvement of CO<sub>2</sub> enrichment methods by exhaust gases is expected in the coming years, therefore, the association of large protected cropping farms with landfill biogas plants in an efficient way would lead the industry to the technological worldwide forefront.

It is the perfect time for councils and producers to understand the potential of biomass and biogas in greenhouses and implement changes for better communication

between both Industries making them grow reciprocally and helping to create a more sustainable and efficient protected cropping industry.

### More information

For further information about the features of different biomass systems and in which type of greenhouse they best fit, visit: [fyi.extension.wisc.edu/energy/files/2016/09/BiomassEnergyforGreenhouses.pdf](http://fyi.extension.wisc.edu/energy/files/2016/09/BiomassEnergyforGreenhouses.pdf)

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Figure 4

Average agricultural waste in Western Australia (WA DPI&RD 2018).

Biomass type	Tonnes per year
Cereal straw	6 930 000
Dairy effluent (wet weight)	2 313 000
Hardwood residues	1 186 000
Softwood residues	371 000
Horticulture	76 000
Grape marc	20 200
Cattle feedlots	19 500
Broiler litter (wet weight)	19 300

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# New path for disease control

In the third of our series presenting student research, Angela Hill investigates the development of clay particles to deliver a double stranded RNA application as a spray to manage plant diseases in crops.

Currently, 30-40 per cent of the world's food production is lost due to damage from pathogens. There is a growing need to utilise technology to control pest and diseases, as chemical resistance develops in our food crops. The global agricultural industry has been investing in the research of alternatives



WSU student Angela Hill reviewed exciting research underway at the University of Queensland to use technology to control pests and diseases.

including dsRNA – or double-stranded RNA (ribonucleic acid) – to switch off gene expression and utilise the plant's own defence mechanisms to protect crops against pests and diseases.

Under development in Australia is a technology known as BioClay™. It offers an alternative to chemical pesticides and has been developed by researchers at the University of Queensland to address the need for pesticides that are environmentally friendly and reduce chemical resistance.

Professor Neena Mitter, Director for the Centre for Horticultural Science, QAAFI and Professor Gordon Xu from the Australian Institute for Bioengineering and Nanotechnology, are leading research in the development of BioClay. Prof Mitter describes the material as "a spray of degradable clay particles used to release double-stranded RNA that protects plants from specific disease-causing pathogens".

It is used to stimulate the immune system of the plant to fight pathogens that affect the health of the crop. It has been developed to deliver a platform that combats the overuse of chemical pesticides, which in turn leads to pathogens building resistance.

## Design strategies

DsRNA or gene silencing is an existing technology but it has some significant barriers that have not justified the cost of using currently available products. Applying dsRNA alone is inefficient as it lacks protection from the elements such as ultraviolet light, rain or commercial watering. As a naked product, dsRNA lasts only seven days and is often washed off or degraded by enzymes naturally occurring on the leaf. This new technology addresses those barriers to provide an economical and environmentally friendly alternative to chemical pesticides →

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RNA is loaded on to sheet-like clay particles (Layered Double Hydroxide, LDH) to form dsRNA-LDH complexes (BioClay). Carbon dioxide and moisture break down the clay releasing the dsRNA directly onto the plant. The carbonic acid formed by the combination of carbon dioxide and water enables a slow and sustained release of the dsRNA. The application of the BioClay is topical, dsRNA is not integrated into the genome of the plant and so does not genetically modify the plant. dsRNA is likely to be taken up by the plant either by passive diffusion or by an active transport process. The LDH particles are biodegradable circumventing the issue of residues, which makes this product suitable to be used in nursery production as well as other types of commercial cropping.

The developers of BioClay investigated existing dsRNA technology to produce an easy-to-apply product that reduces the agricultural industry's reliance on chemical pesticides and provides a more stable and cost-effective solution to the challenges of utilising naked dsRNA.

### Risks and opportunities

This is a versatile approach well suited to the protected cropping industry. The non-toxic nature of the clay means that growers may be able to apply this product in a closed environment without significant workplace health and safety (WHS) issues. It is being tested for protection of vegetable crops from viruses and does not genetically modify the plant, affect its growth potential or leave any residues.

The properties of BioClay give potential for it to be used for fungal and pest applications, as well as the viral pathogens it is currently being tested for. The design of the dsRNA can be made target specific: this reduces any harm to other insects or plants, meaning that beneficial insects and crops are safe from damage upon application and



supports growers with a wider range of pest management options that are sustainable, integrated and targeted.

### Strategic goals of clay nanosheets for agriculture

Queensland's Agricultural Strategy is to double that state's food production by

2040. This gave Professor Mitter and her colleagues the inspiration to work on developing practical solutions to the issues surrounding global food security. Driving productivity while minimising costs in the agricultural sector was a shared goal of the Queensland Government and the University of Queensland.



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Prof Mitter (far left) with two members of her research team, Dr Elizabeth A Worrall and Dr Karl Robinson, who are developing double stranded RNA as a spray to manage plant diseases.

Trials on the product are continuing with research supporting the core goals of increasing crop yields while reducing chemical inputs and the use of pesticides.

### Logistics and implementation

This BioClay technology can be applied as a spray application. It has been designed

to work with existing spray equipment. The LDH clay itself was designed as a cheap carrier for the dsRNA, however at this point, dsRNA is expensive to manufacture. There are companies internationally that are looking at methods to mass-produce dsRNA to address this issue. The BioClay research is progressing in partnership with industry and various other stakeholders.

SA

## WSU student work showcased

*Soilless Australia* magazine continues to publish student research reports that highlight new or emerging technologies that may be of interest to protected cropping specialists. These reports are the individual work of students who have recently undertaken the Tertiary Pathway in Protected Cropping units at Western Sydney University (WSU). The pathway bridges the gap between TAFE and university to give continuing education options and support for the PCA industry and its dedicated workforce in the form of specialised, online units. The student reports formed an assessable task for those enrolled in 'Protected Cropping Climate Control and Technology' at WSU, which they took on with enthusiasm to bring PCA readers a balanced and informative insight into adoptable technologies.

### More information

For more information contact Louise Graham, WSU Engagement Officer, by email at [l.graham@westernsydney.edu.au](mailto:l.graham@westernsydney.edu.au), or phone 1300 897 669.

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## Michelle Mak

In an open letter new PCA board member Michelle Mak introduces herself to readers. Michelle Mak is Associate Lecturer in Horticulture and a PhD candidate (Biological Science) at Western Sydney University.

Dear *Soilless Australia* reader,

I am so grateful to have been appointed to your PCA board. I look forward to meeting as many of you as possible in the coming term and I am open to any questions you may have about my work, my background of myself.



Michelle Mak.

To start off, I normally introduce myself as an agricultural scientist, specialising in sustainable agriculture for food security. I consider myself an applied scientist because although my skills are the same as any other scientist, my goals are always for solutions to reach growers and help businesses.

I work as the associate lecturer in protected cropping at Western Sydney University, Richmond, New South Wales, where I develop and teach agricultural and horticultural science with a particular focus on developing coursework specifically tailored to the protected cropping industry. Like many of you I am excited to see where our industry can build and prosper, especially in the areas of technology adoption, resource sustainability, workforce security, career development, export markets, data utilisation and agricultural literacy for consumers.

I am dedicated to communicating science in a way that makes it accessible to all and sharing my passion for sustainable, Australian agriculture. I have expertise in integrated pest management, plant physiology and postharvest, and a keen interest in pollination services and medicinal herbs. My entrepreneurial mindset helps me convey the complex interactions between plants, insects and the environmental, delivering easy to understand and applicable to real-world situations.

In my spare time, I enjoy sharing my knowledge through community gardening and grass roots environmental groups, listening to podcasts and researching all things investment. I also love walking, which helps balance out my love for cooking (healthy) and baking (yummy) treats for friends and family.

Yours truly,

*Michelle Mak*

Contact Michelle Mak on  
michelle.mak@protectedcropping.net.au  
or on (02) 4570 1376

## PCA Memberships to suit individuals, micro businesses, SMEs and Corporates – Growers and Allied Trade

Become a Member to access discounts, networking, referrals and to support PCA's role in advocating on behalf of the protected cropping sector.

PCA has structured its membership to enable individuals, growers and allied trade organisations to access membership in a way that serves their needs and budgets. PCA understands that larger organisations can contribute more to support our work – while offering lower Individual fees to enable smaller operators to be involved, learn and benefit.

There are four key categories of Membership:

### Individual Membership – \$275 + GST

are personal memberships offered for small and medium growers and allied trade organisations. They provide a range of benefits for an individual.

### Corporate Memberships – \$1000 + GST

are structured to maximise benefits for the medium to larger grower and allied trade organisations. They include five Individual Memberships within the corporate 'bundle' and offer increased discounts and opportunities for participation and hosting of tours, webinars and conferences.

### Student Memberships – \$50 + GST

are personal memberships for students studying protected cropping at recognised tertiary institutions. Students are encouraged to engage in PCA activities to build networks and access learning opportunities.

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enable individuals to access information relating to the protected cropping sector.

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Protected Cropping Australia



# WSU teaching team wins horticulture award

The teaching team at Western Sydney University, led by Prof. Zhonghua Chen, has won an Award of Merit for their contribution to training and education. The award acknowledged new courses offered specifically for the protected cropping industry.

Due to COVID restrictions the presentation of the award was delayed until April 2021 when an event was held at the Ivy Penthouse in Sydney.

Western Sydney University is leading the field in providing a smooth transition from high school and vocation education into higher tertiary education to support the industry's need to fill middle and upper management positions with locally trained talent.

Keeping in the theme of education, the awards also celebrated the efforts of Student of the Year 2020, Lauren Danecek (Certificate III Horticulture) of Ryde College TAFE NSW. The Kim Morris Student Award of Merit 2020 was presented to Brook Toovey (Certificate III Horticulture) of the Canberra Institute of Technology.

The lifetime achievements of Dr Peter Valder were also celebrated. Dr Valder received an award for his service to horticulture, science, media and the community. Dr Valder turned 94 this year. This award was accepted on Dr Valder's behalf by fellow horticulturist and media personality Judy Horton, who left the audience moved by her recounts of his dedication, humour, kindness and exceptional intellect.

An impressive career is also being forged by the Horticulturist of the Year 2020, Clarence Slockee. Through his love for the horticultural industry, its people and the overarching passion to protect country and share knowledge, Clarence has promoted horticulture within the broader community through his work with the Botanical Gardens Trust in Sydney and his television segments on *Gardening Australia* on ABC TV. There was not a dry eye in the awards room as Clarence humbly accepted his award, thanking all those who had mentored him during his career and reminded the audience of the important work still to be done supporting indigenous youth and culture through horticulture and conservation.



The horticulture teaching team from Western Sydney University's Hawkesbury Campus accept an Award of Merit presented by the AIH. Shown left to right: Michael Casey (AIH President), Prof. Zhonghua Chen (WSU), Dr Michelle Mak (WSU), David Randall (WSU), Matt Mitchley (AIH Secretary).

## Flavorite merger

Glasshouse grower, the Flavorite Group, announced its merger with the family-owned business Murphy Fresh in March.

In announcing the merger, Flavorite said it will make Flavorite the largest owner-operator of glasshouses in Australia.

Plans are also underway to construct an additional 16.5 hectares of glasshouses in Victoria, including 4.5ha at the Flavorite Warragul site, which will be completed by September this year, and a further 12ha of construction at the newly acquired Tatura site. The new structures will supply glasshouse-grown tomatoes, cucumbers and capsicums to consumers and create a number of new jobs in regional Victoria.

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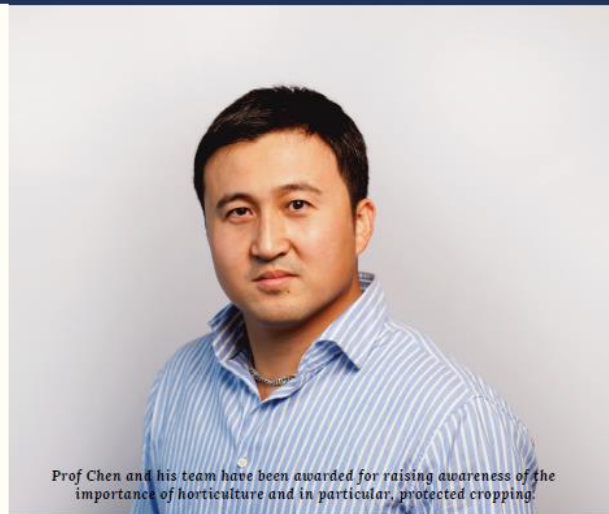
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**"The NVPCC glasshouse delivers high-quality research outcomes that improve Australia's ability to produce food crops in advanced protected cropping systems"**

Professor  
Chen



*Prof Chen and his team have been awarded for raising awareness of the importance of horticulture and in particular, protected cropping.*

## Protected cropping team gets recognition

The team at Western Sydney University (WSU) that presents Australia's leading protected cropping course, has received recognition from the Australian Institute of Horticulture. Each year AIH celebrates excellence in horticulture recognising diverse projects, experiences and people and acknowledging their achievements.

This year Prof Zhonghua Chen and the team from WSU received an Award of Merit for raising awareness of the importance of horticulture in today's world. The award was given in recognition of food donations made to the charity Foodbank NSW and ACT from the National Protected Cropping Centre's Glasshouse at the University's Hawkesbury campus.

In the past three years, more than 58 tonnes of fresh produce has been produced and donated to the charity. The fresh produce is grown in the glasshouse as part of trials into glasshouse horticulture optimisation, has proven to be a source of fresh, clean and highly nutritious produce. Once it has been analysed, weighed and cleaned, the produce is in an ideal condition for donating to Foodbank NSW and ACT.

"The NVPCC glasshouse delivers high-quality research outcomes that improve Australia's ability to produce food crops in advanced protected cropping systems," said Professor Chen.

He said current research in the glasshouse at WSU includes trials of smart glass films that could save on glasshouse cooling costs, indoor pollination of crops using native stingless bees, and variety trials of eggplants, cucumbers and melons that could improve regional food production options.





education

## Why students study protected cropping



Protected cropping students and teachers at WSU.

### Michelle Mak provides an insight into the students studying protected cropping and asks who are those signing up and how are they doing it?

In full disclosure, I am one of those academic lecturers at Western Sydney University developing the courses that are designed to help this industry, your industry and mine, educate the future leaders and innovators as we move into, what I believe, is a bright future.

On the other hand, I am also a single parent, who left a secure, well-paid job, where I had 20 plus years of experience to enrol in university as a mature-aged student and pursue the education that I did not have the opportunity or support to pursue in my youth. My reason? I wanted to see Australian farmers, like my grandfather, uncles and cousins, get some real answers to their challenges, and I felt that science and technology should be uncovering these solutions and passing them along to the people who needed them.

Now that I am on that other side (after 10 long years of study), I strive to build units of study that give our growers and allied trades people the knowledge and applicability they desire. So, with the newly developed units being offered in 2020-21 and our first, trail-blazing student cohorts devouring the content, I was keen to know how these



Michelle Mak is one of the teachers shaping the future of protected cropping students. She lectures at Western Sydney University and is a member of the PCA Board.

men and women are finding their study experience and who those first graduates are we will congratulate?

In order to bring you real data and insights, not just my opinion, I asked our students to give me their honest, unfiltered feedback with no marks or reward in return. I should not have been surprised that many, wanting the best for our industry, had no problem giving a transparent insight into their experience in order to help others decide on the value of self-education.

I wanted to know what inspired these people to take on study, often as mature people with families to support, jobs to maintain and sometimes business to run. Their answers included comments such as: wanting to find out more information before making large capital investments; being inspired to learn more about technology; wanting to learn how to grow on marginalised land; and wanting to personally achieve the highest qualifications currently offered in this area.

### Study workload

As I got to know these students it became obvious that our first cohort was made up of both highly motivated and very busy individuals, so I asked them: "How many units are you taking at once while working full-time and how do you find the workload?" The answers ranged from three units to one unit per semester, which is equivalent to 30 hours per week to 10 hours per week on top of their work commitments. Most of the students agreed that two was ideal.

*"I picked two units each term and for me it is perfect for a full-time worker to manage between life, work and study. Would suggest to go for one unit if the workload is so intense and do not go for three."*

Student comment







Students are able to get hands on during face-to-face sessions including learning how to do sap analysis.

### Aiming high

Since enrolment in these courses, the Graduate Certificate in Protected Cropping (six months full time equivalent) and the Graduate Diploma in Protected Cropping (12 months FTE), is based on either strong industry experience or having achieved a bachelor's degree or equivalent previously, I wondered: "What was the main aim for the study they undertook?"

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Some of the reasons included: "gaining technical knowledge", wanting to know the "current status of the industry and the direction it is heading to", wanting to solidify their existing practical experience with "a scientific understanding of the function and mechanisms which drives processes", and to "investigate the feasibility of a small, low to medium tech, protected cropping farm".

One student and I held the exact same motivation and he summed it up beautifully.

*"I was already aware of food insecurity, which made me passionate about protected cropping and the solutions it can bring in the future. The industry will only meet the future challenges if trained specialists can support these efforts and drive innovations."*

Student comment

### Employer support is critical

Knowing that these students were motivated to learn even while juggling a lot in life, I was curious to know: "How influential had their employers been in helping them decide to study?"

Those people running their own business aside, the majority of the students engaging so far had rated their employers as being highly supportive and encouraging. Some employers were helping to finance the study knowing that the added confidence and knowledge would benefit their business many times over. Others had committed to allowing paid study leave and covering flights and accommodation to attend the on-campus workshops for the practical skills and networking opportunities.

*"Very Influential. I first toured the National Vegetable Protected Cropping Centre at WSU through a PCA event my employer sent me to. My current job in allied trade is benefiting greatly from my studies and they are very happy to support my personal efforts to better know and service this industry."*

Student comment

Only one student, from an entirely different industry, was completely independent and making the bold leap on his own. This showed me that, if our industry wants to secure an intelligent and committed workforce, we need to be as committed and dynamic as the individuals studying by supporting their efforts.

### Flexibility is key

All were unanimous in their agreement that "the course is very flexible in terms of study attendance, entirely online with Zoom tutorials". Our students studying a Masters of Science full-time and seeking a major in Greenhouse Horticulture, are also finding the material challenging but loving this new flexible delivery not seen in the usual higher tertiary degree. Our working students all reported similar gratitude in the structure of the units and the materials delivery.



One of WSU's state-of-the-art smart glass glasshouses.



*"The online structure has made it much easier to balance work and life commitments around the studies. Not requiring regular attendance on campus has reduced time required for commuting. The weekly online tutorials are often scheduled to allow most students to be able to attend after work hours, and the one hour duration has meant it can be easily slotted into the weekly calendar."*

*Student comment*

*"Online lecture and tutorial has fit well, just the workshop is a bit hard because of the location."*

*Student comment*

*"If this course wasn't offered as a composite study there is no way I would have been able to take on this study; the structure was really a perfect fit for balancing my work and study and home life. Having all your lecturers accessible via emails, phone calls and zoom sessions along with the online materials and online communication with my fellow students has been excellent."*

*Student comment*

*"Yes, considering the content, I don't see how it could be any more convenient. I really have to give WSU credit for the platform."*

*Student comment*

## **New avenues and fresh opportunities**

Today's students are savvy investors. They look not only for quality teaching and applicable skills, they also look for networking opportunities and new avenues to pursue. In a nutshell, they invest in themselves and their education like any other investor, looking for maximum return on investment and demanding more than a qualification alone. So I asked these investors: "Has the study material opened new avenues for your career or personal goals?"

The answers were telling and thankfully we (teachers) seem to have delivered.

*"Absolutely yes! The course has involved many leading and KOL [Key Opinion Leaders] people in the industry. I can see my value and how I could contribute to my business throughout the discussion with them. I even got a job offer not just from my sponsor but also a start-up business during this course."*

*Student comment*

We also heard from students that having access to the most up-to-date knowledge was a great benefit, which saved them immeasurable time. They felt that the materials broadened their knowledge and deepened their understanding, opening their eyes to what is really happening on a world scale. They also commented that the materials were thought provoking.



*Students working with a light refractometer on site at Hawkesbury Campus.*

*"It has exposed me to some of the realities and opportunities in the sector, I need to decide what to do about that."*

*Student comment*

With this revelation in mind I wanted to ask: "What would you say has been the most surprising aspect of your studies?"

For those students who hadn't studied for a while, the answers seem to be themed around the new way we deliver information and assess understanding through practical exercises and assessments. They also loved the networking opportunities and were definitely surprised by "the diversity of not only students and instructors but of invited speakers as well as has brought us a really good view of this industry".

## **Feedback on the protected cropping industry**

Additional feedback about the industry itself was both positive and negative. One student says: "I had the realisation that the industry community is in fact not very large, however there is a strong sense of support amongst most people in helping to make the industry grow".

And, from another: "It shouldn't have been surprising, but the dominance of the big players in the sector, and therefore pressure on smaller producers, was surprising."

This last comment especially leads me to believe with even more conviction that these courses are essential in developing a highly educated, innovative, and solutions driven, local talent pool. As the science of cropping and pest and disease control becomes more detailed, it needs to be communicated effectively so it can be applied by growers.

As technology becomes more advanced, and data more complex, the systems we will use to feed our growing population, manage our labour force and fulfil export potentials will need higher levels of understanding to realise the greatest gains. As we expect more from our growers and their expertise, we as an industry must be willing to give the appropriate support and time for their skills to develop. This will take training and passion, which I have no doubt is there in spades, and it will also take collaboration and open sharing of information within this small industry.

I wish every one of our growers and allied trades people the very best for a prosperous and sustainable future. You all have my upmost admiration and respect.

Dr Michelle Mak is Associate Lecturer in Protected Cropping at Western Sydney University based at the Hawkesbury Campus, Richmond, New South Wales. She can be contacted via email at [m.mak@westernsydney.edu.au](mailto:m.mak@westernsydney.edu.au)







## Offering further education opportunities to veg industry members

In July this year, a new 12-month Masterclass will commence with a focus on protected cropping. The course will include a combination of flexible online learning modules and intensive on-site workshops. Specialised units under the themes of science, technology, business and industry-focused research will be delivered to allow students to select those units best matched to their employers' requirements and participants' career objectives. *Vegetables Australia* reports.

Protected cropping is expected to drive the next wave of profitability (domestic and export) for the Australian horticultural sector. Many growers are already planning for significant expansion in protected cropping, which will require hundreds of new staff to meet projected demand.

Recognising this, Western Sydney University has joined forces with Hort Innovation and five industry partners to deliver the Masterclass in Protected Cropping, a one-year course that will offer a range of graded qualifications, culminating in a Graduate Diploma (Protected Cropping).

The course will include a combination of flexible online learning modules and intensive on-site workshops, and students and current employees of the protected cropping industry will have opportunities to enrol. Holding a tertiary qualification is not compulsory to apply for this course, and the first intake of students is planned for July this year.

*Emerging Leaders in Protected Cropping* (LP18000) is a strategic partnership under the Hort Frontiers Leadership Fund.

### Developing skills

Western Sydney University Professor Zhong-Hua Chen is leading the project, and stressed its importance in filling an education gap in a rapidly growing industry.

"The protected cropping industry in Australia has been growing quite rapidly, at an average of around 4-5 per cent per year, and we do not have any single

horticulture course – let alone a graduate diploma-specific to protected cropping," Professor Chen said.

"As the industry's growing, it requires more skilled people, but it cannot get them. There are lots of other courses in agriculture, but they are more focused on cattle, field crops or broadacre production. Most of those students have limited knowledge and skills in horticulture because horticultural crops are very different to the crops they study."

Professor Chen explained that this is creating a problem for horticultural growers, especially major vegetable operations.

"Agriculture graduates from many universities have very little practical skills in protected cropping and it's difficult for the protected cropping companies to re-train those students to get sufficient skills to move into middle management or even in the office of major vegetable growing businesses," he said.

"One of the drivers for this project is to get their existing staff trained and to attract young people to the protected cropping industry."

The Masterclass in Protected Cropping will also be helpful for those already in the horticultural industry, particularly those junior growers who are looking to upskill and learn more about this sector.

### Course structure

The Masterclass in Protected Cropping was designed by Western Sydney University with input from protected

cropping peak bodies, Protected Cropping Australia and the Hydroponic Farmers' Federation, and academics from Wageningen University Research in the Netherlands. It incorporates low-, medium- and high-tech cropping.

There will be six online units and two industry-focused research project units delivered during the Masterclass, including:

- Plant-climate interactions in controlled environments.
- Greenhouse crop production.
- Greenhouse control systems.
- Advanced greenhouse technology.
- Business operations and logistics.
- Strategic business management.
- Industry project.
- Extended industry project.

"The good thing about this graduate diploma is that we will run four workshops to replace the practical classes, which are usually associated with theoretical learning in the university system," Professor Chen said.

"These four workshops will focus on software and hardware systems; crop and produce management; integrated pest management; and fertigation systems. These will be offered during the off-peak times for the protected cropping industry.

"Effectively, the students will only need to come to the university for a total of two weeks to complete all four workshops. They can still work part-time and do most of the learning online, so this gives them a lot of flexibility."

It is expected that the Masterclass in





Education and training staff members and postgraduate students at the Hort Innovation and Western Sydney University's National Vegetable Protected Cropping Centre.



Protected Cropping will be merged into Western Sydney University's Master of Science (Greenhouse Horticulture), which will add an extra year of study for those students looking to take that extra step.

#### The bottom line

Professor Chen is optimistic that the inaugural Masterclass of Protected Cropping will be a success.

"I think this is a course that the horticultural industry – especially the protected cropping industry – wants to have, and Hort Innovation is supportive of it. For the broader vegetable industry, it has a very important value, especially when we look at the changing climate," he said.

"We have such a dry climate here. We're expecting that some growers may want to get into protected cropping, and this will

provide them with the opportunity to see the benefits of protected cropping. They may want to change or convert a quarter of their farm production into protected cropping (as a result), ensuring resilience of vegetable growing businesses into the future."

#### There is one final message from Professor Chen to the vegetable industry: Get involved.

"We want more participation in the future, especially from vegetable growers. If you are a vegetable grower, please provide a scholarship or an internship to any employees or identified students to participate in this course. They have the potential to become an emerging leader for the Australian vegetable industry, and it is likely to benefit your business."

#### Find out more R&D

Please contact Professor Zhonghua Chen at [z.chen@westernsydney.edu.au](mailto:z.chen@westernsydney.edu.au) or on 02 4570 1934 or 0466 544 696.

*Emerging leaders in protected cropping* is funded by the Hort Frontiers Leadership Fund, part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from Western Sydney University, Flavorite, Costa Group Holdings, Perfection Fresh, Australian Fresh Leaf Herbs, ICI Industries and contributions from the Australian Government.  
Project Number: LP18000



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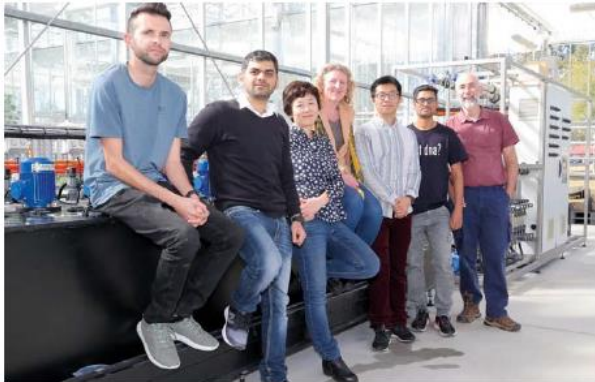
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inspire locally.*





## Keeping you up to date



Staff of the newly established Protective Cropping Unit at Western Sydney University. From left to right: Goran Lopaticki, Dr Sachin Chavan, Dr Lihua Li, Michelle Mak, Dr Chenchen Zhao, Mohammad Babla and David Randall. (Absent: Assoc. Prof. Zhonghua Chen and Dr Wei Liang)

### Protective cropping unit gets going at WSU

A new protected cropping unit is being offered by Western Sydney University. On the academic team are David Randall, Senior Education Officer, who designs online teaching materials; Dr Lihua Li, who has been researching the technologies and putting together the lecture materials and who is the students first contact person during their studies. Also involved are Goran Lopaticki, Senior Technical Officer of Operations, who works in the National Vegetable Protected Cropping Centre on campus and is responsible for all the technology and sensor controls the greenhouse uses; Dr Wei Liang, Senior Technical Officer of Crop Management, who is in charge of the NVPC's crops, both those for teaching and training and also those grown for research; Dr Sachin Chavan, the research scientist working on the SmartGlass project who will speak to students about the research behind new technologies during their on-campus workshop; and Associate Professor Zhonghua Chen, who is leading the Tertiary Pathway project.

"At this stage we have a very small cohort, which ensures individual students are mentored through their studies no matter their academic background," says Michelle Mak from WSU. "The units are open to all, whether you have studied agriculture at high school, TAFE/Tocal College or equivalent, or your sole education to date is from industry experience."

"The units run for one semester each, which is approximately 13 weeks, and are delivered primarily online to keep staff within the industry while they study. The only on-campus commitment is to attend a two-day workshop to gain first-hand practical experience within the NVPC, to use the climate control software and to network with the student cohort."

The first unit, which is underway, looks at Protected Cropping Climate Control and Technology with a focus on how growers can understand and manipulate the growing environment to produce higher yields and extend the growing season. The next course available is a Protected Cropping Plant Nutrition unit that will run from November 25.

To find out more, see WSU online handbook ([handbook.westernsydney.edu.au](http://handbook.westernsydney.edu.au))



The Outstanding Achievement award went to Marcus Brandsema.

### Award winners presented at PCA conference

PCA Chair, Nicky Mann, presented awards to growers and industry members at the 2019 PCA Conference Dinner at the recent PCA conference on the Gold Coast.

The recipients were:

**Chair's Award:** Job Roskam, formerly Managing Director, Brinkman Australia

**Service Award:** Saskia Blanch

**Young Achiever of the Year:** Lian Price, LaManna Premier

**Grower of the Year:** Ian Lines, Holla Fresh

**Industry Development Award:** Karen Brock, Brocklands Nursery

**Outstanding Achievement Award:** Marcus Brandsema, J&A Brandsema



Grower of the Year was presented to Ian Lines, Holla Fresh.



Karen Brock runs a tissue culture facility Brocklands Nursery and is president of Greenlife Industry Australia, the new national body representing the nursery industry. Karen was presented with the Industry Development award.



## Workshop for Emerging Leaders a success!



Photo Acknowledgement: Prof Zhonghua Chen

At the end of April, students in the Graduate Diploma in Protected Cropping and MSc programs participated in on-site workshops at Western Sydney University – Hawkesbury campus. These workshops were part of the Emerging leaders in Protected Cropping program.

The workshops were related to units on Greenhouse Control Systems and Greenhouse Crop Production. The workshops are part of a blended learning program consisting of online lectures, tutorials and essential readings. In the workshops, participants were informed on aspects of greenhouse control and crop production by Western Sydney University academic and technical staff.

We were privileged to have very informative sessions from industry experts, including Graeme Smith (Graeme Smith Consulting), Dion Potter (Syngenta), Marcus van Heijst (Priva) and Bao Duy Nguyen (Sun City Produce). Engagement with the industry is an important aspect which contextualises the more theoretical learning which is necessary for students to have a deep understanding of plant processes and interactions.

Practical sessions for the workshops were held in the National Vegetable Protected Cropping Centre at WSU-Hawkesbury. Participants in the Greenhouse Control Systems unit worked with the NVPC technical staff to learn about the Priva system installed at the facility. For the greenhouse Crop production unit, participants investigated aspects of crop growth related to plant nutrition and root / shoot temperatures. They were able to work with some high tech plant monitoring equipment which is used to measure aspects of crop health and plant photosynthesis, and also were introduced to the high tech world of plant genetic modification.

The workshop is the second for this program, the previous one being held last December. We are looking forward to the first cohort of students graduating from this program and moving on to make a positive contribution to the protected cropping industry in Australia.

For more information on this program; Contact Dave Randall: [david.randall@westernsydney.edu.au](mailto:david.randall@westernsydney.edu.au) Please [click here](#) to visit our website.

## Produce protection for Queensland apple and pear growers

The Queensland Government has released details of the Horticulture Netting Program for apple and pear growers in the state.

Eligible growers will receive 50 per cent of the cost of purchasing and installing protective netting, up to a maximum of \$150,000.

The scheme will begin from 24 May 2021 and will operate until 30 June 2023 or until funds are fully exhausted. Applications will be assessed strictly in order of receipt from 24 May 2021.

### Fast Facts:

- The agreement with Queensland is a part of the 'Horticultural Netting Program - trial' included in the 2019 MYEFO.
- Eligible growers will receive 50 per cent of the cost of purchasing and installing protective netting, up to a maximum of \$150,000.
- Queensland produced 10 per cent of Australia's apples and 12 per cent of overall horticultural exports in 2019-2020.

For more information visit [daf.qld.gov.au](http://daf.qld.gov.au) or phone 13 25 23.

## PCA 2021 Webinar Series



Hopefully you were able to attend our recent webinar presented by Haifa with speaker Peter Anderson on some of the specifics of Hydroponic Nutrition and what to consider with product selection.

We have a number of webinar topics coming up also with speakers presenting on:

- Substrate and Irrigation Management
- Pollination under high tunnels
- Bee Health
- Lighting

And Agronomic Waste and Bio-stimulants.

Our subscribers get access to two webinars for free and our financial members have unrestricted access.

I look forward to seeing you at the webinars!

## Soilless Australia - Hard Copy Opt-Out



Wanting to be more eco-friendly?

Then opt-in for an e-copy of Soilless Australia!

Log into your dashboard and change your preference or send us an email at

[protectedcropping@asnevents.net.au](mailto:protectedcropping@asnevents.net.au)



# Teaching crop a success at Western Sydney University

Grown in Western Sydney University's high-tech greenhouse, the crop used for teaching students in the undergraduate and postgraduate courses is yielding a bountiful harvest.

The crop of snacking capsicums is being grown in the National Vegetable Protected Cropping Centre's 450 m<sup>2</sup> teaching bay. Three new varieties of snacking capsicum were provided by Syngenta and they have proved to be sweet, high-yielding, and of consistently high quality.

Students in the undergraduate course Greenhouse Technology for Food Sustainability planted the crop and monitored its growth and yield as they studied aspects of greenhouse crop production. Produce from the crop provided the materials for their study of post-harvest produce quality. The crop was also utilized for the on-site workshops for the postgraduate Diploma in Protected Cropping's unit Greenhouse Crop Production.





The Postgraduate Diploma and associated Postgraduate Certificate programs have been developed to skill the next generation of leaders in the Australian horticultural sector and have been supported by Australian industry experts and grower organizations.

The research programs in the National Vegetable Protected Cropping Centre include pollination studies utilizing species of native Australian bees, and these were used in this teaching crop as part of that ongoing research.

In addition to providing practical experience to undergraduate and postgraduate students, the highly nutritious produce from the crop is donated to Foodbank. This charitable organization provides food relief to vulnerable Australians by supplying food to charities.

For more information:



**Western Sydney University**  
David Randall  
Senior Horticultural Education Officer

02 45701143

[david.randall@westernsydney.edu.au](mailto:david.randall@westernsydney.edu.au)

[www.westernsydney.edu.au](http://www.westernsydney.edu.au) (<http://www.westernsydney.edu.au>)

Publication date: Wed 16 Jun 2021

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## Advertising within industry periodicals

The industry publications targeted for this domestic advertising campaign are;

- Soiless (Protected Cropping Australia)
- HFF Newsletter (Hydroponic Farmers Federation)
- Vegetables Australia (AusVeg)
- Berry Journal
- Flowers Magazine
- Australian Tree Crop Magazine

These periodicals cover all areas of protected horticulture where our course is relevant, with a slight bias to the production horticulture sector.

The students who are participating are;

**Andrew McIlwain** – General manager Operations from Green Camel, PCA young grower of the year 2022 and Young Organic Leader award winner at the 2022 Australian Organic Industry Awards

**Mamta Khadka** – Assistant grower from Green Camel with responsibilities for Integrated Pest Management

**Elliott Akintola** Agronomist and category manager of plant health and protection from Garden City Plastics

These are the advertising material for 2023-2024

WESTERN SYDNEY UNIVERSITY  
SCHOOL OF SCIENCE

“Studying at WSU allowed me to understand, interpret and apply the theoretical knowledge of crop cultivation into everyday practical applications in my glasshouse”

Andrew McIlwain  
General Manager  
Operations Green Camel

To find out more about our protected cropping courses, give us a call on 1300 897 669, visit our webpage or contact Prof Zhonghua Chen on 0466 544 696  
z.chen@westernsydney.edu.au  
CRICOS provider code 00917X

WESTERN SYDNEY UNIVERSITY  
SCHOOL OF SCIENCE

“From this course I gained a deep understanding of how crops are produced in controlled environments which I now apply in my job.”

Mamta Khadka  
Assistant Grower  
Green Camel

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z.chen@westernsydney.edu.au  
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WESTERN SYDNEY UNIVERSITY  
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“The new skills I gained, the added qualification, & expertise were a perfect springboard in propelling my promotion at work and helping me deliver next level solutions to key clients in the industry”

Elliott Akintola  
Agronomist and Category Manager  
Plant Health and Protection  
Garden City Plastics

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z.chen@westernsydney.edu.au  
CRICOS provider code 00917X



Examples of paid advertising within industry periodicals

Soilless Australia (Volume 16 Spring 2023)

HFF Newsletter (Volume 7, Issue 3, October 2023)

In this issue:-	
The Secretary	pg 2
Presidents report	pg 3
Memberships report	pg 3
Royal Brinkman	pg 4
Fernland	pg 5
Bushfire Season Warning	pg 6
HFF Conference 2024	pg 7
HFF Grower Day	pg 8
HFF Overseas	pg 9
Solar Glass for Greenhouses	pg 10
PCA Conference Update	pg 11
Ecomix	pg 12
The Mongolian Story	pg 13
Eclipse Enterprises	pg 14
Western Sydney University	pg 14
Powerplants	pg 15
Agnova Technologies	pg 15
Committee membership invite	pg 15
Vale Brian Hanger	pg 16
Vale Frank Donato	pg 16
Harvesting by vacuuming	pg 18
A and D Australasia	pg 19
AIS Greenworks	pg 20



Vegetables Australia (Autumn 2023)

**vegetables** australia  
AUTUMN 2023

now including onions

TAYLA FIELD - VEGETABLES TO FOODBANK | FAIR WORK ACT CHANGES FOR HORTICULTURE  
THE BIG PICTURE ON TASSIE ONIONS | HERBICIDE RESISTANCE IN ONIONS  
FAIR WORK ACT CHANGES FOR HORTICULTURE  
MEET THE 2022 HORT CONNECTIONS CORTEVA AGRISCIENCE YOUNG GROWER OF THE YEAR

ADVOCACY UPDATE

**Small Claims**  
Under the FW Act, an employee can make an application in the small claims jurisdiction within the Fair Work Division of the Federal Circuit and Family Court of Australia, or a Magistrates Court, and seek orders for compensation relating to entitlements that an employer was required to pay to, or on behalf of, an employee.  
Currently, an employee can make an application for compensation in the small claims court if the claim is \$20,000 or less and the order for compensation of unpaid/underpaid entitlements relates to:

- a term of a NES;
- a term of a Modern Award;
- a term of an enterprise agreement;
- a workplace determination;
- a national minimum wage order;
- an equal remuneration order; or
- a safety net contractual entitlement (which could include a contractual entitlement that relates to the NES or any term that is permitted by a modern award, for example minimum wages, overtime, penalty rates, allowances etc).

Employees are also permitted to make an application in the small claims jurisdiction to settle some disputes that relate to the conversion of casual employment to full-time or part-time employment.  
The small claims jurisdiction is not bound by the ordinary rules of evidence and may inform itself in any manner it thinks fit, without regard to legal forms or technicalities and therefore the process is generally informal compared to most court proceedings. Further, lawyers do not have an automatic right of appearance and are not permitted to appear on behalf of parties unless permission is granted from the court.  
From 1 July 2023, the Amendment Act increases the maximum monetary threshold on amounts that can be awarded in small claims proceedings from \$20,000 to \$100,000 (exclusive of interest). The types of claims that can be brought by an employee (limited to those listed) not changed.  
The court in a small claims proceeding will also be empowered to award to a successful claimant any fees they paid to the court, as costs from the other party (which is not currently available).  
**When do these changes come into effect?**  
These provisions commence on 1 July 2023

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General Manager  
Operations Green Camel

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Berry Journal (Winter 2023, Edition 15)

AUSTRALIAN BERRY JOURNAL  
WINTER 2023 EDITION 15

FARMER WELLBEING CRISIS 16  
HILLWOOD HEADS NORTH 61  
NEW BREEDING PROGRAM 68  
SOIL HEALTH TIPS 101

References  
Kempster, M.N., Anonafelger, D.C., Zanon, A., Dyer, A.D. & Davis, A. Spatial Modelling and Heat Behavioural Analysis Using Computer Vision for Precision Livestock. Int J Comput Welf, 3(1)-066 (2023). <https://doi.org/10.1007/s10263-022-0275-4>

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Monika Niaz-Rahmatpour does not work for, consult, own shares in or receive funding from any company or organization that would benefit from this article, and has disclosed no relevant affiliations beyond their academic appointment.

MONASH University

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Elliott Akintola  
Agronomist and Category Manager Plant Health and Protection Garden City Plastics



Flowers Magazine (Issue 98: Feb/Mar 2024)

ISSUE 98: FEB/MAR 2024

# Flowers Magazine

The essential guide for the Australian flower and foliage industry

ISSN 1448-417X

Blooming Challenges  
Down Under  
Floral design trend  
predictions for 2024

JARDIN MAJORELLE  
A Moorish  
Garden Escape

PLUS Making the most of Trading Opportunities

Stay connected, inspired and informed. Subscribe today [www.flowersmagazine.com.au](http://www.flowersmagazine.com.au)

**MELBOURNE INTERNATIONAL FLOWER AND GARDEN SHOW**

PRESENTED BY Osmocote

The coveted Melbourne International Flower and Garden Show, is set to transform the world heritage-listed Carlton Gardens and Royal Exhibition Building from Wednesday 20th March until Sunday 24th March 2024.

With dozens of breathtaking horticultural designs to ignite visitors' senses, the enchanting works of the country's best garden and floral experts won't be an event to miss. The Great Hall of Flowers will be blooming bigger and better than ever with new floral displays and competitions, reflecting the flourishing world around us and the trends that come within it. The eye-see-inspiring Landscape Design Show Gardens will also be unveiling nine incredible gardens.

**EVENT HIGHLIGHTS:**

- Landscape Design Show Gardens - Acclaimed landscape designers will harness their creative prowess to unveil a series of breathtaking designs.
- Boutique Gardens - A selection of leading creatives will reflect the dynamic and diverse nature of contemporary outdoor spaces.
- Achievable Gardens - budding horticulturalists will showcase their skills with inspiring yet achievable designs for cosy spaces.
- Balcony Gardens - by emerging and established designers.
- Bonsai Gardens - fresh perspectives on small space design by some of Australia's finest gardening minds.
- Bloomer! Wharfedale - the exhibition sees thriving plants breathe new life into retired vehicles in an ingenious transformation.
- Hanging Basket Competition - an open call for horticultural lovers to craft and exhibit stunning hanging basket arrangements.
- NGV - returning to help entertain and educate little ones with a series of immersive experiences to fuel their horticultural aspirations.
- Art & Sculpture Project - blending the beauty of nature with the creativity of artistic expression.
- Gardens by Twilight - experience the Show under a whole new light as Carlton Gardens transforms into a twinkling paradise.

Inside the Royal Exhibition Building, showgoers will be delighted by a kaleidoscope of colour, stunning perfumes, endless floral varieties, and award-winning displays in the Great Hall of Flowers.

- Blooms Unleashed - brand new floral displays with aerial installations.
- Brush & Bubble - Create floral-inspired artworks whilst sipping bubbly.
- Wedding Inspiration - John Emmanuel showcases the world-class floral installations ready to fill the Big Day with beauty and delight.
- Floral Fashion by RMT - students showcase intricate petal pattern designs - a marriage of fashion and flora.
- High Tea - a sophisticated affair to lounge and savour the blooms.
- Cocktails & Tapes - in a Show first, the lounge will extend its menu for Gardens by Twilight on Friday with Cocktails & Tapes.

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Flowers Magazine - Feb/Mar 2024 | [www.flowersmagazine.com.au](http://www.flowersmagazine.com.au) | 15

Australian Tree Crop Magazine (Apr/May 2024 Issue)

A U S T R A L I A N  
**TREE CROP**

THE MAGAZINE FOR THE TREE CROP INDUSTRY [WWW.TREECROP.COM.AU](http://WWW.TREECROP.COM.AU)

APRIL/MAY 2024

**NEWS**

- Connect and thrive at Hort Connections
- Farmers wanted for online survey
- CV orchard aggregation for sale

**FEATURED CROPS**

- Avocados
- Citrus

**KNOW YOUR PEST**

**TREE CROP INSIGHTS**

**FEATURES**

- Spraying equipment and application
- Marketing and export

**PRODUCTS & SERVICES**

**SPRAYING EQUIPMENT & APPLICATION**

previously only placed on large agricultural machines, are now available in HVC equipment.

SmartApply can help growers achieve as much as 95 per cent less chemical runoff and up to an 87 per cent reduction in airborne drift, while reducing chemical and water use by an average 50 per cent.

Additionally, our joint venture with GLESS is delivering spray units that bring together a sophisticated combination of GPS and light detection and ranging (LiDAR), vehicle sensors and software to navigate through rows autonomously.

From an overarching perspective, integration of tech and in-field monitoring with John Deere Operations Center means growers can access another level of insights and data analysis to support better documentation, traceability and data-informed management decisions.

This is an exciting and rewarding era, and we want to work side-by-side with growers to produce some of the best fruit, vegetables and wine in the world through uptake of technology we know can make an impactful contribution to industry and our farming communities.

You deserve to have the world's best tech powering your machine. We are listening and we are committed to high value crops.

WESTERN SYDNEY UNIVERSITY  
SCHOOL OF SCIENCE

**"From this course I gained a deep understanding of how crops are produced in controlled environments which I now apply in my job."**

Hanna Khadka  
Assistant Grower  
Green Camel

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APRIL / MAY 2024 AUSTRALIAN TREE CROP 29



## Protected Cropping Marketing Overview

<b>Objective</b>	Drive awareness of the Graduate Diploma of Protected Cropping, in the industry, in order to drive students to apply and ultimately enrol for the course.
<b>Targets</b>	60 new enrolments from 2023 to 2025 in addition to the current numbers
<b>Audience</b>	Non-Current School Leaver students in the protected cropping industry and domestic and international students with Bachelors qualifications
<b>Budget</b>	\$15,000 PA from WSU

Here is an overview of 23 key methods for Market Plan of Protected Cropping course in 2023, 2024 and beyond the duration of the Project Emerging Leaders in Protected Cropping (LP18000)

- Promote the course through the current and future industry partners
- Promote the course through the extensive network of Hort Innovation
- Protected Cropping Australia Soiless Magazine advertisement
- HFF newsletter Protected Cropping advertisement
- Search Engine Optimisation (SEO)
- WSU website course pages
- UAC guide to future students
- Unique selling points used by Student Support Hub team
- Lead capture via course enquiry
- Postgraduate Information Sessions
- Explore Western Events
- Western Open Day Events
- Sponsorship of the Protected Cropping Australia conferences in 2023 and 2025
- Participation via booth and speakers at PCA conferences in 2023 and 2025
- Email contact via Graeme Smith to his industry contacts (over 700 emails sent to Australian contacts in the protected cropping industry)
- Emails to over 50 identified allied industries.
- Emails to deans of every (16) Agriculture course in Australia asking them to publicise to alumni or interested students.
- Follow up emails to prospective students who has expressed interest through enrolments or via the website.
- Phone contact with anyone who has progressed with any further interest.
- Publish articles about the course and news about WSU and its protected cropping students and research in industry publications Soiless, growing undercover, Vegetables Australia, e-update and Hortidaily.
- Advertise on industry journals and weekly emails of berry industry and nursery industry
- Utilize current videos and create new videos to promote the protected cropping courses
- Advertise the course at the CRC Future Food Systems website.

*August 2022 - Office of Student Experience and Marketing - Strategy & Planning*

# 2023 and 2024 Marketing Campaign Timeline



BAU ACTIVITY		Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Building Brand Awareness	<ul style="list-style-type: none"> <li>- On Campus Digital Screens</li> <li>- Parra South EB Banner</li> <li>- Media/PR Opportunities</li> </ul>	WSU Cares More Out of Home Ads											
		The College T1 Campaign			The College T2 Campaign				The College T3 Campaign			The College T1 Campaign	
Creating a Brand Response	<ul style="list-style-type: none"> <li>- Website</li> <li>- Homepage Banners</li> <li>- On Campus Digital Screens</li> <li>- SEM</li> <li>- SEO</li> <li>- Engagement Marketing Events and Comms</li> <li>- Partnership Opportunities</li> <li>- SSH Outbound./Inbound</li> <li>- Organic Social</li> </ul>												
UG Product Marketing	<ul style="list-style-type: none"> <li>- SEM</li> <li>- SEO</li> <li>- Course pages</li> <li>- Course Guide</li> <li>- UAC Guide</li> <li>- USPs shared with SSH &amp; EM Teams</li> </ul>												

WSU Cares More Out of Home Ads

The College T1 Campaign

The College T2 Campaign

The College T3 Campaign

The College T1 Campaign

MYID Campaign

Open Day Campaign

MYID Microsite and Sessions\*

OD Microsite and Sessions\*

# Campaign Overview for 2023 and 2024



Campaign	Audience	Key Events	Campaign Dates	Objective	Channels
Postgraduate Recruitment Autumn 2023 and 2024 Campaign	<p><b>Primary Audience:</b> Horticulture and agriculture employee, graduates with a Diploma with work experience, and graduates with a Bachelor degree in agriculture, horticulture, science, engineering, technology, and agribusiness</p> <p><b>Secondary Audience:</b> Influencers (Parents, Teachers and Career Advisors)</p>	Open Day - August	July - Nov	<p><b>Brand Response:</b></p> <ul style="list-style-type: none"> <li>Drive awareness of WSU offering as a whole amongst relevant audience/s and drive them towards the website to a relevant landing page (Discovery).</li> <li>Focus on the primary audiences and win the intention (Engage) by generating enquiries and leads through the website, event registrations and SSH calls.</li> <li>Drive applications</li> </ul>	<p><b>Paid</b> ARN, Precise TV, Student Edge, ATAR Notes, Facebook/Instagram, Snapchat, TikTok, Display Retargeting, Google Search, YouTube, Solus eDM.</p> <p><b>Owned/Earned:</b> Future Student Website (microsite and banners), Communications (staff, students and leads), Digital Signage, Yammer, SSH Outbound Campaigns, Leveraging Media/PR opportunities, Leveraging Partnership opportunities (Solus eDMs, digital signage, print ads and socials), Leveraging Engagement Marketing opportunities (Comms and Newsletters to High Schools and Influencers)</p>
				<p><b>Postgraduate Product Marketing:</b></p> <ul style="list-style-type: none"> <li>Facilitate Open Day event where each AOS (incl SGSM) is represented via content on a microsite landing page, presentation material and Q&amp;A sessions.</li> </ul>	<p><b>Owned/Earned:</b> Future Student Website (microsite), AOS specific OD sessions, Course Guides. UAC Guides.</p>
Postgraduate Recruitment Autumn 2023 and 2024 Campaign	<p><b>Primary Audience:</b> Horticulture and agriculture employee, graduates with a Diploma with work experience, and graduates with a Bachelor degree in agriculture, horticulture, science, engineering, technology, and agribusiness</p> <p><b>Secondary Audience:</b> Influencers (Parents, Teachers and Career Advisors)</p>	Mid-Year Information Day - May	April - June	<p><b>Brand Response:</b></p> <ul style="list-style-type: none"> <li>Drive awareness of WSU offering as a whole amongst relevant audience/s and drive them towards the website to a relevant landing page (Discovery).</li> <li>Focus on the primary audiences and win the intention (Engage) by generating enquiries and leads through the website, event registrations and SSH calls.</li> <li>Drive applications</li> </ul>	<p><b>Paid:</b> Fandom, YouTube, TikTok, Snapchat, Facebook/Instagram, Google Search, Adobe Display Retargeting.</p> <p><b>Owned/Earned:</b> Future Student Website (microsite and banners), Communications (staff, student, and leads), Digital Signage, Yammer, SSH Outbound Campaigns, Leveraging Media/PR opportunities, Leveraging Partnership opportunities (Solus eDMs, digital signage, print ads and socials), Leveraging Engagement Marketing opportunities (Comms and Newsletters to TAFEs and Influencers)</p>
				<p><b>Postgraduate Product Marketing:</b></p> <ul style="list-style-type: none"> <li>Facilitate Mid Year Information Day event where each AOS (incl SGSM) is represented via content on a microsite landing page, presentation material and Q&amp;A sessions.</li> </ul>	<p><b>Owned/Earned:</b> Future Student Website (microsite), AOS specific MYID sessions, , Course Guides. UAC Guides.</p>





### Marketing Plan for Emerging Leaders in Protected Cropping (LP18000)

Marketing Methods	Main Organisations for Implementation	Supporting Organisations
<ul style="list-style-type: none"> <li>• WSU website course pages</li> </ul>	Office of Student Experience and Marketing, School of Science, National Vegetable Protected Cropping Centre, Western Sydney University	N/A
<ul style="list-style-type: none"> <li>• UAC guide to future students</li> </ul>	Western Sydney University, Office of Student Experience and Marketing	N/A
<ul style="list-style-type: none"> <li>• Search Engine Optimisation (SEO)</li> </ul>	Western Sydney University, Office of Student Experience and Marketing	N/A
<ul style="list-style-type: none"> <li>• Unique selling points used by Student Support Hub team</li> </ul>	Western Sydney University, Office of Student Experience and Marketing	N/A
<ul style="list-style-type: none"> <li>• Lead capture via course enquiry</li> </ul>	Western Sydney University, Office of Student Experience and Marketing	Western Sydney University, School of Science
<ul style="list-style-type: none"> <li>• Postgraduate Information Sessions</li> </ul>	Western Sydney University, Office of Student Experience and Marketing, WSU International Office	Western Sydney University, School of Science



• Explore Western Events	Western Sydney University, Office of Student Experience and Marketing	N/A
• Western Open Day Events	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	Western Sydney University, Office of Student Experience and Marketing
• Promote the course through the current and future industry partners	Flavorite, Perfection Fresh, Costa Group, Fresh Leaf, Priva Oceania, Greenworks, Syngenta Australia, Lynch Group Australia, Green Camel, Southern Cross Produce Brisbane, OptiFarm	Western Sydney University, School of Science provides the course information
• Promote the course through the extensive network of Hort Innovation	Hort Innovation	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre
• Protected Cropping Australia Soilless Magazine advertisement	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	Protected Cropping Australia
• HFF newsletter Protected Cropping advertisement	Western Sydney University, School of Science	Hydroponic Farmers Federation



• Sponsorship of the Protected Cropping Australia conferences in 2023 and 2025	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	Protected Cropping Australia, Hort Innovation
• Participation via booth and speakers at PCA conferences in 2023 and 2025	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	Protected Cropping Australia
• Email contact via Graeme Smith to his industry contacts (over 700 emails sent to Australian contacts in the protected cropping industry)	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A
• Emails to over 50 identified allied industries	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A
• Emails to deans of every (16) Agriculture course in Australia asking them to publicise to alumni or interested students	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A
• Follow up emails to prospective students who has expressed interest through enrolments or via the website	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A
• Phone contact with anyone who has progressed with any further interest.	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A
• Publish articles about the course and news about WSU and its protected cropping students and research in industry publications Soilless, growing undercover, Vegetables Australia, e-update and Hortidaily	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A
• Advertise on industry journals and weekly emails of berry industry and nursery industry	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre	N/A





<ul style="list-style-type: none"><li>• Utilize current videos and create new videos to promote the protected cropping courses</li></ul>	Western Sydney University, Office of Student Experience and Marketing, WSU International Office	Western Sydney University, School of Science, National Vegetable Protected Cropping Centre
<ul style="list-style-type: none"><li>• Advertise the course at the CRC Future Food Systems website</li></ul>	Western Sydney University, Office of Student Experience and Marketing, WSU International Office	CRC Future Food Systems

**Appendix 14. Project Monitoring and Evaluation (M&E) Plan**



# Monitoring and Evaluation Plan:

## Emerging Leaders in Protected Cropping (LP 18000)

**Western Sydney University**

M&E Plan. LP 18000 Emerging Leaders in Protected Cropping

## 1 Program logic

### Higher level outcomes for the project.

To address the key gap in the protected cropping industry through training and equipping next generation leaders with broad academic, business and scientific skills who could guide the development of the industry into the future.

Recently Nicky Mann the chair of Protected Cropping Australia and manager of Family Fresh Farms commented;

“Labor, I think, is an issue around the globe, but in Australia, this seems to be one of the most important challenges all growers face,” says Nicky. “To start with, getting a reliable workforce is a challenge, as is getting skilled employees. Especially managers and growers that have the technical ability and knowledge of agronomy, and are able to manage labor, budgets, and the business overall, are hard to find”

Therefore, to get the best people, companies are offering attractive salaries which can then put these skilled people out of reach for small and medium-size horticultural businesses.

<https://www.hortidaily.com/article/9366235/labor-seems-to-be-one-of-the-most-important-challenges-all-growers-face/>

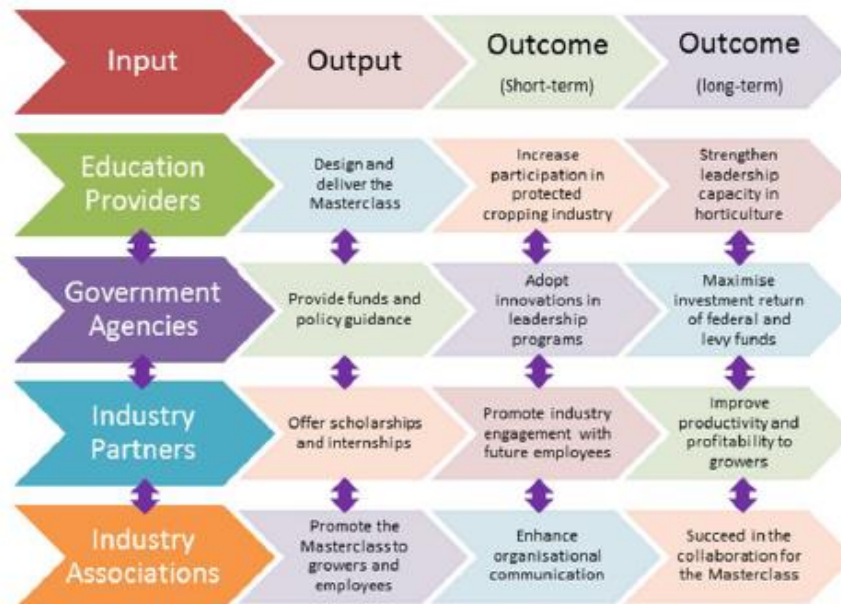
The peak grower body ‘Protected Cropping Australia’ have identified this need in their submission to the Standing Committee on Agriculture and Water Resources inquiry into growing Australian agriculture.

*Already, demand for highly skilled technicians is outstripping supply and there is little structured training for new entrants into the protected cropping industry. This means there is a strong reliance on overseas workers – but these too are in short supply.*

~~<https://protectedcropping.net.au/wp-content/uploads/PGA-Submission-Growing-Australian-Agriculture-to-2030-Oct-2019.pdf>~~ <https://protectedcropping.net.au/wp-content/uploads/Protected-Cropping-2030-140120.pdf>



M&E Plan. LP 18000 Emerging Leaders in Protected Cropping



Program logic shows input, output, outcome and benefits from the Protected Cropping courses to levy payers and industry through the co-investment from education providers, government agencies, industry partners and industry associations.

**End of Project outcomes**

An ongoing program to equip and train graduates in this stream, who will possess high-level skills in protected cropping and can lead the Australian protected cropping industry into the future.

A stable and established education program will operate at Western Sydney University, which will be self-sustaining through student enrolments and industry support by scholarships and internships.

**Intermediate Outcomes**

The development of relevant units for upskilling professionals, are made available for enrolment

The enrolment of 110 students in the Masterclass in Protected Cropping and the award of Graduate Diploma accreditation to at least 88 participants, with a pipeline of future students to ensure the Masterclass in Protected Cropping is self-sustaining beyond the funding envelope.

Two established training locations for the intensive on-site workshops in two states, with a roadmap to achieve national coverage in subsequent years in partnership with industry expansion.

A new career path developed with industry partners to retain the graduates with highly valuable skills in horticulture through internships and placements.

M&E Plan. LP 18000 Emerging Leaders in Protected Cropping

An annual nationwide recruitment strategy, including a long-term partnership with the Protected Cropping Australia (PCA) and Hydroponic Farmers Federation (HFF); and

Industry partnerships expanded beyond the major growers and suppliers to include participants from across the protected cropping sector.

An increased utilization of the National Vegetable Protected Cropping Centre at WSU for education and training.

**Activities**

Design, develop implement and deliver a Graduate Diploma (AQF8) course with elements encompassing Science, Technology, Business, and Industry focused research.

Courses designed with flexible modes of delivery to allow concurrent work and study for students in the industry.

Alternative pathways and credentials including Transcript of study, Graduate Certificate, Graduate Diploma, and Master of Science major. Advanced Standing for Master of Research (MRes) or MBA

Development of scholarship and internship agreements with industry partners.

Formation of a Project Reference Group (PRG) comprising WSU project team members, Horticulture industry representatives and a Hort Innovation representative.

Advertising of the course using a range of modes to increase industry awareness and student interest

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## 2 Project M&E scope

### 2.1 Audience

Table 1: M&amp;E audience and their information needs

Audience	Information need
<b>Primary</b>	
Project team	All data and information developed for M&E
Hort Innovation	Milestone Reports
<b>Secondary</b>	
<i>Project Reference group</i>	Review the progress, risks and award scholarships and internships
<i>Industry partners</i>	Provide scholarships and internships to students in the courses



## 2.2 Key evaluation questions

Table 2: Project key evaluation questions

Key evaluation questions	Relevant?	Project-specific questions
<b>Effectiveness</b>		
1. To what extent has the project achieved its expected outcomes?		What is the number of students who have been admitted to the course? How many students have enrolled in units? How many students have completed the various credentials offered within the course? How many locations have been used for on-site workshops? What is the take up by students and industry of internships? To what extent has the recruitment strategy been successful? To what extent has there been development of additional industry partnerships.
<b>Relevance</b>		
2. How relevant was the project to the needs of intended beneficiaries?		How relevant was the course as perceived by; (a) Participating students (b) Industry partners (c) Protected cropping industry employers
<b>Process appropriateness</b>		
3. How well have intended beneficiaries been engaged in the project?		What engagement has there been with the industry about this project? Did every company engage in the project via the Project Reference Group? Student feedback, through formal and informal course feedback mechanisms. What opportunities were afforded to students to demonstrate leadership in the industry?

M&amp;E Plan. LP 18000 Emerging Leaders in Protected Cropping

Key evaluation questions	Relevant?	Project-specific questions
<b>Efficiency</b>		
4. What efforts did the project make to improve efficiency?		<p><i>How are the funds used efficiently for personnel and teaching?</i></p> <p><i>Guest lecturers</i></p> <p><i>Course promotions on site and online</i></p> <p><i>In-kind contributions</i></p> <p><i>University funded lecturers</i></p>

### 2.3 M&E budget

For assistance, refer to Section 1: Project M&E Guide – part 2.3.

- List the financial and human resources available for implementation of the M&E plan, i.e. for monitoring data collection, analysis, synthesis and reporting, as well as any additional data collection (and analysis, synthesis) that might be required at the point of evaluation. It is expected that delivery partners in most instances will be collecting monitoring data through normal project activities and record keeping.

Most of the record keeping and data will be collected by the normal record keeping associated with the enrolment and delivery of courses by the university. The collation and reporting of this data will be the responsibility of the project leader (Professor Z. Chen) or his delegate. M&E budget will cover the cost for the Senior Horticulture Education Officer to coordinate the course development, course review, and Project Reference Group (PRG) meetings.

External evaluation is essential to guarantee the quality of the course for the Australian Protected Cropping Industry to cover the travel and consultancy of the experts at \$20,000 p.a. for 2019 and 2023. The review of the course materials will be conducted after one cycle of delivery of the units, and a review based on student feedback, employer satisfaction will occur as part of the final evaluation.

M&amp;E Plan. LP 18000 Emerging Leaders in Protected Cropping

### 3 Performance expectations, data collection and analysis

For assistance, refer to Section 1: Project M&E Guide – parts 3 and 4.

➤ Describe any performance expectations against the activities, outputs and outcomes of your project in Table 3, as well as the data collection details (method, source, timing and responsibility). This should provide the bulk (if not all) of the monitoring information you need to understand and demonstrate project effectiveness.

Note: Not all activities, outputs and outcomes need to be monitored - be selective. Refer to what the primary audience wants to know.

Table 3: Project monitoring plan

Logic level	What to monitor	Performance expectation (KPIs) and/or monitoring questions	Data collection – method (e.g. survey) and source (e.g. growers)	Timing of, and responsibility for, data collection
Foundational activities	Formation of Project reference group			August 2019 (Z. Chen)
	Development of Course Proposal for Graduate Diploma in Protected cropping, Graduate Certificate in Protected Cropping and Master of Science (Greenhouse Horticulture)			July-November 2019 (Z. Chen, A. Broderick, M. Williams)
	Approval of course proposals for Western Sydney University course units			December 2019 (Z. Chen)
Activities and outputs	Development and delivery of units of study and on-site workshops	Units delivered to students 2 per teaching semester with associated workshops		January-December 2020 (Unit coordinators M. Mak, Z. Chen, O. Ghannoum, R. Sharwood, H. Lau, J. Bye, J. Bose)
	Agreements for internships and scholarships with industry partners	Number of agreements signed with industry partners		End of 2021 Ongoing Z. Chen
	Course Promotion		Records of advertising and	For each milestone



M&E Plan. LP 18000 Emerging Leaders in Protected Cropping

			course awareness information through industry publications and industry contacts.	report (D Randall, L. Graham)
	<i>Locations of on-site workshops</i>			Hawkesbury Campus, S40 Greenhouse (Z. Chen)
<b>Intermediate outcomes</b>	<i>Participant numbers</i>	<i>Number of admissions, subject enrolments and completions</i>	Numbers from enrolments department, and extracted from subject enrolment information	After census date of each semester (Unit coordinators, M. Mak, Z. Chen, O. Ghannoum, R. Sharwood, H. Lau, J. Bye, J. Bose)
	<i>Industry partner and student engagement</i>	<i>Number of students engaging in internships</i>	WSU to monitor	
	<i>Course Review by industry experts from Australia and overseas and educational expert from WSU</i>	<i>Experts will review course structures and online materials for their quality and relevance</i>	<i>Feedback forms from reviewers</i>	After one cycle of delivery of units (October 2021) (D Randall to collate and recommend changes to units)
	<i>End of course review</i>	<i>Data from students and industry partners on the relevance and applicability of the course materials</i>		At conclusion of project
	<i>Student feedback</i>		<i>Data from university subject feedback (where numbers are large enough) and informal feedback sought from students by course coordinators</i>	After the completion of each unit (Course coordinators, M. Mak, Z. Chen, O. Ghannoum, R. Sharwood, H. Lau, J. Bye, J. Bose)

M&E Plan. LP 18000 Emerging Leaders in Protected Cropping

<b>End-of-project outcomes</b>	<i>Number of students participating in course</i>  <i>Number of awards of grad diploma</i>	<b>What is the number of students who have been admitted to the course?</b>  <b>How many students who have enrolled in subjects?</b>  <b>How many students have completed the various credentials offered within the course?</b>		<i>Annually and at end of project for Final Report (Z. Chen, D. Randall, M. Mak)</i>
	<i>Feedback from industry partners</i>	<b>Seek feedback from industry partners at PRG meetings</b>	<i>PRG meeting minutes</i>	<i>Twice per year at PRG meetings  D. Randall &amp; Z. Chen</i>
	<i>Scholarships and internships</i>	<b>Number of students receiving industry scholarships and participating in internships</b>	<i>Data from WSU scholarship office</i>	<i>Updated at each scholarship cycle  Z Chen</i>
	<i>Development of Industry partnerships</i>	<b>To what extent has there been development of additional industry partnerships.</b>		<i>During the course of the project (Z. Chen, M. Mak, R. Sharwood, J. Bose)</i>

Table 4. Project Risk Management

<b>Risk</b>	<b>Risk Management Strategy</b>	<b>Likelihood (1-5)</b>	<b>Consequences (1-5)</b>	<b>Rating (1-5, Negligible, Low, Medium, High, Extreme)</b>
<i>COVID-19 related campus shutdown and state and country-wide lockdown impact on teaching, workshop,</i>	<b>WSU to work with Hort Innovation to negotiate extension of the project without additional funding</b>	5	5	<b>Extreme</b>

## M&amp;E Plan. LP 18000 Emerging Leaders in Protected Cropping

<i>and course promotion</i>				
<i>Failure to obtain approval for course development</i>	Project staff members are well trained to prepare the course approval paperwork	2	2	Low
<i>Failure of course delivery</i>	Project staff members are very experienced in preparing high quality course content for both online and on-site delivery of the course.  WSU makes significant investment in new staff recruitment in Horticulture to ensure the success of the course.	1	1	Negligible
<i>Insufficient student enrolment</i>	Project staff members to engage with Hort Innovation, the protected cropping industry, universities, TAFE for course promotion. Project staff members to work with International Office at WSU to promote the courses	4	4	High
<i>Insufficient student graduate</i>	Project staff members to work with Hort Innovation, the protected cropping industry, universities, TAFE for course promotion	4	4	High
<i>Insufficient industry engagement</i>	WSU is making a significant investment to develop a Horticulture Futures strategy, of which the protected cropping courses will be one of the pillars to amplify the engagement and impact of research, teaching and training with industry partners  Project staff members to work with Hort Innovation and staff members at National Vegetable protected Cropping Centre (NVPCC) to efficiently engage with the industry partners	3	4	Medium to High
<i>Project</i>	Project staff members to work with	2	2	Low



M&amp;E Plan. LP 18000 Emerging Leaders in Protected Cropping

<i>Management leads to reporting challenges</i>	<i>Hort Innovation and staff members at NVPCC</i>			
<i>Environment or economic impact within partner organisations</i>	<i>The level at which participating enterprises are prepared to abide by cooperation agreements when these become unfavorable due to changes in market conditions. Ensure institutional processes for example, realistic and clear goals, transparency in equity and inclusiveness, facilitate participation &amp; consensus building at critical stages of development, develop a responsive system to deal with issues as they arise.</i>	3	4	Medium to High

## 4 Evaluation

*Note: A well-designed monitoring plan usually provides the information you need to demonstrate project effectiveness. Any data collected at the point of evaluation usually complements the monitoring data to either answer the effectiveness KEQ more fully and/or answer other evaluation questions identified in Table 2.*

Table 5: Additional evaluation data requirements

KEQ	Data collection requirement	Source and method
1. To what extent has the project achieved its expected outcomes?	<i>Numbers of students</i> <i>Number of scholarships/internships awarded</i> <i>Number of active industry partners</i>	<i>From WSU enrolment data</i> <i>From WSU scholarship office</i> <i>From WSU Office of Advancement</i>
2. How relevant was the project to the needs of intended beneficiaries?	<i>Feedback from;</i> <i>Students</i> <i>Industry experts</i> <i>Industry partners</i>	<i>Formal Student Feedback to Unit (SFU), Student Feedback to Teaching (SFT) and informal feedback</i> <i>Course review input from industry and university experts</i> <i>From representatives on PRG</i>
3. How well have intended beneficiaries been engaged in the project?	<i>Industry engagement</i> <i>Student engagement and leadership</i>	<i>Engagement on PRG</i> <i>Student publications and presentations</i>

M&E Plan. LP 18000 Emerging Leaders in Protected Cropping

<p>4. What efforts did the project make to improve efficiency?</p>	<p><i>Utilization of industry in learning</i></p>	<p><i>Guest lectures and practical classes by industry experts</i></p> <p><i>Unit coordinators to improve the content and delivery based on SFU, SFT and course review comments of industry experts</i></p>
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Table 6: Independent evaluation studies (as required by Hort Innovation)

Type of evaluation	When (start and finish)
<i>Mid-term evaluation</i>	<i>Course review by Australian and international experts End of 2021</i>
<i>Final evaluation</i>	<i>Final course review by Australian and international experts End of 2023 to determine the transition from a co-funded course to a WSU course without Hort Innovation funding.</i>

M&amp;E Plan. LP 18000 Emerging Leaders in Protected Cropping

## 5 Reporting and continuous improvement

For assistance, refer to Section 1: Project M&E Guide – part 6.

➤ List the report(s) will you prepare, to whom and when.

Note: Apart from usual project reporting, consider any reporting or communications to secondary audiences.

Table 6: Project progress reporting

Report type	To whom	Timing
<i>e.g. Milestone Reports</i>	<i>Hort Innovation</i>	<i>Six-monthly</i>
<i>e.g. Final Reports</i>	<i>Hort Innovation</i>	<i>At end of project</i>
<i>e.g. Articles</i>	<i>Industry magazine</i>	<i>Annually</i>
<i>e.g. Written and verbal update</i>	<i>Project Reference Group</i>	<i>Six-monthly</i>
<i>e.g. Financial reports</i>	<i>Project Partners</i>	<i>Annually</i>
<i>Scholarship office</i>	<i>Scholarship balance</i>	<i>semester</i>
<i>Admissions office</i>	<i>WSU team</i>	<i>semester</i>

➤ What learning and improvement process(es) will your project use?

Table 7: Project continuous improvement activities

Continuous improvement process	Details	Timing
<i>e.g. Reflection meeting with Hort Innovation R&amp;D Manager</i>	<i>Meeting between R&amp;D Manager/Marketing Manager and Delivery Partner to discuss progress to-date and what's working well/not, and agree any follow up actions</i>	<i>Six-monthly</i>
<i>e.g. Project Reference Group meetings</i>	<i>Meetings between project team members, Hort Innovation and industry representatives to gain feedback on project activities and refine methodology</i>	<i>Six-monthly</i>
<i>Team meetings</i>	<i>Feedback, course development</i>	<i>Weekly</i>
<i>Employers</i>	<i>Feedback on graduate quality and course improvement required for future employees</i> <i>Improvement in employee skills etc by meeting the graduates and employers to discuss the course</i>	<i>At the end of the project</i>